# "A SOCIAL MARKETING INTERVENTION MODEL TO INFLUENCE THE SOCIAL ACCEPTANCE OF NATURAL DYES, FROM DOMESTIC FOOD WASTE RESOURCES IN MEXICO WITHOUT METALLIC CHEMICAL ADDITIVES FOR TEXTILE DYEING"

Stephanie De la Cruz Mercado

A thesis submitted to the University of Huddersfield in partial fulfilment to the requirements for the degree of Doctor of Philosophy

University of Huddersfield

September 2021

## Dedication

To my dear grandmother Antonia, grandfather Cristóbal and uncle Martín, who are always in my heart. I am sure you are smiling down from heaven, for another dream I have achieved.

To Salvador and Mary, my wonderful parents and my amazing siblings Kevin and Jacqueline, for being with me in the darkest and brightest moments of my life, giving me always the right words, support and love no matter what.

## Acknowledgements

Firstly and foremost I would like to express my gratitude to God, the Virgin Mary and all the saints for blessing me all the time.

I would like to express my gratitude to my supervisors: Prof. Parik Goswami, Dr. Bruce Carnie and Dr. Andrew Hebden. I look forward to continue working with you.

Prof. Parik Goswami thanks for challenging me and for inspiring me to do a PhD. You always had the right advice, thank you for believing in me!

Dr. Bruce Carnie, thank you for believing in me, for the constant encouraging words and for being a source of motivation when most needed.

Dr. Andrew Hebden, thank you for being my friend and source of support and constant motivation, but most importantly thank you for always been there! I will never forget the times you made me laugh during the stressful times.

Lastly, but no least, I would like to thank the participants that took part in the online survey, my Mexican country and Conacyt because without your financial support this personal dream would not have been possible.

## Abstract

This research proposes a social marketing intervention model to educate and thus influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. The foundations of this research are the water and food waste situation in Mexico. This study includes experimental work with *Allium Cepa* (onion) skin as an example of a Mexican food waste resource to analyse its performance as a natural dyestuff without metallic chemical additives on cotton and re-frames the design problem, challenging what has previously been considered to be suitable by the market with regards to natural dyed textiles such as colour strength and colour fastness. The study investigates the social acceptance towards natural dyed textiles with limited colour strength and colour fastness, embracing the limitations of the process as an opportunity to personalise the end garment and take ownership of the creative process, rather than using metallic chemical additives that could affect Mexico´s waterways adversely.

The survey utilised to collect data, shows that for Mexican females from 18 to 33 years old the environmental impacts of metallic chemicals are more important, than the colour strength and colour fastness of a garment. This validates the hypothesis of the study, which is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes. The novelty of this study is a social marketing intervention model in the transition design domain in which co-design was identified as the channel by which the target audience could translate their acceptance of natural dyes from domestic food waste resources without metallic chemical additives into action by becoming co-designers of their own natural dyed garments. While, DIY re-dye activity, and customisation were identified as the promotion (strategic tools) in the model that could influence the attraction of the target audience.

Key words: Social marketing, Mexico, natural dyes, domestic food waste, transition design, co-design, DIY, re-dye, customisation.

## Table of contents

## List of figures

**List of tables**

## List of abbreviations

AASM – Australian Association of Social Marketing

BCW – Behaviour Change Wheel

BOD – Biological Oxygen Demand

°C – Celsius

CAGR – Compound Annual Growth Rate

CEC – Commission for Environmental Cooperation

DIY – Do It Yourself

DW – Deionised Water

ENIGH – Encuesta Nacional De Ingresos Y Gastos De Los Hogares - National Household Income and Expenditure Survey

ESMA – European Social Marketing Association

EU – European Union

FAO – Food and Agriculture Organisation

GDP – Gross domestic product

GHGs – Greenhouse Gas Emissions

GOTS – Global Organic Textiles Standard

HCI – Human Computer Interaction

IDC – International Data Corporation

IMSS – Instituto Mexicano del Seguro Social - The Mexican Social Security Institute

INEGI – Instituto Nacional de Estadística, Geografía e Informática - National Institute of Statistics, Geography and Computing of Mexico

iSMA – International Social Marketing Association

Kg – Kilogram

LDCs – Least Developed Countries

NaCl – Sodium chloride

$Na_2SO_4$ –Sodium sulphate

NIH – National Institutes of Health

Nm – Nanometre

PPM – Parts Per Million

R&D – Research and Development

SAGARPA – Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (México) - Secretary of Agriculture, Livestock, Rural Development, Fishing and Food

SDC – Society of Dyers and Colourists

SMEs – Small and Medium-sized businesses

TU – Toxicity units

UK – United Kingdom

USA – United States of America

UV – Ultraviolet

UV/Vis – Ultraviolet-Visible Spectroscopy

WHO – World Health Organization

## Structure of the thesis

Chapter one contains a brief introduction, the research context, main aim, objectives, scope of the study and a research synopsis. In this chapter the context of the research is explored in order to guide the reader through the investigation process in which the hypothesis of the study is established. In addition, the scope of the study section clarifies how the validation of the strategic tools identified for the development of the novel model were modified due to the COVID-19 pandemic.

Chapter two presents discussions of each of the identified themes involved in this study within the overarching theme of textile colourants and natural dyes and provides an overall conclusion.

Chapter three presents the research methodologies and identifies the appropriate methodological composite to be used and applied in this study. The selection of a mixed research method was utilised in order to obtain a deeper understanding of the research problem, which is the social acceptance of domestic food waste as a natural resource for textile dyeing without metallic chemical additives.

Chapter four provides the experimental work undertaken using *Allium Cepa* skin, as an example of a Mexican food waste resource for natural dyes in wearable textiles. Natural dye extractions and analysis were conducted to compare the findings with existing *Allium cepa* extraction studies. Dyeing, experimental tests and analysis were conducted using the natural dye extract on cotton. The experimental tests comprise: colour measurement, colourfastness to washing, light and dry cleaning. The content of this chapter accomplishes the first of the research objectives, which is to perform experimental work with *Allium cepa* skin as an example of a Mexican food waste resource to analyse its performance as a natural dyestuff without metallic chemical additives on cotton carrying an evaluation of the dyed fabrics, using standard textile tests to simulate conditions to which the fabrics would be subjected while in an environment of standard use.

Chapter five provides a discussion around the following design themes: Transition design, co-design, wabi sabi aesthetic, and emotional attachment approaches. The content of this chapter addresses the second of the research objectives, which is the exploration of design routes that could facilitate the target audience's acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

Chapter six focuses on the data collection and the analysis of the review of the acceptance of natural dyes from domestic food waste resources without metallic chemical additives in which co-design, customisation and emotional approaches are explored. In addition, the analysis of the collected data demonstrates a validation of the hypothesis of the study.

Chapter seven provides a discussion around the social marketing field, analysing the definitions proposed by different practitioners. Furthermore, it has been identified that the use of the marketing mix 4P´s (product, price, place and promotion) is fundamental in a social marketing intervention in order to use them as mental constructs in the development of a social marketing intervention model. The content of this chapter addresses the last of the research objectives, which is to create a social marketing intervention model to influence the acceptance of Mexican females from 18 to 33 years old towards natural dyes from domestic food waste resources without metallic chemical additives. In addition, this chapter exemplifies how the model strategies could be validated through a DIY domestic natural dyeing workshop.

Chapter eight focuses on the presentation of further work and identifies the contribution to knowledge this research project makes. This chapter identifies how the study aims and objectives were reached, identifies the contribution to knowledge and includes a reflection of the study limitations and future research projects that could be undertaken based on the results of this study.

# Chapter 1. Introduction

This chapter provides the research context and inspiration that was rigorously interrogated in this PhD study, in order to lay the foundations to develop a social marketing intervention model that could educate and influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

This model when applied longer term, may change consumer behaviour to an extent that may elicit change within Mexico´s textile industry, in order to contribute towards the reduction of some of the negative impacts that the textile dyeing processes currently have on Mexico´s waterways. In addition, the social acceptance of natural dyes from domestic food waste resources aims to provide a positive impact on the farming economy in Mexico by adding socioeconomic value to Mexico's food waste. However, these two aspects are outside the parameters of this study. This section provides the research aims, the three main objectives of the study, the scope of the study and a research synopsis.

## 1.1. Research Context

The inspiration for this study is Mexico. A key problem was identified within the primary economic sector of Mexico; agriculture. According to Mexico´s Secretary of Agriculture, Livestock, Rural Development, Fishing and Food (SAGARPA) the agricultural activity is the most dynamic amongst these sectors (SAGARPA, 2017a). SAGARPA (2017a, p.13) points out that …[translated to English] "Mexico is the third largest food producer in Latin America and 12$^{th}$ in the world…". However, according to Pérez (2015) a considerable amount of food ends up in waste, becoming a pollutant in Mexico´s landfill sites. Moreover, Mexico´s superficial waterways are being affected by the textile industry's wastewater discharge (Arellano Aguilar, 2018). Therefore, based on these two main problems, this study lays the foundations to develop a social marketing intervention model in order to influence the social acceptance of natural dyes from domestic food waste resources avoiding the use of metallic chemical additives that could affect Mexico´s waterways adversely. In this study the target audience is Mexican females from 18 to 33 years old. This target audience was selected because this demographic group has more access to social media and it was via this medium that the questionnaire was delivered. Further details about the selection of the target audience of this study can be found in Chapter 6.

### 1.1.1. Water situation in Mexico

The average clean, drinkable, water supply in Mexico, has dwindled by 78% from 1950 to 2017 (Water resources group, 2018). Aquifers, an important water source are being squandered by overexploitation in Mexico; For example, Mexico City´s aquifer is overexploited by 50% of its replenishment rate, leading to millions of pesos being paid out in costs for damage caused to these waterways (Water resources group, 2018).

According to Water resources group (2018) 80% of the Mexican population lives in urbanised areas. As urbanisation increases the demand on water supplies will intensify, affecting the rest of the Mexican population who lives in peri-urban and rural areas; since only 20% of Mexico´s wastewater is treated (Water resources group, 2018). This suggests that Mexico needs to act in order to reduce water pollution and consequently avoid, in the near future, a major issue: scarcity of drinking water.

In Mexico, industrial discharges must comply with the official Mexican standard NOM-001-SEMARNAT-1996, which establishes the permitted limits of contaminants in wastewater discharges (Secretaría de Medio Ambiente y Recursos Naturales, Comisión Nacional del Agua, 2013). Heavy metals and cyanides including arsenic, cadmium, cyanide, copper, chromium, mercury, nickel, lead and zinc are all limited (Secretaría de Medio Ambiente y Recursos Naturales, Comisión Nacional del Agua, 2013). The industrial discharge of wastewater to rivers and natural and artificial reservoirs must comply with the permissible limit of heavy metals and cyanides concentration following the Official Mexican Standard NOM-001-SEMARNAT-1996. (See Table 1). [Translated to English]" "The permissible range of hydrogen potential (pH) is 5 to 10 units" (Secretaría de Medio Ambiente y Recursos Naturales, Comisión Nacional del Agua, 2013, p.13).

| DAILY AVERAGE LIMITS OF CONTAMINANTS IN WASTEWATER DISCHARGES FROM PUBLIC URBAN USE | |
|---|---|
| CONTAMINANTS | RIVERS / NATURAL AND ARTIFICIAL RESERVIORS |
| ARSENIC | 0.2 mg/L |
| CADMIUM | 0.2 mg/L |
| CYANIDE | 2.0 mg/L |
| COPPER | 6.0 mg/L |
| CHROMIUM | 1.0 mg/L |
| MERCURY | 0.01 mg/L |
| NICKEL | 4.0 mg/L |
| LEAD | 0.4 mg/L |
| ZINC | 20 mg/L |

*Table 1. Mexico´s daily average limits of contaminants in wastewater discharges adapted from Secretaría de Medio Ambiente y Recursos Naturales, Comisión Nacional del Agua (2013)*

Arellano Aguilar (2018) points out that approximately 70% of Mexico´s superficial waterbodies are highly contaminated. The central zone of Mexico´s country has been identified as the area with the highest level of chemical contamination, since most of the transnational industries were placed there to strengthen the country's economy (Arellano Aguilar, 2018). However, the wastewater discharges of this industries are causing epidemiological problems to the communities that live near Atoyac, Santiago, Lerma, Tula and Coatzacoalcos rivers; heavy metals like: chromium, cadmium, lead, mercury and zinc can be found in these waterbodies (Arellano Aguilar, 2018).

According to studies by the Mexican Institute of Water Technology, elevated levels of chemical substances have been found in Mexican rivers from different industries, for example, toluene, hexane and hexachlorobenzene from the pharmaceutical, automotive and textile industry (Arellano Aguilar, 2018).

The colourants used in the textile industry are creating negative effects in the photosynthesis of aquatic plants and microorganisms, since the coloured chemical substances impart colour to the waterbodies (Arellano Aguilar, 2018). Moreover, Arellano Aguilar (2018) stresses that the official Mexican standard NOM-001-SEMARNAT-1996, which establishes the permitted limits of contaminants in wastewater discharges should be updated since it is not controlling the water contamination in Mexico (Arellano Aguilar, 2018).

### 1.1.2. Case Study of Industrial Discharges in Atoyac River

Saldaña Fabela and Gómez Balandra (2016) carried out an evaluation of 23 industrial discharge sites to identify their compliance with the NOM-001-SEMARNAT-1996 standard in Mexico´s Atoyac River, located in the state of Puebla, to identify the mixture of contaminants and their toxicity (using the luminescent bacterium Vibrio fischeri). [Translated to English] "The Atoyac River is formed from the ice thaws that descend from altitudes higher than 4000 m from the eastern flank of the Iztaccíhuatl volcano, on the borders of the states of Mexico and Puebla. In its route it receives several relevant contributions from tributaries, such as the Nexapa, Mixteco, Acatlán, Zahuapan, Alseseca and others rivers" (Saldaña Fabela and Gómez Balandra, 2016, §3).

According to the studies of Saldaña Fabela and Gómez Balandra (2016, §5) [translated to English] "Of the 23 industrial discharges, 74% had toxicity levels ranging from 2 to 1165 toxicity units (TU)". 2 TU is classified as toxic and greater than 4TU is highly toxic (Saldaña Fabela and Gómez Balandra, 2016). Of the previously mentioned 74% with toxicity levels above 2TU, 46% is attributed to textile industry wastewater discharges (Saldaña Fabela and Gómez Balandra, 2016). The 74% of industrial discharges classed as toxic contributes to the deterioration of water quality within the Atoyac River and the disruption of its aquatic system (Saldaña Fabela and Gómez Balandra, 2016). Therefore, this indicates that most of the industries located near the Atoyac River lack the ability, or propensity to efficiently remove the contaminants in their wastewater (Saldaña Fabela and Gómez Balandra, 2016).

According to Saldaña Fabela and Gómez Balandra (2016) the textile industry is the sector that exceeds the limits established by the Mexican standard norm NOM-001-SEMARNAT-1996 the most with regards to heavy metals and cyanides classed as contaminants. Moreover, Saldaña Fabela and Gómez Balandra (2016) point out that the colouration of water that this industry generates is greatly affecting the water quality in the Atoyac River, during the sample collection, red, blue and yellow colours were identified in the Atoyac River. See Figure 1. Although, colouration limits are not established in NOM-001-SEMARNAT-1996, Saldaña Fabela and Gómez Balandra (2016) stress that it is necessary to put a limit on the amount of colourants used by the textile industry in Mexico, since the water quality of the Atoyac River is having a significant negative impact on local communities due to the textile dyeing activity. This negative impact suggests that a high amount of synthetic dyes and metallic chemical additives may be used during the dyeing processes of the textile industries located near the Atoyac River. According to El- Sheekh *et al.* (2009) and Rai *et al.* (2005) azo compounds represent the main composition of synthetic dyes and their xenobiotic nature hinder biodegradation generating problems in the environment especially in water ecosystems.

*Figure 1. Wastewater discharge into the Atoyac River (Saldaña Fabela and Gómez Balandra, 2016, §4)*

According to Saldaña Fabela and Gómez Balandra (2016) some of the industries located near the Atoyac River discharge their wastewater directly to the Atoyac River without prior treatment, while other companies treat their wastewater but the treatments used are not effective enough or not suitable for the removal of the heavy metal compounds used through their production processes. This lack of effective treatment of wastewater suggests that the water pollution from the Atoyac River is mainly because of the high amount of heavy metal compounds that end in the river from the industrial wastewater discharges. This is just one example of the negative effects that the wastewater discharges from the textile industry are having in Mexico´s waterbodies. For this reason, this study highlights the importance of consumer education on the negative environmental impact that metallic chemical additives in the textile dyeing activity can have on the environment and on the the difference between natural and synthetic dyes in order to make a shift in consumer's purchase decision making process. Further details about how these topics were determined as central for the selected target audience of the study can be found in Chapter 6.

### 1.1.3. The Strength of Cotton in the Mexican Textile Apparel Sector

According to José Cohen (2018a) president of the Mexican chamber of the textile industry (Canaintex), the Textile and Apparel sector in Mexico represents 10% of the manufacturing gross domestic product (GDP), generating 1.2 million direct jobs, where women represent 80% of the of the workforce. In addition, Cohen (2018b) points out, that 50% of the cotton used for Mexico´s textile production is grown in the country. Mexican textile sector exports leads to $6500 million (USA) in trade (Cohen, 2018a).

According to Cohen (2018b), Mexico has small and medium-sized (SMEs), and large textile companies; the large companies, have presence and production plants in the United States of America (USA). Cohen (2018b) points out that USA, is the primary destination of Mexican fashion exports; however, the Mexican textile industry is working to establish market presence in other areas, such as the European Union.

Cohen (2018b) argues that Mexico has two main strengths in the textile sector; the first one is the production of their own cotton and the second is strong investment in technology. Mexico has invested $2500 million (USA) in recent years in technology (Cohen, 2018a). This investment in technology according to Cohen (2018b), has allowed Mexico to maintain its market competitiveness despite unequal conditions making it difficult for Mexico to compete in the global market. Cohen (2018b) stresses that the lack of regulations that could avoid the access of undervalued international goods into the country is jeopardising Mexico´s textile sector.

Due to the importance of cotton in Mexico´s textile apparel sector, cotton in this study is used as the substrate to allow evaluation of the performance of *Allium Cepa* skin as a natural textile dyestuff. Further details about the rationale behind the choice of cotton can be found in section 4.1.6.

## 1.2. Research Aim and Objectives

This research proposes a social marketing intervention model to educate and thus influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

This study aims to address the following hypothesis: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives, such as lack of colour strength, standardisation and durability when compared to synthetic dyes.

In order to address this hypothesis, the following objectives have been identified:

1. Perform experimental work with domestic food waste exemplified by *Allium cepa* skin an example of a Mexican food waste resource to analyse its performance as a natural dyestuff without metallic chemical additives on cotton carrying an evaluation of the dyed fabrics, using standard textile tests to simulate conditions to which the fabrics would be subjected while in an environment of standard use.

2. Explore possible design routes towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

3. Create a social marketing intervention model to influence the acceptance of Mexican females from 18 to 33 years old towards natural dyes from domestic food waste resources without metallic chemical additives.

## 1.3. Scope of the study

- The water and food waste situation in Mexico were the foundations to develop a social marketing intervention model to educate and thus influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

- In this study a mixed method was selected since the research problem involves multidisciplinary variables such as chemistry, design and social marketing. Therefore, a combination of qualitative and quantitative methodologies was needed in order to enable the interaction and triangulation of the multiple findings from each discipline. This study is both exploratory and explanatory, further details about the rationale can be found in Chapter 3, section 3.5.

- The target demographic validated, through an online questionnaire, the hypothesis of the study which is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes. Further details about this validation can be found in (Chapter 6).

- The expected outcome of the study was to validate the strategic tools identified for the development of the novel model such a: Co-design, customisation and DIY re-dye activity. These tools were theoretically explored and the intended practical validation was not possible to carry out because of the COVID-19 pandemic impacts. However, this study does include a detailed explanation in section 7.8 with regards to how these strategies could be validated. This section includes the following content: A pilot version of the DIY domestic natural dyeing workshop stages based on referenced action research of the introductory exercise proposed by Kadolph and Casselman (2004). An explanation detailing the pilot version of the workshop in two modalities: Face to face and online delivery. An explanation of how data will be collected from the pilot DIY domestic natural dyeing workshop. An explanation of how the DIY domestic natural dyeing workshop could be used in order to identify an initial behaviour change from the demographic cohort in the short-term (This includes a post-questionnaire that can be found in Appendix 4).

## 1.4. Research synopsis

The design field was key to this project, since design thinking was applied as an interactive process through which a reframing strategy was employed to explore alternatives that could contribute towards the acceptance of natural dyes' performance without metallic chemical additives. According to Razzouk and Shute (2012) design thinking is a process that enables problem restructuring, in order to find solutions through a re-exploration of ideas in which possible connections can be created between problem and solution through a creative experimentation involving different routes. The problem framing strategy allows design thinkers to re-imagine the problem scenario and subsequently develop a design strategy (Dorst, 2015). Scholarly study in reframing can be attributed to Dorst (2015) who developed a frame creation model to address complex problems through a further exploration of the context, which consequently leads to the investigation of new themes that become the starting point for problem-solving through design action strategies. Dorst (2015) points out that reframing is an example of showing that design limits are only determined by the ability of the designer to create new ways of thinking. Therefore, reframing facilitates open thinking in order to consider alternative approaches in multidisciplinary fields for problem solving (Dorst, 2015).

For this study at a point when the scientific testing had been undertaken and the results indicated that the colours achieved were both limited and had poor colour fastness an alternate pathway was required to re-position these limiting aspects and re-frame them into a positive pathway forward for this study. In order to establish what the demographic cohort response was to these identified outcomes of poor fastness properties, colour yield and colour variations, a need was identified to investigate their responses via an online survey questionnaire. The results of the questionnaire indicated that Mexican females from 18 to 33 years old were receptive to the idea of accepting natural dyes from food waste resources without metallic chemical additives. Although, the barriers towards market adoption of natural dyes without metallic chemical additives included poor fastness properties, colour yield and colour variations. Transition design, wabi sabi aesthetic (impermanence, incompleteness, imperfection), co-design and emotional product attachment were explored as design strategies that could influence the acceptance of natural dyes without metallic chemical additives. Further discussions about the design routes explored will be presented in more detail in Chapter 5.

The transition design framework guides the study in general, aiming to provide a holistic posture in which different themes are integrated in order to develop design strategies towards the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives, for Mexican females with an age range of 18-33 years.

According to Tonkinwise (2015), transition design aims for more sustainable ways of living in which design could be used as a powerful tool to tackle contemporary issues, such as pollution. Moreover Tonkinwise (2015) points out that design should be applied to foster social changes in order to contribute towards the creation of more sustainable consumer lifestyles, reframing the existent problems that the society encounters. Transition design will be discussed in more detail along with co-design in Chapter 5 and how these frameworks inform the theoretical and conceptual thinking that is central to this study.

This study in conjunction with other fields such as social marketing, chemistry and design aims to develop a social marketing intervention model to educate and thus influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. This study does not aim to highlight that the use of natural dyes automatically means that the process is more sustainable, but instead aims to provide an opportunity for discussion around Mexico´s context in which domestic food waste resources were detected as an opportunity for the production of natural dyestuffs. In comparison with other natural dyeing techniques that use metallic chemical additives, this study proposes to not use such additives during the natural dyeing process that could in turn harm Mexico´s waterways. Since pollution of waterways due to textile industry wastewater discharges was a significant problem detected in Mexico´s context.

This study proposes a social marketing intervention model to educate and thus influence a behavioural change of Mexican females from 18 to 33 years old towards the acceptance of natural dyes without metallic chemical additives within a given demographic. These natural dyes will be made from domestic food waste resources and the social marketing intervention model will aim to influence a social acceptance. According to the International Social Marketing Association (iSMA), the European Social Marketing Association (ESMA) and the Australian Association of Social Marketing (AASM) (2013, p.1) "Social Marketing seeks to develop and integrate marketing concepts with other approaches to influence behaviour that benefit individuals and communities for the greater social good. Social Marketing practice is guided by ethical principles. It seeks to integrate research, best practice, theory, audience and partnership insight, to inform the delivery of competition sensitive and segmented social change programmes that are effective, efficient, equitable and sustainable". The importance of acknowledging the dynamic nature of social marketing and the importance of incorporating different disciplinary approaches fits with the design thinking and the transition design application in this study. It is for this reason that the following steps have been taken throughout the phases of the study to work through addressing the identified challenges in a Mexican context :

1. Science. Experimental work with *Allium Cepa* (onion) skin was conducted to evaluate its performance as an example of a Mexican domestic food waste resource for natural dyes in wearable textiles. In this study, cotton and *Allium cepa* were selected to conduct the dyeing process, because of their relevance to Mexico´s economy. Further details about the rationale of selecting cotton and *Allium cepa* instead of the first crop to conduct the experimental work can be found in Chapter 4. The experimental work using *Allium Cepa* (onion) as a natural dyestuff without metallic chemical additives on cotton indicated limitations to the wearable textile applications: High colour change when washing and high colour fading when exposed to light. Therefore, this study re-frames the design problem in order to find creative solutions that could lead towards social acceptance of natural dyes from domestic food waste resources without metallic chemical additives, where colour strength and colourfastness in natural dyed textiles is desirable. This study sets out and challenges what has previously been considered to be suitable to market with regards to natural dyed textiles such as colour strength and colour fastness.

   Consequently, this study investigates whether rather than using metallic chemical additives that affect waterways adversely, instead the demographic cohort is open to accept natural dyed textiles with limited colour strength and colour fastness, embracing the limitations of the process as an opportunity to personalise the end garment and take ownership of the creative process.

2. Questionnaire. A detailed discussion regarding questionnaire development will be presented in Chapter 6. Due to the necessity to re-frame the design problem as a consequence of the findings from the chemistry experimental section (limited colour strength and colour fastness through the use of natural dyes without metallic chemical additives), the next step was to validate the hypothesis with the demographic selected through a questionnaire. The hypothesis is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes. The questionnaire was designed to get a clear idea of the following objectives:

i. Demographic: Validate if Mexican females from 18- 33 years old are interested in the environment. Further details about the selection of this demographic and their interest in the environment can be found in Chapter 6.

ii. Environment care interest- clothing and purchase: Investigate to what extent the target audience is interested in the environment, and see if their answers are coherent with their purchase decisions.

iii. Colour- natural dyes- food waste: Investigate how important is colour for the target audience. Ascertain through the questionnaire how familiar the target audience is with natural dyes. Validate if they will be willing to accept the idea of having a piece of clothing dyed with food waste.

iv. Emotions – clothing: Validate the use of emotional attachment as a design strategy towards sustainable consumption through a long- life garment with active use.

v. Co-design and experience (customise, renovate): Validate first, if the user is interested in being part of the garment colour design process, and second if co-design could influence the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

One of the purposes of the questionnaire was to identify if the target audience would be interested in becoming co-designers of their own garments and if they will be interested in re-dyeing their garments at home once the initial colour fades using available domestic food waste from their cooking.

3. Social Marketing. In this study, the research proposes a social marketing intervention model, in which co-design was identified as the place (channel) in which the target audience could translate their acceptance of natural dyes from domestic food waste resources without metallic chemical additives into action by becoming co-designers of their own natural dyed garments. DIY re-dye activity, and customisation were identified as the promotion (strategic tools) in the model that could influence the attraction of the target audience. In this study, a new social marketing intervention model has been created to educate and thus influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives overcoming the limitations identified in the BCW framework and the COM-SM model.

# Chapter 2. Research Themes

## 2.1 Textile colouration activity and its negative effects on water

The textile market is expected to reach a compound annual growth rate (CAGR) of 4.3% by 2027 (globenewswire.com, 2020). In addition, textile colouration is highly desired by consumers, due to its aesthetic purpose (Samanta and Agarwal, 2009). According to Kant (2012, p. 22) "Colo[u]r is the main attraction of any fabric". Chavan (2011) points out that consumers are mainly influenced by the market requirements of textile dyes, such as broad colour palettes, deep colour shades and an acceptable dye performance while in an environment of standard use such as fastness to light, laundering, rubbing and dry cleaning. However, consumers are often not aware of the negative environmental impacts behind their textile dyeing choices (Chavan, 2011).

Wastewater discharges from the textile industry is a concerning environmental issue due to the high amount of chemicals used during the dyeing and finishing processes (Babu *et al.*, 2007). According to World Bank (2014), the dyeing and finishing processes of the textile industry contribute globally to 20% of water pollution. In Mexico, 70% of superficial waterways are contaminated due to the chemical releases of different industries; the dyes used in the textile industry not only contribute to this water pollution but also negatively impact aquatic life (Arellano Aguilar, 2018).

Babu *et al.* (2007) points out that the wastewater generated from the dyeing processes generally contains dye molecules imparting colour to the water, high metallic salt concentrations and requires a high biological oxygen demand (BOD). According to the Glossary of Environmental Terms of the World Bank Group(1998, p.443) BOD is defined as: "A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD the greater the degree of pollution". According to Greenpeace East Asia (2010) 81% of the water and sediment samples that were analysed and previously taken from two provinces of China (Xintang and Gurao) mainly dedicated to the textile industry, show evidence of heavy metals such as cadmium, chromium, copper, lead and mercury. This Greenpeace East Asia study drew attention to the fact that the textile dyeing factories have affected the local river in Gurao, there are no more fish living in the river and water can no longer be used for drinking purposes because it is contaminated and has an unpleasant smell, due to the wastewater discharges. It is not unreasonable to deduct that this negative scenario has a strong likelihood of happening in Mexico if the current manufacturing of textiles continue discharging dyes and chemicals to the superficial waterways.

## 2.2 Textile Colourants

Colourants are the substances that give colour to diverse kinds of substrates and depending on their solubility can be classified as dyes or pigments (Rai *et al.*, 2005). "Organic dyes are soluble substances mostly applied to various substrates from solution" (Hao and Iqbal, 1997, p.203). In contrast, organic pigments are insoluble and are fixed to a substrate through dispersion techniques (Hao and Iqbal, 1997). This suggests that the main difference between dyes and pigments is their solubility and thus their method of application.

"Dyes are defined as colo[u]red substances that when applied to fibers give them a permanent colo[u]r that is resistant to action of light, water, and soap" (Rai *et al.*, 2005, p.220). These dyestuffs can be classified based on their chemical structure into the following groups : anthroquinone dyes, azo dyes, phthalocyanine dyes and triphenylmethane dyes (Rai *et al.*, 2005). Including also: acid, basic, direct, azoic, nitro, disperse, vat, reactive, solvent and sulfur dyes.

The invention of the first synthetic dye (Mauveine) in 1856 gave raise not only to the creation of more dyes following the same chemical principles but also to their application in multiple and diverse industries (Rai *et al.*, 2005). However, as previously discussed in section 1.1.2 by El- Sheekh, *et al.* (2009) and Rai *et al.* (2005) azo compounds represent the main composition of synthetic dyes and their xenobiotic nature hinder biodegradation generating problems in the environment especially in water ecosystems. A high percentage of these compounds remain in the wastewater following the textile dyeing process, affecting the natural growth of bacteria and plants (Rai *et al.*, 2005). However, according to Hernández-Zamora *et al.* (2015) the use of synthetic dyes especially the azo dyes group is highly demanded in the textile industry due to its lower price, colour fastness and colour variation when compared to natural dyes. This suggests that these characteristics are more important for the social acceptance than the environmetal threats of their use. This latter will be further explored with the target demographic cohort through an online questionnaire. Further details of this exploration can be found in Chapter 6.

## 2.3 An alternate view to non-uniform colouration in textile dyeing

According to Clark (2011) historically humans have shown a keen interest in colouration activity, using dyes mainly from vegetable sources to dye materials such as furs. Since then, developments in the textile dyeing field have been achieved through research and experimentation (Clark, 2011).

"The objective of dyeing is to produce uniform colouration of a substrate usually to match a pre-selected colour." (Clark, 2011, p.3). Clark (2011) indicates that uniform colouration is a fundamental aspect in textile dyeing, stressing that a dyed substrate should not have any shade variation within. Similarly, Burkinshaw and Salihu (2019, p.520) point out that if colour is non-uniform in a substrate, "it is most likely unsaleable". In contrast to Clark, Diadick-Casselman (2001a, cited by Kadolph and Casselman, 2004, p.15) point out, that "[c]onsumers now accept the unique dye colors and random patterning produced by newly developed natural dye methods that cannot be replicated or duplicated". This claim needs to be further explored, since this acceptance could change depending on the country and context of use. However, according to Tian *et al.* (2001, p. 50) "[p]roducts and their uses or displays that become classified as being outside of the norm may serve as recogni[s]able symbols of uniqueness or specialness". In this case, a dyed textile with non-uniform colouration could be classified as outside of the norm and therefore serve as a unique symbol. Tian *et al.* (2001) points out that possessing unique consumer goods comes from a personal need for individuality. Nowadays this need of possessing unique/different products from others could be arguably reasonable, since according to Humphreys *et al.* (2019) the current economy is complex due to a dynamic market in which fragmentation is high and standardisation is an obstacle towards consumer differentiation, therefore businesses need to reinvent regularly in order to adapt to emerging markets.

For example, the study conducted by Hashim *et al.* (2021) explored the acceptance of natural tie-dyed t-shirts by tourists and vendors as souvenirs in an attractive tourist district in Malaysia, using local resources such as rhizomes of *Curcuma longa* and leaves from *Lawsonia inermis Linn.* as natural dyestuffs. This study concluded that the majority of the tourists and vendors accepted natural dyed t-shirts as a souvenir and emphasised that its uniqueness was the most interesting element of the souvenir (Hashim *et al.*, 2021). Therefore, this could support the argument previously discussed by Tian *et al.* (2001) and Humphreys *et al.* (2019) that uniqueness is more valued for consumers. Therefore, this provides an opportunity to explore the acceptance of natural dyes from domestic food waste resources without metallic chemical additives in Mexico, challenging what has been considered as fundamental in the textile dyeing field namely colour uniformity and reproducibility.

Clark (2011) points out that exhaustion, continuous, also known as padding, and printing are the dyeing methods more used to apply colour in substrates. However, according to Khattab *et al.* (2019) the more popular dyeing methods are exhaustion, continuous and high-temperature. Since, these methods are used especially with cellulosic fibers, and "[c]ellulosic fibers account for the highest world textile [consumption]" (Khattab *et al.*, 2019, p.3804). This suggests that the dyeing processes for cellulosic fibres are the most used in the textile industry. In addition, with regards to natural dyeing, according to Kadolph and Casselman (2004, p.16) "[t]he standard approach to the preparation of natural dyes among craft and textile practitioners is the immersion method". However, Kadolph and Casselman (2004) point out, that contact dyeing is an alternate option to immersion due to its benefits particularly in respect of water resources. Due to the focus of the research on natural dyes from domestic food waste resources and the use of cotton due to its importance in the Mexican context of the study, only the following methods will be discussed: exhaustion, continuous and contact natural dyeing.

However, more detail will be given to contact dyeing due to its relevance in this study. Since, this is a natural dyeing method that aims to provide one-of-a-kind dyeings through unpredictable colouration; in which flexibility, experimentation and personal creativity are immersed in the contact dyeing process (Kadolph and Casselman, 2004). Moreover, in this method, the person carrying out the dyeing activity does not have to follow precise procedures or recipes when compared to almost all of the existing textile dyeing methods (Kadolph and Casselman, 2004). The latter suggests that contact dyeing could be an enjoyable experimentation activity carried out by non-experts in the dyeing field. Similarly to contact dyeing, this study aims to investigate if natural dye's perceived barriers such as poor fastness properties, colour yield and colour variations could be used as design opportunities in order to attract the target audience (Mexican females from 18 to 33 years old) without experience in the dyeing field towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives through a co-design channel in which they could customise and re-dye their garments with available domestic food waste at home, taking ownership of the process. This personal involvement through design strategies such as co-design, customisation and re-dyeing activities, could be key in terms of acceptance and adoption of natural dyes from domestic food waste resources without metallic chemical additives. Since, according to Kadolph and Casselman (2004, p. 21) "[t]he ultimate satisfaction of natural dyes in a mass-market environment is personal involvement in a simple aesthetic exercise that restores individuality and cultural meaning to otherwise ordinary clothing and textiles". This suggests that personal involvement is an enabler towards the creation of a unique personal product that could serve as a self-extension symbol. Since according to Belk (1989, p.160) "[s]elf-extension occurs through control and mastery of an object, through creation of an object"... This not only suggests that in order to consider a product as an individual self-extension, the individual should be involved in the product creation process, but also is linked to the importance of individuality (differentiation) previously discussed by Tian *et al.* (2001). Similarly, Ball and Tasaki (1992) points out that personal involvement (customisation) allows the individual to transfer their personal identity to the product. In addition, this personal involvement is fundamental in order to develop an attachment bond between owner-product and consequently a long-life interaction with the product. However, according to Ball and Tasaki (1992) the key element for attachment between owner-product is the ability of the latter to maintain the identity of the owner. Further details about the importance of the design routes in this study can be can found in Chapter 5.

### 2.3.1. Exhaustion dyeing- an immersion dyeing process

According to Burkinshaw and Salihu (2019) exhaustion dyeing is an example of an immersion process. The most important aim of the immersion dyeing processes is to produce uniform colouration, since according to Burkinshaw and Salihu (2019, p.520) if colour is non-uniform, “it is most likely unsaleable”.

Khattab *et al.* (2019) and Clark (2011) point out that the dyes used for this method could vary from partially soluble to completely soluble in aqueous solutions (dye-bath). According to Clark (2011, p.4) … “the dye-bath, is transported to the fibre surface by the motion of the dye liquor or by motion of the substrate being dyed”. Once in the dye-bath, the substrate adsorbs the dye and once adsorbed the dye is expected to diffusion within the substrate (Clark, 2011). This suggests, that an acceptable exhaustion dyeing is achieved when the dye is diffused not only in the substrate matrix but also in its whole substrate structure. This is the reason why; the exhaustion dyeing process is conducted through two phases, the adsorption phase followed by the diffusion phase. In addition, almost all of the exhaustion dyeing processes start at room temperature, increasing the heat slowly until the desired temperature is achieved, this latter stage will vary depending on the type of dye (Clark, 2011). See Figure 2.

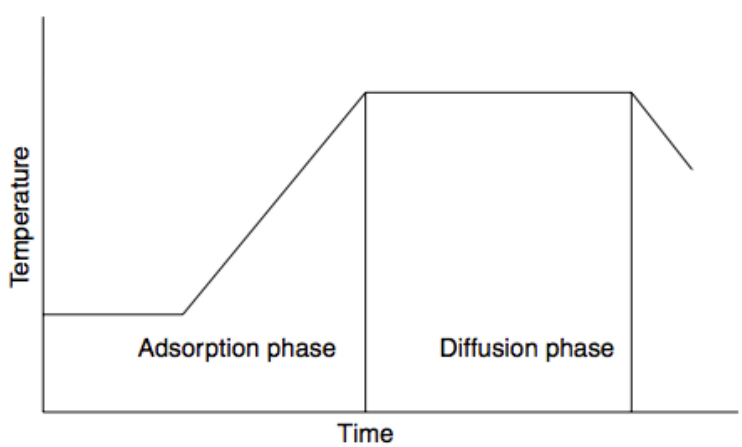



*Figure 2. Typical dyeing profile (Clark, 2011 p.4)*

For example, during the exhaustion dyeing process of cellulosic fibres with direct dyes, prior to placing the dyestuff into the dyebath, this should be dissolved in hot water (Khattab *et al.*, 2019). Electrolytes, such as sodium sulfate ($Na_2SO_4$) or sodium chloride (NaCl), are used at high concentration when dyeing cellulosic fibres in order to force the attraction between the dyestuff and the fibre; these salts could be added to the dyebath in two stages: 1. at the start of the heating process or 2. once the optimal temperature of dyeing is achieved (Khattab *et al.*, 2019). Once the dyeing process is finished, the cellulosic fabric needs to be washed using cold water, in order to remove any superfluous residues (Khattab *et al.*, 2019).

According to Clark (2011) there are two types of equipment to carry out exhaust dyeing: circulating machines and circulating-goods machines. The difference between them is that in circulating machines, the substrate remains static while the dye liquor is the one in motion and in the circulating-goods machines both the substrate and dye liquor are in motion (Clark, 2011).

One of the key disadvantages of the immersion dyeing processes is its negative environmental impact, specifically on water resources. According to (Johnston, 1997, p.7) "immersion dyeing uses twenty times the amount of water as fabric (by weight)". Kadolph and Casselman (2004, p.16) point out that "[i]n many regions of the world, water resources are strictly limited, and pure water for dyeing represents an extravagance expense". In the same vein, Burkinshaw and Salihu (2019, p.522) stress that "water shortages exist in many regions". For example, Mexico´s superficial waterways are being affected by the textile industry's wastewater discharge (Arellano Aguilar, 2018). In addition, the average clean, drinkable, water supply in Mexico, has dwindled by 78% from 1950 to 2017 (Water resources group, 2018).

Moreover, after conducting an immerse dyeing process the wastewater generated is highly coloured representing a threat to water pollution since it may contain a mix of organic and inorganic compounds (Burkinshaw and Salihu, 2019). As discussed in section 2.1 by Babu *et al.* (2007) if a high amount of un-biodegradable compounds are disposed into wastewater a higher amount of BOD will be needed in order to break them down in water. For example, according to the study conducted in the Atoyac river of Mexico by Saldaña Fabela and Gómez Balandra (2016), it has been demonstrated that some of the industries located near this river discharge their wastewater directly to the Atoyac River without prior treatment, while other companies treat their wastewater but the treatments used are not effective enough or not suitable for the removal of the heavy metal compounds used through their production processes negatively affecting its water quality. This is the reason why, this study avoids the use of metallic chemical additives.

### 2.3.2. Continuous dyeing

In this dyeing method, as the name indicates the dyeing and fixation of the substrate are executed without interruption (continuously) within the same operation (Clark, 2011, Khattab *et al.*, 2019). "This is traditionally accomplished using a production line system where units are assembled into lines of consecutive processing steps"…(Clark, 2011, p.6). Although this suggests a particular advantage in time due to automatisation, it also involves an important economic risk, since according to Clark (2011) if the machinery suffers a break down it can ruin fabric, especially if high temperatures are used since this can cause discolouration and burning.

Dyestuffs can be applied through two ways: 1. directly onto the substrate or 2. continuous immersion, which means that the substrate is placed in a dye-bath followed by padding in which the superfluous dye liquor is eliminated through squeezing rollers (Clark, 2011).

Khattab *et al.* (2019, p.3806) defines padding… "as the continuous dipping of garments in a dye-bath and elimination of the excessive liquor by squeezing". By drawing on the concept of padding, Clark (2011, p.7) points out that "padding involves passing the substrate through a pad trough containing the dye liquor." This suggests that a padding process most of the times involves a padding bath in which the substrate gets immersed in a solution followed by a squeezing roll system in which the substrate is squeezed in order to remove any dyestuff that was not adsorbed (pickup) by the substrate. In addition, it is crucial that prior to padding the substrate is sufficiently wet in order to maximise colour uniformity (Clark 2011; Khattab *et al.*, 2019). With regards to this latter point, it is highly recommended to dry the substrate after carrying out padding, this can be done via contactless heating through infrared heat or hot air steam (Clark, 2011). However, once fixation is obtained, it is suggested to wash the substrate in order to remove any superfluous residues (Clark, 2011).

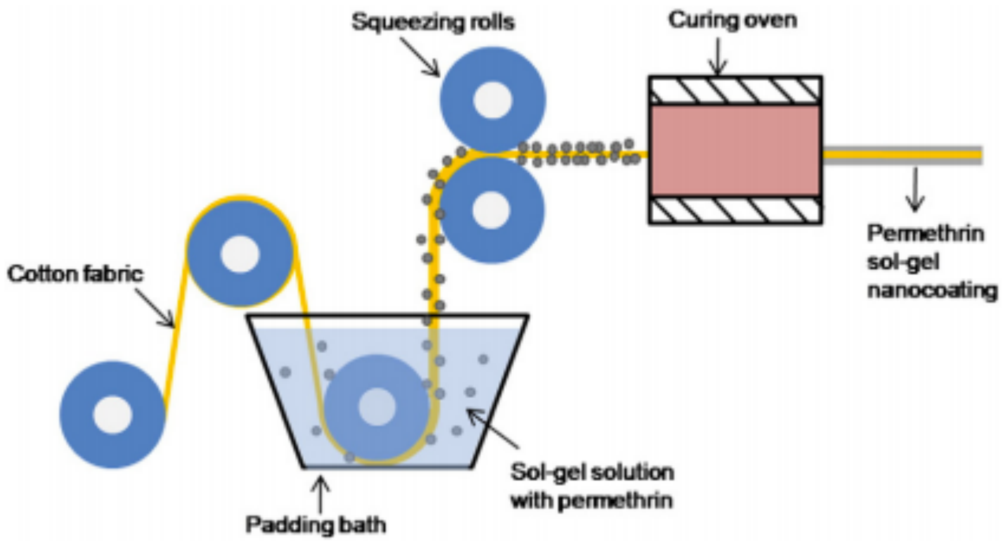



*Figure 3. Schematic illustration of the fabrication process for permethrin-loaded textiles (Ardanuy et al., 2014, p.133)*

Although Figure 3 represents a fabric treatment process, it is useful to explain how the padding process can be carried out. In this case the substrate (cotton) moves through rolls to different process stages, in the first stage it is immersed in the padding bath, this bath may contain dye liquor, auxiliaries or textile finishes. For example, in the research carried by Ardanuy *et al.* (2014) in which the aim was to develop an insecticide textile, the padding bath contained a sol-gel solution containing permethrin. Similarly, Khattab *et al.* (2019, p. 3808) points out that in the pad dyeing process … "[dyestuff], alkali, and auxiliaries are applied to the fibers by [immersion]"… This suggests that a padding bath may contain different solutions depending on the textile functionality. Once the substrate passes through the padding path, it enters the squeezing rolls in which any solution that was not fixed to the substrate is removed and finally the substrate enters the drying equipment.

However, this dyeing process similarly to the previous discussed (exhaustion dyeing) involves an aqueous dyebath in which different auxiliaries can be added including metallic bio-persistent compounds depending on the desired substrate functionality becoming a threat in terms of water pollution.

### 2.3.3. Contact natural dyeing

This method, in comparison with other natural dyeing methods avoids the use of chemical mordants and minimises the use of water, in order not only to contribute to a reduction in water pollution but also to create unpredictable colouration through inexpensive materials (Kadolph and Casselman, 2004). According to Khattab *et al.* (2019) one of the main disadvantages of most of the natural dyeing methods is a dependence on metallic additives in order to fix the natural dyestuffs onto the fibres and the considerable amount of water needed. However not all the metallic chemical additives used in textile dyeing have the same impact on the environment. Therefore, within the context of this study the following metal salts will be considered as polluting substances (chromium, tin, copper), see section 4.1.5 for further discussion on mordants and the negative impacts of their utilisation.

Kadolph and Casselman (2004) share a contact dyeing introductory exercise, which consists of eight steps. (See Table 2). Kadolph and Casselman (2004) stress that the person carrying out the contact dyeing exercise should feel free to modify every step if needed. In addition, the choices presented could vary, since "all choices are optional" (Kadolph and Casselman, 2004, p. 16).

| STEPS | DESCRIPTION/ CONSIDERATIONS |
|---|---|
| 1. Materials selection | - Textile: A second hand garment, or a personal garment that is no longer used in order to give it a second life. The textile selected should be clean before starting the contact dyeing.<br><br>- Dyestuffs: Fruits/ organic waste.<br><br>- Self-sealing plastic bag/ wide-mouthed jar/ aluminium foil.<br><br>- Liquid mordants: Left over wine, vinegar, fruit juice, tea, and household cleaners.<br><br>- Dry mordants: Table salt, sugar, baking powder with alum, baking soda, deodorant, coins, pulverised limestone or chalk, scrap metal.<br><br>- Binding agents: Rubber bands, dental floss, lace, trim.<br><br>- Spray bottle. |

| | |
|---|---|
| 2. Dyestuff application | This step refers to co-location of the dyestuff on the textile, the person carrying out the activity is free to mash it into the textile or not. |
| 3. Liquid mordant application | This step refers to spraying in order to slightly moisture the textile with the liquid mordant selected. |
| 4. Dry mordant application | This step refers to sprinkling the textile with one or more dry mordants. |
| 5. Bundle creation | This step refers to tightly wrapping the textile using any material that will exert force between the dyestuffs/ mordants towards the textile.<br><br>Choices for binding are: rubber bands, dental floss, string, lace, ribbon and trim. These bundle choices are safe if the person carrying out the activity wants to place the bundle in a microwave in step 7.<br><br>In addition, a hammer could be used once the bundle is created in order to enhance the contact between the dyestuff and textile by carefully hitting the bundle with a hammer. |
| 6. Bag the bundle or not | This step refers to placing the bundle in a self-sealing plastic bag, once inside remove any excess of air.<br><br>However, this step is optional. The person carrying out the contact dyeing activity could avoid this step, and consider other alternatives, such as placing the bundle in a wide-mouthed jar. Further options will be discussed in the next step. |

| | |
|---|---|
| 7. Dye bundle processing | This step refers to heating the bundle via: steaming, baking, microwaving, grilling or through solar heat.<br><br>- Steaming can be done using a self-sealing plastic bag, a wide-mouth jar or the bundle by itself. The first two options can be placed in a pot of water and brought to boil (both self-sealing plastic bag and wide-mouth jar should be perfectly sealed). If steaming is done using the bundle by itself, it is important to consider that the bundle should be completely dry before steaming and that after steaming the plastic bag and jar should be cool before opening).<br><br>- Baking can be done by undoing the bundle, and expanding the textile on a flat pan, placing the pan in an oven at low temperature.<br><br>- Microwaving can be done by placing the self-sealing bag slightly opened into the microwave. If this option is selected it is important to remove any pieces of metal before microwaving.<br><br>- Grilling can be done by placing the bundle in aluminium foil, wrap it and grill it.<br><br>- Solar heating can be done by placing either the self-sealing plastic bag or wide-mouth jar in a place in which direct light can passes through it. |
| 8. Finishing | This step cures the dyed textile. This can be done by un-bundling the textile and letting it dry at ambient temperature away from direct sunlight before washing the textile.<br><br>The person carrying out the activity could decide to leave the dyed textile drying for one week or more. However, the textile can be washed after leaving the textile for one week drying at ambient temperature. In addition, the textile can be ironed, in order to reinforce colouration before drying. |

*Table 2. Introductory exercise in contact dyeing adapted from Kadolph and Casselman (2004)*

The advantages of this method are the following: inexpensive materials, suitable and safe for carrying out dyeing in a domestic setting, no sophisticated equipment needed, and most importantly does not require big volumes of water and avoids the use of standard metallic mordants commonly used in natural dyeing (Kadolph and Casselman, 2004). In addition, contact dyeing suggests the creator does not need to buy new materials for dyeing but rather can use whatever they have found or already own. Since, Kadolph and Casselman (2004, p.16) mention that …"salvaged plant materials, household and hygiene products, cosmetics, food-related items, and found scraps of metal, wire, yarn, fabric, trims, and thread" are examples of dyestuff resources.

Due to the avoidance of standard metallic mordants, use of organic waste as natural dyestuffs, openness and flexibility of this natural dyeing method in which the person carrying out the contact dyeing activity could take ownership of the process and conduct it at home, this dyeing process aligns with transition design, which is one of the main theoretical positions taken for this study. This is the reason why, the introductory exercise in contact dyeing proposed by Kadolph and Casselman (2004) will be adapted in this study in order to conduct a DIY domestic natural dyeing workshop activity in which a cohort of the target audience will be invited to conduct this activity and evaluate not only their experience but also their acceptance towards the use of natural dyes from domestic food waste resources without metallic chemical additives as part of the testing of the strategies developed for the social marketing intervention model of this study. Further details about the DIY natural dyeing workshop can be found in section 7.8.

## 2.4 Environmental and performance discussion between synthetic and natural dyes

William Henry Perkin in 1856 produced the first synthetic dye (Mauveine) made from coal tar (Holme, 2006). After the creation of the first synthetic dye in 1856, the textile industries diminished the use of natural dyes, which were the first source of textile colouration (Chavan, 2011). In the same vein Holme (2006, p.237) points out that that by 1890… "90% of all dyestuffs were of synthetic origin". According to Holme (2006, p. 243)… "the Society of Dyers and Colourists (SDC) gave the first and second Perkin Medals ever to be awarded in 1908 to Prof. Graebe and Prof. Liebermann for the synthesis of alizarin and in 1911 to Prof. Adolf von Baeyer for the synthesis of indigo". This suggests that the first naturally occurring dyes that were produced synthetically were Alzarin and Indigo. The textile industry's shift from natural to synthetic dyes may have been caused due to certain competitive advantages of synthetic dyes when compared with natural dyes. According to Patel (2011) and Samanta and Agarwal (2011) most of the natural dyes have a poor wash and light fastness in comparison with synthetic dyes. This poor fastness is attributed to the natural dyes' chromophore, which is susceptible to photochemical degradation (Patel, 2011). This photochemical degradation means that when a naturally dyed textile is exposed to light the colour fades over time. Hernández- Zamora *et al.* (2015) points out that synthetic dyes, especially those containing azo groups have perceived benefits when compared to natural dyes such as: lower price , colour fastness and colour variation. In addition, Samanta and Agarwal (2009, p.384) argue that synthetic dyes in comparison with natural dyes have batch consistency and a "reproducible colour yield".

However, natural dyes have recently come back into the public interest (Patel, 2011), due to customers demand for more environmentally friendly textiles (Samanta and Agarwal, 2009). As previously mentioned in section 1.1.2, El- Sheekh, *et al.* (2009) and Rai *et al.* (2005) point out that azo compounds represent the main composition of synthetic dyes and their xenobiotic nature hinder biodegradation generating problems in the environment especially in water ecosystems. In contrast natural dyes, which according to Samanta and Konar (2011) are mostly plant based, tend to have characteristics that are more renewable and biodegradable when compared with synthetic dyes; synthetic dyes being petrochemical based compounds, tend to be non-renewable, and also problematic to biodegrade. As discussed by Samanta and Konar (2011) promoting the use of natural dyes could contribute towards sustainability through the reduction of fossil fuels. This is the reason why this project aims to validate if the use of domestic food waste resources as natural dyestuffs without metallic chemical additives could become accepted by the demographic cohort .

According to Chavan (2011), it is somewhat surprising that most consumers are often not fully informed about the environmental consequences when selecting a particular dye. Consumer selections are mainly influenced by market requirements, which mean achieving an acceptable dye performance while in an environment of standard use such as fastness to light, laundering, rubbing and dry cleaning (Chavan, 2011). The addition of auxiliaries is needed during the dyeing processes in order to meet the market requirements, and consequently a considerable amount of toxic chemicals end up being discharged into the wastewater, because these auxiliaries do not fully fix on the fibres during the dyeing process (Chavan, 2011). This suggests that the market does not consider the negative effects caused on the natural environment due to the considerable amount of auxiliaries released in order to achieve an appropriate dye performance. Therefore, the use of natural dyes without auxiliaries could contribute to the reduction of water pollution. However, the performance of natural dyes may represent an obstacle to acceptance by consumers when compared with the generally accepted performance of synthetic dyes. This is the reason why; this research project carried out a contextual and target audience analysis (Mexican females from 18 to 33 years old) in order to explore if the demographic cohort is open to embrace the limitations of the use of natural dyes without metallic chemical additives, such as lack of colour strength, standardisation and durability when compared to synthetic dyes, after being aware of the environmental impact that is made through the use of synthetic dyes.

As discussed by Samanta and Agarwal (2009), almost all-natural dyes lack colour yield reproducibility and light stability, have poor to moderate colour fastness to light and launder. Nevertheless, these characteristics mentioned before could be an indicator that natural dyes' market value should not be measured only from this particular technical view point since these characteristics could contribute towards more sustainable textile dyeing practices.

However, it is important to consider some arguably less favourable points with regard to using natural dyes, Hill (1997) points out that some natural dyes have a higher cost and a limited availability (specific climatic conditions to grow). According to Chhabra (2015) plants represent the raw material for most of the natural dyes. However, large quantities of plants are needed in order to create intense colour shades and consequently the price of natural dyes from plants resources is elevated (Chhabra, 2015). This suggests that accessibility to natural dyes made from plants could be limited due to their limited availability and higher cost. In addition, the use of land to grow plants for the production of natural dyes is negatively disputed (Chhabra, 2015). This latter point could be because land could be used to grow food crops for human feed and not for the production of natural dyes. In addition, chemical auxiliaries are mostly needed in natural dyeing processes in order to fix the dye to the fibre (Chhabra, 2015). This is the reason why; this study aims to influence the social acceptance of natural dyes without metallic chemical additives. On the other hand, despite these concerns with regards to the higher costs and land consumption of natural dyes, there is a strong argument that food waste can be used as a natural dye resource, a theme which this thesis will investigate in greater detail (see Chapter 4).

## 2.5 Discussion of natural resources such as non-timber forest products (NTFPs) and food waste as possible resources for natural textile dyestuffs and their ability to generate socioeconomic value

The Center for International Forestry Research (CIFOR) defines NTFPs as …"any product or service other than timber that is produced in forests. They include fruits and nuts, vegetables, fish and game, medicinal plants, resins, essences and a range of barks and fibres such as bamboo, rattans, and a host of other palms and grasses" (cifor.org, n.d., para.1). In the case of food, according to the Commission for Environmental Cooperation (CEC) (2017), the terms food waste and food loss could be related since both concepts refer to food intended for human consumption composed of edible and non-edible food parts. Food waste is intentionally discarded due to mismanagement or neglection which includes: expiration, spoilage and un-consumption and occurs at the bottom of the food supply chain which entails: distribution, retail, food services and consumers (Commission for Environmental Cooperation, 2017). In contrast, food loss refers to either quantity or quality reduction of food when it is produced and processed before entering the market. A lack of efficiency within the food supply chain such as non-adequate refrigeration and a weak infrastructure leads to increased food loss (Commission for Environmental Cooperation, 2017).

According to Stenmarck *et al.* (2016), in the EU, 20% of total food production becomes food waste; 173 kilograms of food waste is generated every year per person. On the other hand, in Mexico almost 40% of their total food production goes to waste and ends up been disposed of as rubbish, becoming a pollutant (Pérez, 2015). Food waste has become a concerning environmental problem that arguably requires immediate attention. According to the Food and Agriculture Organisation of the United Nations, most of the global food waste ends up in landfill, contributing to the creation of methane in the atmosphere (fao.org, 2020). Bill Mollison (1988, cited by Holmgren, 2020) defines a pollutant as a residue that is not used in an effective way. Holmgren (2020) points out that this definition has propelled the exploration of different routes in order to give an effective use to existent pollutants.

The possibility of giving an effective use for food waste as a natural dyestuff resource, could increase the competitiveness of the food and the textile industry. Therefore, this represents a sustainable way to reduce the pollutants caused by food waste upon disposal and an alternative towards the water pollution caused by the release of chemicals when using synthetic dyes. In addition, natural renewable resources such as food waste and forest resources such as NTFPs could not only help to improve the environmental impact of the textile industry practices especially in water pollution terms, but also to improve the quality of life of people that live in rural areas. For example, Mogra (2013) identified twenty-one NTFPs in India more specifically in the area of Rajasthan that can be potentially used as natural textile dyestuffs providing the following colours: yellow, blue, orange, brown, red, purple and pink. Mogra (2013) argues that the collection of NTFPs could provide a source of employment for Indian tribal women. However, "[t]ribal women are unaware about the potential uses of natural products; their knowledge is limited up to only collecting wood for fuel" (Mogra, 2013, p.520). Furthermore, several constraints need to be addressed in order to boost the collection activity of NTFPs carried out by Indian tribal women, for example there is an existent lack of education, motivation, incentives, programmes and government investment (Mogra, 2013). Due to this, a lot of work and development is needed in order to position the NTFPs collection and commercialisation acitivities as a stable and reliable source of employment for Indian tribal women (Mogra, 2013).

However, the use of forest resources does not represent an ideal raw material for the production of natural dyestuffs in Mexico, which is the context of this study. For example, nowadays the main obstacles towards the use of plant-based resources in the Mazahua community to produce natural dyestuffs are their availability, high monetary costs and time consumption (Franco-Maass *et al.*, 2018). *Dahlia coccinea Cav., Cuscuta jalapensis Schlechtendal and Tagetes erecta L.* are the most common plants used for natural dyeing but these are only available in specific seasons in the Santa Rosa de Lima region, and their collection requires a lot of effort since "long journeys are necessary for its collection" (Franco-Maass *et al.*, 2018, p.18). In addition, the Mazahuan women have an inclination towards the use of indigo and cochineal, because these have been traditionally used in their ethnic group, however these sources can only be found in markets at very high prices (Franco-Maass *et al.*, 2018). Similarly, Hill (1997), mentioned in section 2.4, concluded that some natural dyes have a higher cost and a limited availability (specific climatic conditions to grow). Moreover, land is required to grow plants for natural dyeing purposes (Chhabra, 2015) and this represents an issue in the Mazahua community since "[t]he region was formerly covered by temperate forests but is currently dominated by agriculture, mainly for the rainfed cultivation of maize (for autoconsumption) in low-output production [systems]" (Franco-Maass *et* *al.*, 2018, p.15). It is not unreasonable to deduce that this scenario has a strong likelihood of happening in other ethnic communities in Mexico; therefore, the use of food waste could represent an opportunity to preserve the ancestral tradition of natural dyeing in Mexico making use of domestic food waste as a raw material for the production of natural dyestuffs. Since according to Franco-Maass *et al.* (2018) the use of purple cabbage and mulberry represent a cheaper and more readily available alternative to indigo in the Santa Rosa de Lima region. This also suggests that readily available resources for natural dyeing could vary depending on the region; this is the reason why this study aims to motivate the target audience to make use of their kitchen food waste. Therefore, this project aims to use domestic food waste as a natural resource for textile dyestuffs without metallic chemical additives and consequently address the following hypothesis: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes.

## 2.6 Global Market - Natural Dyes

"The global natural dyes market is anticipated to generate revenues of approximately $5 billion by 2024, growing at a CAGR of around 11% during 2018-2024" (Researchandmarkets.com, 2019, para.1).

According to the report of Researchandmarkets.com (2019) the global colouration market is now considering alternative routes towards environmental protection, such as the use of natural raw materials. One such alternative route, is using natural dyes, instead of synthetic dyes, which have led to the reduction of natural resources and the creation of pollutants which alter the ecological balance. This alternative of using natural dyes should be supported by the application of rigorous government environmental policies with regards to pollution, higher living conditions and disposable income per capita. The industries that are considering the use of natural dyes are: cosmetics, food and beverages, pharmaceutical, textile and leather industries (Researchandmarkets.com, 2019).

Researchandmarkets.com (2019) points out that synthetic dyes optimisation has been the main focus of research and development (R&D) within the dyeing industry so far, due to their low-cost, wide colour spectrum and colourfastness which suits the high contemporary needs of consumers and are therefore preferred in different end usages. However, this sector is now showing interest in natural dyes, therefore R&D are actively seeking ways to develop effective greener prospects and process innovations. For example, using enzymes and ultrasonic dyeing techniques in India, has become a growing alternative towards the optimisation of natural dyes without using metal mordants (Researchandmarkets.com, 2019). The use of alternative mordants, designed to improve fastness properties, will facilitate the adoption of natural dyes in the textile industry (Researchandmarkets.com, 2019). However, this study investigates if consumers are open to accept natural dyed textiles with limited colour strength and colour fastness, through the development of a social marketing intervention model that could facilitate the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

Researchandmarkets.com (2019) stresses that the growing number of consumers who are concerned about the environment, and who prefer organic, sustainable and natural made products, has also propelled the demand for natural dyes. Therefore, industry developments, market conditions and technological innovation is driving the development of natural dyes for the global market (Researchandmarkets.com, 2019).

The report by Researchandmarkets.com (2019) suggests that innovation in production technology and a wider palette of colours are key for intensifying the competition in the global market of natural dyes. However, this project research investigates whether rather than using damaging metallic chemical additives that affect waterways adversely, instead consumers are open to accept natural dyed textiles with limited colour strength and colour fastness, embracing the limitations of the process as an opportunity to personalise the end garment and take ownership of the creative process.

## 2.7 Examples of existing companies that specialise in textile colourants from food waste resources (Commercial viability) – Discussion around Mexico´s context opportunity of using food waste as a natural dyestuff resource

| COMPANY | ARCHROMA | AMA HERBAL | KAIKU | KERACOL LIMITED |
|---|---|---|---|---|
| Natural-based product lines | Earthcolors® (Archroma.com, 2021). | Natural Textile Dyes- Extract form (Amaherbal.com, n.d.b).<br><br>Végétal® Bio Actives – Hair Care (Amaherbal.com, n.d.b). | No yet defined, whole startup company is centred on creating natural colourants from food waste (KAIKU, n.d.). | Dr. Craft (Keracol.co.uk, 2019). |
| Natural Sources | Waste from: almonds (shells), cotton plant, bitter orange and saw palmetto (Archroma.com, 2021). | Natural textile dyes: Residues of pomegranate (peels) and forest sources such as: *Indigofera Tinctoria* (leaves), *Acacia catechu* (wood), *Rubia cordifolia* (roots and rhizomes), *Kerria lacca* (sticks), *Terminalia chebula*, *Rheum emodi* (rhizomes), *Quercus infectoria* ( gall nuts), *Tegetas erecta*, *Butea monosperma* and Mulberry tree (leaves) (Amaherbal.com, n.d.b).<br><br>Végétal® BIO COLOUR: *Indigofera Tinctoria, Lawsonia inermis, Rubia cordifolia, Coffea arabica, Baccopa monnieri, Acacia Catechu, Emblica officinalis, Eclipta postrata* (Amaherbal.com, n.d.b). | Waste from: onions, avocados, cabagge, pomegranates, beetroot and lemons (KAIKU, n.d., Ubuntoo.com, 2021). | Fruit waste of british blackcurrants (skins) and essential oils for scenting purposes such as: bergamot, eucalyptus, spearmint, tarragon and lemon (Keracol.co.uk, 2019). |
| Natural dyestuffs names | Diresul® Earth Oak, Diresul® Earth Cotton, Diresul® Earth Sand, Diresul® Earth Clay, Diresul® Earth Forest, Diresul® Earth Stone (Archroma.com, 2021). | Natural Textile Dyes: Bio indigo®, Mallow®, Bee®, Rubia®, Nimbus®, Kareel®, Insect®, Rennet®, Yeliona and Leefy green (Amaherbal.com, n.d.b).<br><br>Végétal® BIO COLOUR: available in soft black, dark brown and burgendy (Amaherbal.com, n.d.b). | No content found on Kaiku oficial page (KAIKU, n.d.). | Dr. Craft´s Natural Purple Berry Brightening Serum (Keracol.co.uk, 2019). |
| Participation of other industries | Cotton, food and herbal (Archroma.com, 2021). | According to Amaherbal.com (n.d.b) no content found. | Agricultural- Farmers (KAIKU, n.d.). | No content found at Keracol.co.uk (2019). |

| | | | | |
|---|---|---|---|---|
| Natural residues suppliers | Unio cooperativa agrícola, Cotton Incorporated, Nutrafur, Area de Guissona and Euromed (Archroma.com, 2021). | According to Amaherbal.com (n.d.a) most of the natural sources are collected from Indian forests giving employment to communities from rural areas. | Farmers, presumably from the United Kingdom since its heardquarters is located in London (KAIKU, n.d., Ubuntoo.com, 2021). | No content found at Keracol.co.uk (2019). |
| Technology | Archroma's Earthcolors® - Patented technology (Archroma.com, 2021). | No content found. | KAIKU system, which is grounded in a vaporisation technology (Ubuntoo.com, 2021). | Patented Technology (Keracol.co.uk, 2019). |
| Application | Textiles/ Cellulosic fibres (Archroma.com, 2021). | Natural Textile Dyes: cotton, wool and silk fabrics (Amaherbal.com, n.d.b).<br><br>Végétal® BIO COLOUR: for men and women hair (Amaherbal.com, n.d.b). | No yet defined, but Kaiku aims that its natural dyestuffs could be used in: textiles (protein and celllulosic fibres), paper, waxes, soaps and bioplastics (KAIKU, n.d.). | Hair (Keracol.co.uk, 2019). |
| Approved/ Certified | Approved by: Zero Discharge of Hazardous Chemicals (ZDHC), Bluesign® and Global Organic Textile Standard (GOTS) (Archroma.com, 2021). | Natural Textile dyes: certified by GOTS version V by control Union of Netherlands (Amaherbal.com., n.d.b).<br><br>Végétal® Bio Actives: approved by Dubai municipality and Société Générale de Surveillance (SGS) India Ltd (Amaherbal.com, n.d.b). | No content found on Kaiku oficial page (KAIKU, n.d.). | No content found at Keracol.co.uk (2019). |
| Commerciali-sation | Only to approved brand owners (Archroma.com, 2021).<br><br>The following fashion brands have launched collections using Earthcolors® technology: Esprit, Vogue, Ternua, Kathmandu, G-Star Raw, Indocount, Patagonia, Peter England and Calida (Archroma.com, 2021). | According to Amaherbal.com (n.d.b) through the following link:<br>http:/www.webuynatural.com/<br><br>Natural Textile Dyes:<br>http://www.webuynatural.com/brand/ama-herbal.html<br><br>Végétal ®Bio Actives :<br>http://www.webuynatural.com/natural-beauty-products-online/natural-hair-care-products/herbal-hair-colour-online-india.html | Not yet in the market, according to Ubuntoo.com (2021) the Technology Readiness of KAIKU Level (TRL) is at a development stage with a 4-5 scale.<br><br>According to Acqnotes.com (2021) when the final scale is reached (9), this means that the technology has passed all the readiness tests successfully. | According to Keracol.co.uk (2019), Dr. Craft´s Natural Purple Berry Brightening Serum will be commercialised in the United kingdom through Amazon.co.uk. |

*Table 3. Comparison table from existing companies that manufacture natural dye*

Similarly, to Archroma and Kaiku, this study aims to use food waste as a natural resource for textile dyeing. As mentioned in section 1.1 food waste is a significant problem in Mexico and its application as a raw material for the production of natural dyes could represent an alternate way in which food waste could be incorporated in a supply chain that could add value to this waste. Consequently this would lead to a reduction in economic loss that especially small-scale farmers experience due to the considerable amount of their food production that ends up wasted. Furthermore, this application could contribute to Mexico´s economy since according to SAGARPA (2017a) agricultural activity is essential to Mexico´s economic growth. In addition, agricultural activity contributes to better living conditions, especially in developing countries worldbank.org (2020b), such as Mexico. Since according to United Nations (2019) Mexico is considered a developing country. However these aspects; contribution to the economy of Mexico´s small-scale farmers and Mexico´s economic growth, are outside the scope of this study and it is only a possible scenario once the social marketing intervention model developed in this study is applied over the long-term.

This study investigates if natural dyes' barriers such as poor fastness properties, colour yield and colour variations could be used as design opportunities in order to attract consumers towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives through the creation of a social marketing intervention model. According to Archroma.com (2017) colour variation and fading is the attraction of the Earthcolors® natural dyestuffs line. This type of evolution in the market in which consumers can find alternate options to synthetic dyed garments could enhance consumer acceptance towards the perceived barriers to acceptance of natural dyes and consequently influence their consumption behaviour towards more aware purchases in which they consider the environmental impacts behind their choices. Since, according to Marchand and Walker (2008, p.1168) …"people's capacity to make changes in their lifestyles and product choices are, among other things, constrained by product availability". However, consumers should first acquire knowledge in specific topics in order to make a change. This is the reason why this study aims to create a social marketing intervention model in which the target audience could first be informed about specific topics in order to influence their acceptance to natural dyes from domestic food waste resources without metallic chemical additives and consequently build a more conscious consumption behaviour. Since as mentioned by Chavan (2011) in section 2.4 most consumers lack of knowledge with regards to the environmental impact of textile dyeing. This suggests that consumer's purchase decisions are mainly influenced by the available options in the market. In addition, the social marketing intervention model developed in this study includes tools that could attract the target audience towards natural textile dyes from domestic food waste resources and consequently influence their acceptance. The model can be found in Chapter 7, page 252.

According to Table 3, it is possible to commercialise natural dyestuffs from natural resources, such as food waste and other plant based raw materials from forests, such as roots, leaves and plants. With regards to the latter, Amaherbal is an example of a company in which almost all of their raw materials for the production of natural dyestuffs are forest resources. "The raw material for natural dyes is collected from forests mostly and its left-over comes in for industrial as well as domestic purposes" (Amaherbal.com, n.d.a, para.3). However, the use of forest resources such as plants as mentioned in section 2.4 by Chhabra (2015) represent an elevated price since large quantities are needed in order to obtain natural dyestuffs. In addition, as Chhabra (2015) points out in the same section (2.4) the use of land to grow plants for the production of natural dyes is negatively disputed. This suggests that the previous argument of Chabra (2015) could change depending on the context, since according to Amaherbal.com (n.d.a) in India, forest collection activities enable the employment of rural communities. For example, "[n]atural Indigo and Madder are cultivated especially for Natural Dyes and it opens doors for employment opportunities to the farmers" (Amaherbal.com, n.d.a, para.3). However, in the case of Mexico as discussed in section 2.5 the use of food waste as a raw material for the production of natural dyestuffs represents a better alternative to reduce the pollutants caused by food waste upon disposal.

## 2.8 Conclusion

This chapter has examined the themes related to textile colouration and how this activity impacts negatively in the environment, specifically in water resources. Thus, it is possible to infer the following:

- The negative environmental impact of textile dyeing is seriously affecting Mexican water resources; specifically when the Mexican water supply is limited.

- Context is fundamental, every country has different problems and therefore the possible alternatives to tackle them will vary. In this study the context of the study is Mexico and food waste represents an alternate resource to produce natural dyestuffs.

- Educating consumers with regards to the environmental impact of textile dyeing is important when aiming for a change in their consumption behaviour.

- The current market in which uniqueness is more valued when compared to other decades represents an opportunity to accept the performance of natural dyes without metallic chemical additives.

Consumer´s education with regards to the environmental impact of the textile industry and the performance of natural dyes from food waste resources without metallic chemical additives will be further explored in the selected target audience through an online questionnaire which can be found in Chapter 6.

# Chapter 3. Research Methodologies

This chapter discusses the broad systems of methods that frame the scope and complexity of this study. Recently, researchers have shown an increased interest in mixed method research and in this chapter, rationales will be presented for the selection of the methodological mix used in the study. Moreover, this chapter will include a description and analysis of quantitative and qualitative research methods.

The selection of a mixed research method was appropriate in order to obtain a deeper understanding of the research problem, which is the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives. The selection of a mixed methodology for this study and the subsequent analysis of the data collected enabled the validation of the data in both the scientific enquiry and the subsequent questionnaire used to determine a given demographic response to the proposed natural dyed textiles with domestic food waste without metallic chemical additives. These data sets and analysis were crucial for the creation of the social marketing intervention model that this study proposes. Details of these two discrete areas of study can be found in Chapter 4 for the scientific investigation and Chapter 6 for the data collection.

## 3.1 Qualitative research

"Qualitative research seeks to explore and represent reality as it exists in context and to enlighten the ways in which individuals experience that reality" (Biddix, 2018, p.76). This definition highlights the importance of the relation between experience, context and reality with the human being. In the same vein, Merrian (2009) points out that qualitative research follows an interpretative/constructivist perspective (see Figure 4), in which the purpose of the research is to describe, understand and interpret multiple realities of a specific topic mainly related to human interactions in order to construct knowledge. "Basically, qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world" (Merrian, 2009, p.13). These studies by Biddix (2018) and Merrian (2009) highlight the importance of personal narratives in qualitative research and as personal narratives form a central basis for this study, particularly regarding consumer experiences, qualitative research methods and data collection have been utilised at several phases of this study.

| | *Positivist/ Postpositivist* | *Interpretive/ Constructivist* | *Critical* | *Postmodern/ Poststructural* |
|---|---|---|---|---|
| Purpose | Predict, control, generalize | Describe, understand, interpret | Change, emancipate, empower | Deconstruct, problematize, question, interrupt |
| Types | Experimental, survey, quasi-experimental | Phenomenology, ethnography, hermeneutic, grounded theory, naturalistic/ qualitative | Neo-Marxist, feminist, participatory action research (PAR), critical race theory, critical ethnography | Postcolonial, poststructural, postmodern, queer theory |
| Reality | Objective, external, out there | Multiple realities, context-bound | Multiple realities, situated in political, social, cultural contexts (one reality is privileged) | Questions assumption that there is a place where reality resides; "Is there a there there?" |

*Figure 4. Epistemological perspectives (Merrian, 2009, p.11)*

### 3.1.1. Qualitative methods

According to Maanen (1979, p.520) a qualitative method… "is at best an umbrella term covering an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world". Similarly, Biddix (2018) points out that a qualitative research method is selected when the purpose of the research is to answer the how and why of a selected topic (person, phenomenon, place or process) through a deep exploration of qualities and understanding of them.

Merrian (2009, p.5) points out that, the purpose of data collection in a qualitative method is…"understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences". Since, phenomenology and symbolic interaction are also important to consider when conducting a qualitative research method (Merrian, 2009). Phenomenology is associated with the way individuals experience a reality through the use of their senses and symbolic interaction with the way individuals create meanings through interactions (Merrian, 2009). Moreover, Biddix (2018) highlights that context is also relevant, since it could create an impact on an individual experience.

According to Biddix (2018) this type of method has been the most used by students over the past decades, since it enables a holistic knowledge and consequently a deeper understanding of the research topic. The latter, is increased also by the in-depth analysis this method enables through the generation of multiple perspectives when facing a problem (Biddix, 2018).

The main qualitative methods are: review, observation and interview (Biddix, 2018). Similarly, Merrian (2009) points out that, document analysis, observation and interviews constitute the basic qualitative research methods. This suggests that document analysis and review method might refer to the same method. To this end in the following paragraphs each of the main qualitative methods are defined.

Biddix (2018) defines the review method as a noninteractive method meaning that there is no direct interaction between individual-researcher since it consists of a deep analysis and evaluation of existing information from different sources. These sources could be: popular culture documents, public records, personal documents, films, videos, photographs, websites or physical material/artefacts (Biddix, 2018, Merrian, 2019). Merrian (2009, p.140) defines document as "as the umbrella term to refer to a wide range of written, visual, digital, and physical material relevant to the study at hand".

The observation method consists of data collection about individual's behaviour, specific locations and events. (Biddix, 2018). This method in comparison with the review method is more versatile since it could involve direct interaction between individual-researcher (Biddix, 2018).

According to Merrian (2009) the interview method consists of the data collection of individuals or group of individuals perspectives about a selected topic. Merrian (2009) points out that this method is mostly interactive meaning a direct interaction between individual and researcher or group of individuals and researcher. "Interviewing is necessary when we cannot observe behavio[u]r, feelings, or how people interpret the world around them" (Merrian, 2009, p.88). According to Merrian (2009) there are three types of interview: highly structured, semi-structured and unstructured (See Figure 5).

| *Highly Structured/ Standardized* | *Semistructured* | *Unstructured/Informal* |
|---|---|---|
| • Wording of questions is predetermined<br>• Order of questions is predetermined<br>• Interview is oral form of a written survey<br>• In qualitative studies, usually used to obtain demographic data (age, gender, ethnicity, education, etc.)<br>• Examples: U.S. Census Bureau survey, marketing surveys | • Interview guide includes a mix of more and less structured interview questions<br>• All questions used flexibly<br>• Usually specific data required from all respondents<br>• Largest part of interview guided by list of questions or issues to be explored<br>• No predetermined wording or order | • Open-ended questions<br>• Flexible, exploratory<br>• More like a conversation<br>• Used when researcher does not know enough about phenomenon to ask relevant questions<br>• Goal is learning from this interview to formulate questions for later interviews<br>• Used primarily in ethnography, participant observation, and case study |

*Figure 5. Interview structure continuum (Merrian, 2009, p.89)*

The highly structured interview is used when the researcher's goal is to gather common data mainly sociodemographic through predetermined questions, therefore the answers obtained do not enable the researcher to access participant's perspectives due to the rigidity of the interview (Merrian, 2009). In contrast, the semi-structured interview is more flexible and does not contain rigid structured questions in order to allow the researcher to have access to the participants point of view through a more flexible environment (Merrian, 2009). Turning now to the unstructured interview, it has an exploratory focus in which the researcher learns through the conduction of a set of non-predetermined questions (Merrian, 2009).

Biddix (2018) points out that qualitative research may involve more than one method, and this multiple application of methods not only enhances a deeper understanding but also adds legitimacy and rigour to the research. What follows is an account of the qualitative research instruments.

### 3.1.2. Qualitative research instruments

Although there are three main qualitative research methods, which will be discussed in this section, there also exists other instruments for data collection. Biddix (2018, p. 85) defines instrument as "a guide for recording data".

It is very interesting that Biddix (2018) consider researchers themselves as instruments, he points out that they are directly involved in the process of recording data, therefore they are classed as an instrument. Moreover Biddix (2018) adds that guides, forms and questionnaires are also considered qualitative research instruments for data collection. However, the main instruments are: review guides, observations forms and interview questionnaires (Biddix, 2018). As discussed in section 3.1.1, instruments could also fall in the following categories: structured, semi-unstructured and unstructured. A brief description of the main qualitative instruments will be presented below.

1. Review Guide: This type of instrument falls into a structured category, since it is conducted through a highly standardised form in order to collect known and observable facts of document data sources (Biddix, 2018).

2. Observation Form: This type of instrument also falls into a structured category, since it is conducted through a high standardised approach in which the observation form is used to ensure the researcher is highly focused on the specific research theme, including elements such as time, location and details (Biddix, 2018).

3. Interview questionnaire: This type of instrument, compared to the previous two, is the most flexible of all, since it can be adapted depending on the focus of the researcher's study: structured, semi-structured and unstructured (Biddix, 2018). However, the most used approach is the semi-structured approach since it mostly consists of a wide range of questions which could comprise the following data sets: demographics, behaviours, experiences, opinions, values, factual information and feelings (Biddix, 2018).

### 3.1.3. Qualitative research method- the importance of sample selection

As noted by Coyne (1997), sample selection has a direct impact on the research quality. Therefore, rationale and credibility are the primary criteria for sample selection (Biddix, 2018). The term rationale in qualitative research for sample selection is defined by Biddix (2018) as to follow a logical justification for the research purpose. As with regards to the credibility term, Biddix (2018) defines it as to make a proper use of reliable procedures and sources.

Another significant aspect for sample selection is that it needs to intentionally fit the research purpose (Coyne, 1997). Thus, the following factors such as: data knowledge, access, availability and time constraints influence the sample selection (Biddix, 2018). However, it is crucial that a balance is maintained between quantity and content richness (Biddix, 2018). In addition to this argument, Mason (2010, p.14) points out that "the sample size becomes irrelevant as the quality of data is the measurement of its value". According to Biddix (2018) researchers mostly follow either a criterion sampling strategy or a snowball sample strategy.

"Criterion sampling involves specifying a phenomenon, experience, or event and locating participants that meet the criteria" (Biddix, 2018, p.84). The selection of this strategy is mainly guided by the research goals and it involves the researcher's knowledge in order to identify the specific characteristics that the selected dataset or population should have in order to provide the information needed (Biddix, 2018). In contrast, "snowball sampling involves locating information-rich sources based on source recommendations" (Biddix, 2018, p.85). Therefore, this suggests that once a data source or an individual is selected, this selection automatically leads by reference to other possible relevant sources for data collection. The analysis of qualitative data will be explained in the following section.

### 3.1.4. Qualitative research method- Analysis of data collection

"Data analysis is the process of making sense out of the data" (Merrian, 2009, p.175). Merrian (2009) points out that the analysis process starts with the identification of data that provides answers to the focus of the research study or research question. Miles, Huberman, and Saldana (2015, cited by Biddix 2018) point out that data analysis comprises three main tasks:

1. Data condensation: This task mainly refers to the process of identifying and transforming data frequently involving a coding approach.
2. Data display: This task mainly refers to the creation process leading to an organised set of data that could help to sketch conclusions.
3. Drawing and verifying conclusions: This task mainly refers to a careful interpretation process of the data allowing conclusions to be formed that are consequently grounded in the research context but are derived via an open minded approach.

In contrast Merrian (2009) breaks down the step-by-step process of qualitative analysis as follow:

1. Category construction: This initial step consists of reading the data sets collected and identifying the information that is relevant for the research purpose, followed by dividing the identified data into discrete bits of information that can be built into categories. It is important to note, that Merrian (2009, p. 178) also uses the category term as … "a theme, a pattern, a finding, or an answer to a research question". Moreover, is important to mention that, similarly to Miles, Huberman, and Saldana (2015, cited by Biddix 2018) Merrian (2009) points out that, coding is an essential first step in this process, since it is from this that categories are constructed. Moreover, it is very important to highlight that Merrian (2009, p.181) points out that… "categories are abstractions derived from the data, not the data themselves". This abstraction refers to capture "recurring pattern[s]" from the gathered data (Merrian, 2009, p.181). Therefore, this could be interpreted as the sensibility and ability of a researcher to identify the essence within a given dataset, which enables the connection from one person to another, despite the words used. However, this could be argued to be subjective, due to a researcher's personal involvement or indeed the

hypothesis under consideration. This suggests, that the researcher could avoid bias by sharing the category constructions with other people involved in the study, such as supervisors.

2. Sorting categories and data: This step consists of a deep deductive analysis of the previously constructed categories. This involves determining which categories are grounded and which are not and upon reflection adjusting the assignment of categories and data as appropriate.

3. Naming the categories: This step, involves a balance between intuition and congruence, since the naming should match the research question/purpose. Moreover, the categories should follow the following criteria:

- "Categories should be responsive to the purpose of the research" (Merrian, 2009, p. 185). As mentioned in the paragraph below categories should reflect the answers of the research question/purpose (Merrian, 2009).

- "Categories should be exhaustive" (Merrian, 2009, p. 185). All the selected data should be encompassed within the selected categories (Merrian, 2009).

- "Categories should be mutually exclusive" (Merrian, 2009, p. 185). This refers to a perfect fit, meaning that two categories cannot converge (Merrian, 2009).

- "Categories should be sensitizing" (Merrian, 2009, p. 186). Thus categories should offer a clear insight in to the data contained within them and inform the reader by their specificity (Merrian, 2009).

- "Categories should be conceptually congruent" (Merrian, 2009, p. 186). This refers to maintaining the same level of abstraction between all the categories constructed.

4. Becoming more theoretical: According to Merrian (2009, p.188) “The categories describe the data, but to some extent they also interpret the data”. Therefore, this step consists of the interpretation generated from data collection to draw conclusions or making links between categories that could enable the generation of theory (Merrian, 2009). The creation of a visual representation of the relation between categories, through a model or diagram allows the researcher to find possible interrelationships between categories, which could lead to the development of a model or theory that provides meaningful data to the research (Merrian, 2009).

The mode of explaining a quantitative analysis process between Miles, Huberman, and Saldana (2015, cited by Biddix 2018) and Merrian (2009) is quite similar. However, the step by step process provided by Merrian (2009) is much more descriptive enabling a better understanding and consequently a more complete guide to analyse qualitative data.

### 3.1.5. Qualitative research – Coding and its approaches

Biddix (2018, p.88) defines the term coding as… "a process of data analysis that involves identifying patterns and themes in qualitative data to represent findings". Merrian (2009, p. 173) defines the same term as …"nothing more than assigning some sort of shorthand designation to various aspects of your data so that you can easily retrieve specific pieces of the data". Therefore, it could be interpretated that both authors give emphasis to analysing data, although Merrian (2009) does not express it directly. In addition Biddix (2018) suggest the following approaches for coding:

1. Basic: This approach also might be identified by descriptive coding and consists of … "reviewing data, searching for interesting aspects and recurring regularities" (Biddix, 2018, p. 89). *In vivo coding,* which refers to the use of exact words or phrases from the data set is an extension of this type of approach (Biddix, 2018).

2. *A priori*: This approach in contrast with the basic approach consists of the identification of categories from theory, in order to have a clear idea of what specific terms the researcher needs to find in the collected data (Biddix, 2018).

3. Constant comparative: This approach consists of … "coding an initial data source to create tentative categories, then comparing those categories to a second source until a set of themes can be developed" (Biddix, 2018, p. 89-90). This suggests, that prior to a theme development the categories should be analysed deeply.

This section of the chapter has provided a brief summary of the literature relating to qualitative research. The next part of this chapter moves on to consider quantitative research which will highlight the differences between these two discrete areas.

### 3.2 Quantitative research

*"Quantitative research* seeks to identify and explain reality as it exists. Quantitative research is characterized by the use of numerical data" (Biddix, 2018, p.162). This type of research follows a post positivism perspective (Biddix, 2018; Creswell, 2014). See Figure 6.

According to Merrian (2009) this type of perspective aims to describe reality as observable, measurable and stable. Moreover, Merrian (2009) adds that scientific knowledge is acquired through this perspective, since it implies the conduction of experimental research.

In addition, Creswell (2014, p.4) points out, that quantitative research… "is an approach for testing objective theories by examining the relationship among variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures".

| | *Positivist/ Postpositivist* | *Interpretive/ Constructivist* | *Critical* | *Postmodern/ Poststructural* |
|---|---|---|---|---|
| Purpose | Predict, control, generalize | Describe, understand, interpret | Change, emancipate, empower | Deconstruct, problematize, question, interrupt |
| Types | Experimental, survey, quasi-experimental | Phenomenology, ethnography, hermeneutic, grounded theory, naturalistic/ qualitative | Neo-Marxist, feminist, participatory action research (PAR), critical race theory, critical ethnography | Postcolonial, poststructural, postmodern, queer theory |
| Reality | Objective, external, out there | Multiple realities, context-bound | Multiple realities, situated in political, social, cultural contexts (one reality is privileged) | Questions assumption that there is a place where reality resides; "Is there a there there?" |

*Figure 6.Epistemological perspectives (Merrian, 2009, p.11).*

The following part of this chapter moves on to describe in greater detail the quantitative methods.

### 3.2.1. Quantitative research methods

According to Biddix (2018) there are four main quantitative research methods:

1. Descriptive: This type of method consists of the condensation of specific units of information in order to facilitate the researcher's interpretation of data and the capability of using data efficiently; this can be visually represented in graphics (Biddix, 2018)

2. Difference: This method involves of making comparisons between samples, in order to facilitate the researcher's ability to categorise data based on samples differences, and of tracking specific data over time (Biddix, 2018).

3. Relationship: This type of method consists of the examination of variables correlation, in order to not only enable data verification/ theory validation but also to identify potential research variables (Biddix, 2018).

4. Prediction: This approach consists of estimating changes in individual measures such as: attitudes, beliefs, characteristics and values, on determined outcomes (Biddix, 2018).

In addition, according to Hammersley and Campbell (2012) a quantitative research method mostly complies with the following:

1. Hypothesis testing: At the start of the research a hypothesis is proposed and then the data that is required to validate that hypothesis is identified, including any instruments needed to collect the data and any subsequent analysis required.

2. Numerical data: Numerical data can take the form of specific counts or instances, but also measurements e.g. height or weight. Counting or ranking can often be viewed as inferior to measurement.

3. Procedural objectivity: Data collection procedures (Counting or measuring) must be objective and the method in which the data is collected needs to ensure that it is immune to any bias of the researcher.

4. Generalisation: This consists of the use of statistical techniques in order to enable the validation of data sample collected where it is desirable to extend the conclusions to a wider population.

5. Identification of systematic patterns of association: This consists of the use of statistical techniques not only to describe patterns in the data but also to test data correlation.

6. Control of variables: During experimental design attempts are often made to control variables such that any systematic variance within a system doesn't affect any conclusions that can be drawn from variations in the causal variable under investigation. A similar concept can be applied to statistical analysis of populations. More information about variables in quantitative research can be found in section 3.2.3.

### 3.2.2. Statistics in quantitative research

Although quantitative and statistical terms are related to each other they cannot be used as synonyms (Biddix, 2018). "Quantitative refers to data that can be counted (or quantified)" (Biddix, 2018, p. 169). On the other hand, "A *statistic* is the value calculated from a sample" (Biddix, 2018, p.170). However, the term parameter estimate could also be used instead of statistic since it consists of… "estimating the true value (parameter) based on a sample" (Biddix, 2018, p. 170). According to Efron and Ravid (2013) the application of statistical tests are fundamental for quantitative research since these provide support to a hypothesis. In addition, the statistical procedures employed enable the researcher to deeply analyse the numerical gathered data (Efron and Ravid, 2013). Visual representations can facilitate the analysis of data enabling the identification of correlations, differences and trends between variables (Efron and Ravid, 2013).

According to Biddix (2018) statistics can be categorised in two groups:

1. Descriptive: This form of statistics is also known as trend statistics and consists of the description and integration of measures to enable data condensation about sample data.

2. Inferential: This type of statistics consists of making inferences based on the sample data.

### 3.2.3. Variables in quantitative research

Biddix (2018) points out that a researcher constructs or selects variables to allow analysis after data collection. “A *variable* is a measured or manipulated quantity or trait” (Biddix, 2018, p. 171). According to Biddix (2018) variables can be categorised in two ways:

1. Independent: …”is a measured or manipulated quantity or trait that is believed to affect an outcome” (Biddix, 2018, p. 172). Independent variables vary depending on the sources selected for data collection (Biddix, 2018). For example: Demographic data, cognitive data and questionnaire responses are considered independent variables if individuals are selected as a data source (Biddix, 2018).
2. Dependent: …”is an outcome affected by one or more independent variables” (Biddix, 2018, p.172).) This suggests that if in a study, multiple independent variables from demographic data such as age, gender and residence are used in order to determine a factor this will be considered as a dependent variable.

According to Biddix (2018) researchers classify variables into four groups:

1. Nominal: This refers mainly to qualitative responses; an example can be a yes/no response.
2. Ordinal: This refers to the organisation of data depending on their intrinsic value; an example can be medals in a sport competition: gold, silver and bronze.
3. Interval: This refers to the organisation of data based on a measurable value; an example can be a Likert scale.
4. Scale: This refers to the organisation of data based on a numeric range from zero to infinite; an example can be service hours.

In addition, Biddix (2018) points out, that variables can be classified based in its distribution into two main categories:

1. Nonparametric measures: This refers to nominal and ordinal variables, which do not have a numerical value.
2. Parametric measures: These are interval and scale variables, which have a defined numerical value.

### 3.2.4. Quantitative research – Data analysis

"The goal of quantitative data analysis is to answer research questions posed before the start of the study" (Efron and Ravid, 2013, p.190).

According to Efron and Ravid (2013) there are six steps for analysing quantitative data. However, this section will only present the three steps that are considered fundamental to rigorous analysis and their subsequent presentation.

1. "Entering, Organizing, Graphing, and Tabulating Data" (Efron and Ravid, 2013, p.191). This step consists mainly of data inspection after data collection, through this inspection the researcher would need to code variables and assign them measurable values (Efron and Ravid, 2013). Regarding the graphing procedure, Efron and Ravid (2013) point out that, the type of graph selected should be able to reflect easily the specific type of data you want to emphasise. For example: histogram and polygon type of graphs are selected when the aim is to represent a frequency distribution. On the other hand, pie graphs, are …" an effective tool to display segments of data that add up to 100%" (Efron and Ravid, 2013, p.194). Bar graphs consists of reflecting numerical data organised by height (Efron and Ravid, 2013). According to Efron and Ravid (2013) line graphs aim to reflect progressions or trends over time and are represented by one or more horizontal lines that contain two axes (horizontal, vertical) the horizontal axe displays the continuum data and the vertical axe displays the changing variable. However, crosstabs or data tabulation is also another way to represent and organise data, this consists of calculating and summarising data.

2. Analysis of numerical data. This step could be realised through two approaches. The focal point of the first one is the correlation between variables. In contrast to the second one, where the focal point is the difference between variables.

3. Findings presentation. This step consists of projecting the quantitative data findings in an objectively and systematically manner; the use of tables and graphs are mostly found in the results section in order to represent findings visually (Efron and Ravid, 2013). Moreover, the researcher should highlight every finding that could be related to the research question/ hypothesis of the study, such as patterns or trends (Efron and Ravid, 2013).

This section has provided a brief summary of the literature relating to quantitative research and the comparison of these two approaches, qualitative and quantitative, will form the basis for the next section of discussion.

## 3.3 Qualitative and Quantitative Analysis – Discussion

According to Gephart (2004) the qualitative and quantitative analysis have different focus; the first one has a humanistic and the latter a mathematical focus. "An important value of qualitative research is description and understanding of the actual human interactions, meanings, and processes that constitute real life organizational settings" (Gephart, 2004, p.455). "Quantitative, positivist research, in contrast, imposes scientific meanings on members to explain a singular, presumed-to-be true reality that non-scientists may not appreciate" (Gephart, 2004, p.455).

According to Gephart (2004) the pros of using qualitative research is that it provides a deep understanding of human interactions through detailed descriptions. Moreover, the author points out, that this type of research enables the creation of concepts and meanings with regards to a research problem grounded on substantiated insights. According to Neuman (2014) the creation of concepts is fundamental for the qualitative research analysis, since it is a way of not only organising the data but also creating connections between concepts. "Qualitative researchers develop concepts, insights, and understandings from patterns in the data rather than collecting data to assess preconceived models, hypotheses, or theories" (Taylor, Bogdan and DeVault, 2015, p.18). The pros of using quantitative research are that it "codes, counts, and quantifies phenomena in its effort to meaningfully represent concepts" (Gephart, 2004, p.455).

This study encompasses both humanistic and the scientific knowledge. Therefore, both, qualitative and quantitative research are utilised, though to differing degrees, to improve the rigour of the study.

## 3.4 Mixed Methods Research - Qualitative & Quantitative - The importance of an interpretative approach

"Mixed methods involves combining or integration of qualitative and quantitative research and data in a research study" (Creswell, 2014, p.14). "An interpretative approach to research aims to understand how individuals make meaning of their social world" (Hesse-Biber, 2010, p.104). According to Hesse-Biber (2010), the interactions between individuals is what constitutes a social world.

Hesse-Biber (2010) points out that an interpretative approach is not distinguished by the types of research methods used but by the philosophical (ontological and epistemological) standpoint that the researcher applies in their research. See Figure 7. "The interpretative approach does not accept the idea of an 'objective reality' that a positivistic approach takes as given" (Hesse-Biber, 2010, p.104-105). Therefore, it could be understood that the interpretative approach merges the subjectivity and objectivity of a social situation. According to Hesse-Biber (2010) a mixed method research applying an interpretative approach merges qualitative and quantitative methodologies in order to achieve a better understanding of people contexts and experiences.

Interpretative Approaches 105

| | Subjective ⟵ | ⟶ Objective |
|---|---|---|
| **Ontology:** What is the nature of the reality? | Social reality is multiple. | There is a concrete social world "out there." |
| **Epistemology:** What can we know and who can know? | Goal is to understand multiple subjectivities. Individuals are the "experts." Through intersubjectivity we understand human behaviors. There is no definitive subject–object split in knowledge building. | Goal is to ascertain the "truth" in order to predict and even uncover "laws" of human behavior through objective social inquiry. Scientists are the experts. |

*Figure 7.Philosophical standpoints in the research (Hesse-Biber, 2010, p.105)*

### 3.4.1. Mixed Methodology Research Designs

Mixed method is a type of research in which, in order to obtain a more substantiated and validated knowledge, qualitative and quantitative approaches are merged in order to guide the researcher through an open-window of perspectives and positions, with regards to the analysis of a research problem (Johnson, Onwuegbuzie and Turner, 2007).

According to Hesse-Biber (2010) in the mixed method there are two main design categories: parallel mixed methods design and a sequential mixed methods design. Sequential mixed methods design can then be further subdivided into exploratory sequential design and explanatory sequential design (Hesse-Biber, 2010). Similarly Creswell (2014) points out that there are three main models in mixed methods: Convergent parallel, explanatory sequential and exploratory sequential. In the following paragraphs the points of view of Hesse-Biber (2010) and Creswell (2014) will be presented.

1. Convergent parallel/ Parallel mixed method: According to Hesse-Biber (2010) a parallel mixed method consists of carrying out both, qualitative and quantitative methods during research. Interestingly according to Hesse-Biber (2010) the qualitative and quantitative data does not merge until the writing period, but this is done only to support the qualitative findings, since this latter aspect has the dominant role in this type of method. See Figure 8.

   However, the point of view of Hesse-Biber (2010, p.70) is quite contradictive since the author also points out the following: "A parallel design is also used for those research projects with both dominant qualitative and dominant quantitative components, although in this instance they address different aspects of a larger research problem". Therefore, this suggests that this type of method could adapt the dominance of either qualitative data or positioning both (qualitative and quantitative data) at the same dominant level, depending on the research problem.

   In contrast, Creswell (2014, p.15) defines a convergent parallel method as a… "design in which the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem. In this design, the investigator typically collects both forms of data at roughly the same time and then integrates the information in the interpretation of the overall results. In contrast to Hesse-Biber (2010), Creswell (2014) does not highlight the importance of giving a dominant role to either qualitative or quantitative data. However, Creswell (2014) and Hesse-Biber (2010) believe that this convergent parallel method enables the researcher to become more reflective, due to a more comprehensive analysis of different type of data findings. The evidence presented in these two paragraphs suggests that Creswell (2014) provides a more understanding definition for a parallel mixed method.

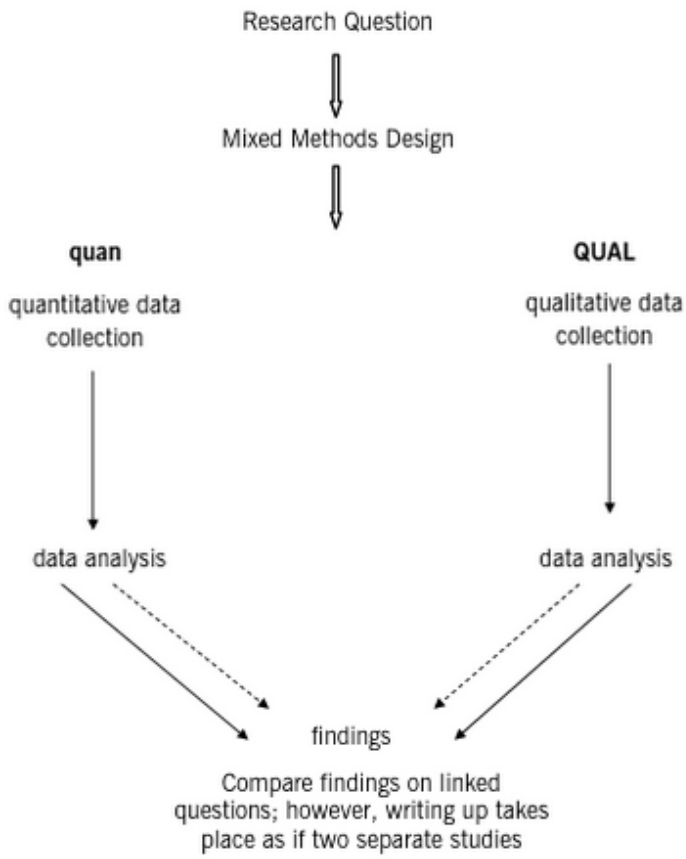



*Figure 8. Parallel mixed methods design (Hesse-Biber, 2010,p.69)*

2. Sequential mixed methods design: According to Hesse-Biber (2010) this design can be further subdivided into exploratory sequential design and explanatory sequential design (Hesse-Biber, 2010).

2.1. Exploratory sequential design: Hesse-Biber (2010, p.71) defines it as follows "In a sequential exploratory mixed methods design, the qualitative component is primary and is used to generate theory or specific theoretical constructs. The quantitative component is used in the service of the qualitative in that it "tests out" ideas generated from the qualitative component". See Figure 9. Moreover Hesse-Biber (2010) points out that this process could be repeated if needed and uses waves to pictorially exemplify how the process would manifest itself. See Figure 10. In addition, Hesse-Biber (2010) mentions that although it is not common, an exploratory design can also starts with a quantitative research followed by a qualitative research. However, Hesse-Biber (2010) stresses that focal point is the qualitative component.

Creswell (2014, p.16) points out, that… "In the exploratory sequential approach, the researcher first begins with a qualitative research phase and explores the views of participants. The data are then analy[s]ed, and the information used to build into a second, quantitative phase". Collectively, these authors' points of view, outline that an exploratory sequential design gives more importance to the qualitative research methodology and uses the quantitative findings in order to give an interpretation of the data yielded from the qualitative methodology.

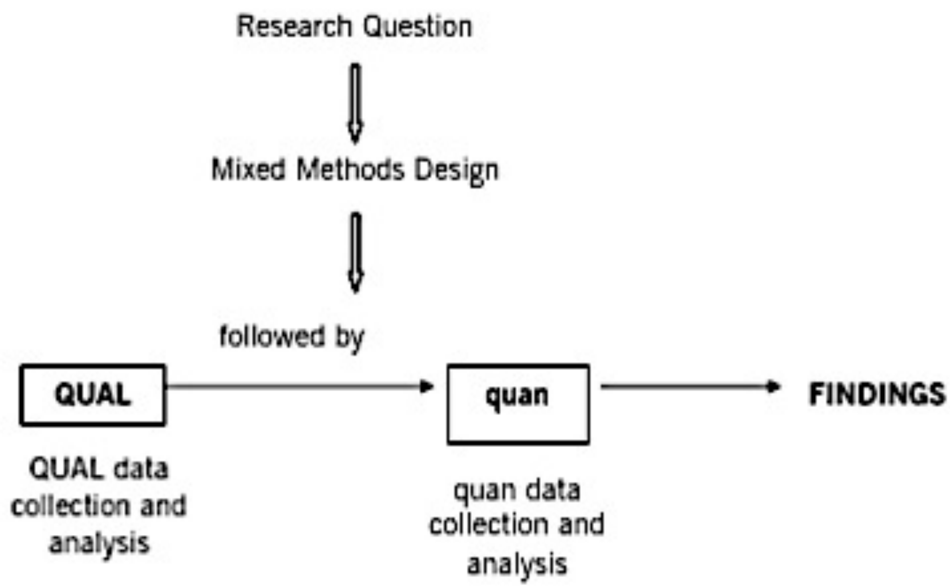



*Figure 9. Exploratory sequential design (Hesse-Biber, 2010,p.71)*

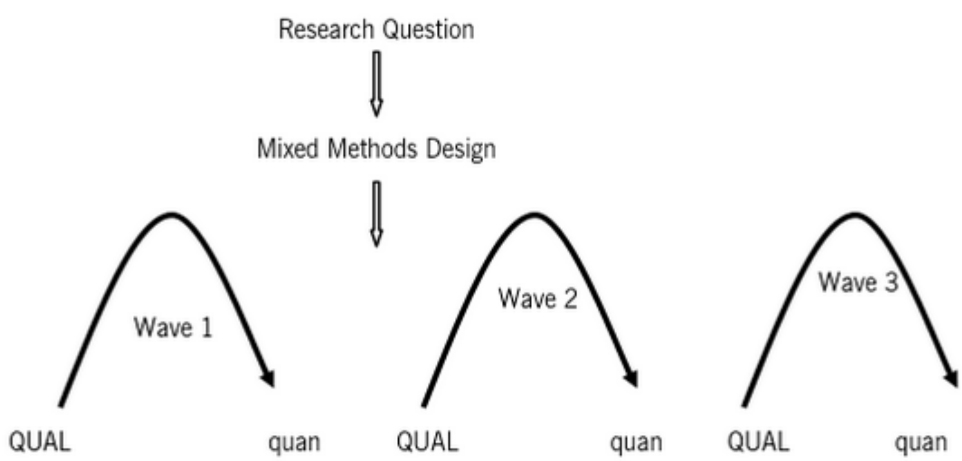



*Figure 10. Integrating methods in a sequential exploratory design (Hesse-Biber, 2010,p.72)*

2.2. Explanatory sequential design: According to Creswell (2014, p.15) in this type of design…"the researcher first conducts quantitative research, analy[s]es the results and then builds on the results to explain them in more detail with qualitative research". Moreover, Creswell (2014, p.15) stresses that "It is considered explanatory because the initial quantitative data results are explained further with the qualitative data". This suggests that the focal point of this type of design are the quantitative findings and the qualitative findings are used to support the quantitative methodology in contrast with exploratory design.

Hesse-Biber (2010) points out, that this research design begins with a quantitative methodology (data collection- analysis) using the findings from this first phase to continue the second phase with a qualitative methodology (data collection-analysis). See Figure 11.

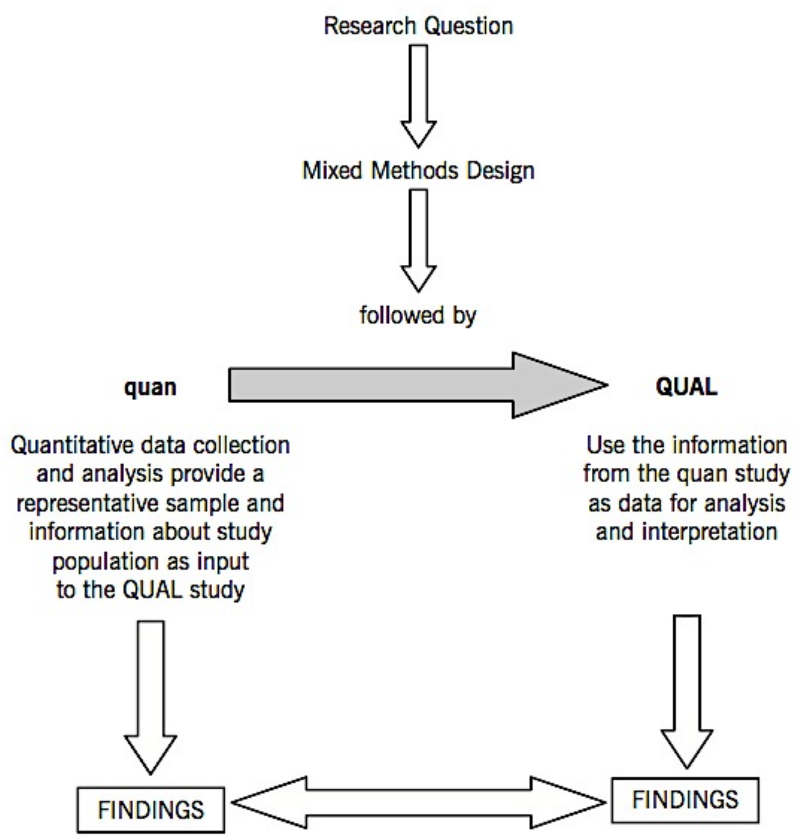



*Figure 11. Explanatory sequential design (Hesse-Biber, 2010, p.73)*

### 3.4.2. Mixed Methods - Challenges

According to Hesse- Bieber (2010) these are the challenges that a researcher may encounter when conducting a mixed methodology approach:

1. *Time*: This refers mainly to an unexpected delay in either the conduction of a qualitative research methodology or a quantitative research methodology, due to the integration of the two methodologies in a study (Hesse- Bieber, 2010).

2. *New research skills*: The integration of the qualitative and quantitative methodologies may require additional new knowledge of a different research team, which could provide new skills or development of the researcher's own skill set (Hesse- Bieber, 2010). In this study, it was deemed necessary that further knowledge in the field of chemistry was required in order to carry out the experimental section.

3. *"More is not necessarily better"* (Hesse-Biber, 2010, p.125): The addition of a methodology does not always lead to a better understanding of the research problem. This is the reason why Hesse-Biber (2010) suggests, prior to selecting a mixed method, to analyse if the addition would enhance new knowledge or a more grounded theoretical outcome.

## 3.5 Rationale behind the mixed methodological design of the study

According to Hesse-Biber (2010), the priority of the research is the research question/problem not the methodology used. However, an understanding of research methodologies is needed in order to lead to a desirable research outcome (Hesse-Biber, 2010). Mixing qualitative and quantitative methodologies enables more dynamic research to be undertaken, which consequently enables the triangulation of findings in order to provide more robust theory (Hesse-Biber, 2010). To conclude, selecting a methodology requires a deep understanding of the research question/problem in order to select the most appropriate way to guide the research through a specific methodology (Hesse-Biber, 2010).

In this study a mixed method was selected since the research problem involves multidisciplinary variables such as chemistry, design and social marketing. Therefore, a combination of qualitative and quantitative methodologies was needed in order to enable the interaction and triangulation of the multiple findings from each discipline. Furthermore, a mixed methodology enhances the validation of the study, generates a more sustained theory, due to the involvement of quantitative and qualitative methodologies (Johnson, Onwuegbuzie and Turner, 2007). In addition a mixed methodology guides the researcher towards open thinking in order to analyse the research problem from different perspectives (Johnson, Onwuegbuzie and Turner, 2007). Moreover this open flexible approach fits with the transition design approach (Irwin, Tonkinwise and Kossoff, 2013), which is one of the main theoretical positions taken for study.

This study cannot be classified as more exploratory than explanatory or viceversa. Since, a mixed methodology, means mixing qualitative and quantitative methodology in which both strengthen and sustain each other. According to Biddix (2018, p.76) “Qualitative research seeks to explore and represent reality as it exists”… On the other hand, “*Quantitative research* seeks to identify and explain reality as it exists"…. (Biddix, 2018, p.162). This suggests that the role of qualitative research is to "explore" and the role of the quantitative research is to "explain". Therefore this study is both exploratory and explanatory and does not fall in a specific category.

The first phase of the study consisted of a scientific experiment in which both quantitative and qualitative data were obtained, through the conduction of experimental work with *Allium Cepa* skin, as an example of a natural dyeing resource from Mexico´s food waste to analyse its performance as a natural dye agent on cotton without metallic chemical additives carrying an evaluation of the dyed fabrics, using standard textile tests to simulate conditions to which the fabrics would be subjected while in an environment of standard use. For the purpose of the study, it was needed first to test and analyse the performance of the natural dyed onion skin dyestuff in the cotton fabric in order to use the gathered numerical data and transform it into qualitative data in order to conduct the second phase of the study.

The second phase of the study consisted of a quantitative-qualitative research through an online survey questionnaire (Chapter 6) in order to validate the hypothesis with the possible users. The hypothesis is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes. However, as mentioned in Chapter 4 (Section 4.1.5-Discussion of Mordants and the negative impacts of their utilisation) not all the metallic chemical additives used in textile dyeing have the same impact on the environment. Therefore, within the context of this study the following metal salts will be considered as polluting substances (chromium, tin, copper).

The limitations of onion skin as natural dyestuff in cotton fabric without metallic chemical additives (colour strength, standardisation and durability) were included in the online survey questionnaire topics along with probing participant's responses to ideas of co-design and generating emotional connections to their garments in order to explore if these approaches could embrace the acceptance of natural dyes performance without metallic chemical additives. In regards to the topic of emotional attachment, the questionnaire format allowed qualitative findings to be garnered in order to know if the chosen demographic cohort (Mexican females in the age range of 18 to 33 years old) would be interested in forming a greater emotional attachment with a garment if they could have an on-going opportunity to be co-designers and re-dyeing their garments any time the natural colour fades using available food waste from their cooking as natural dye sources.

### 3.6 Summary

In this study a mixed research method was utilised in order to obtain a deep understanding of the research problem, which is the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives. The research was conducted in two phases, in which both quantitative and qualitative were equally fundamental :

1. The conducting of scientific experiments to analyse the performance of domestic food waste as a natural resource for textile dyeing and translate this quantitative (numerical) data into qualitative data that could be used to conduct the questionnaire.

2. The conducting of a questionnaire grounded on the data obtained from the experimental section along with additional co-design and emotional approaches. In this phase, again, both quantitative and qualitative methodologies were involved due to the types of questions asked.

The conjunction of the quantitative "explanatory" and qualitative "exploratory" approaches enabled an open-design thinking, in order to analyse the research problem from different perspectives, which led towards the creation of a social marketing intervention model to educate and thus influence the behaviour of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives, in which different disciplines contributed to the creation.

# Chapter 4. Evaluating the performance of *Allium Cepa* skin, as an example of a Mexican food waste resource for natural dyes in wearable textiles

The purpose of conducting experimental work with *Allium Cepa* (onion) skin was to evaluate its performance as an example of a Mexican food waste resource for natural dyes in wearable textiles without metallic chemical additives. In this study, cotton and *Allium cepa* were selected to conduct the dyeing process, because of its relevance to Mexico´s economy.

According to the report of SAGARPA (2017b), Mexico, in 2016, occupied the position of thirteenth in the cotton world producers ranking with a production of almost 488,000 tons. The production of cotton has a positive impact on Mexico´s economy due to the agroindustry. The climatic conditions for the germination of cotton (*Gossypium hirsutum L.)* are optimal in warm temperatures, since the temperature needed for its germination is above 14°C (SAGARPA, 2017b). Mexico, has an average temperature of 23.5ºC annually in the north and central geographic zone (Clima-de.com, n.d). These climatic conditions contribute positively to the production of cotton, especially in these geographic zones.

Although, *Allium Cepa* (onion) does not represent the main crop in Mexico; according to Ochoa Neira (2012) it is the fifth most important crop in Mexico. It was chosen to conduct the experimental phase of the study because of the following rationale: Onion has an important role not only in Mexico´s gastronomy but also in the economic sector (Seminis, 2018; Ochoa Neira, 2012). According to Ochoa Neira (2012, para.1) [Translated to English] "Mexico is the world's leading producer of fresh onion with more than 1.4 million tons per year". However, 32% of Mexico´s onion production per year ends in landfills (gob.mx, 2013). This suggests that .448 million tons of onion ends in waste per year. In addition, the particular aroma and the accelerated growth of phytopathogenic agents on onion (Waldron 2001, cited by Benítez *et al.*, 2011) makes it challenging to find alternative applications to onion waste, which may be profitable in any economic sector. In addition, whilst other crops may be grown on a greater scale than onions, they do not necessarily contain natural colourants, meaning they do not have a role to play in this study. White maize for example is the main crop in Mexico (inegi.org.mx, 2019b), however there were no studies found with regards to the existence of natural colourants within white maize. Therefore, this study aims to evaluate the possibility of adding value to onion skin waste through its application as a natural dyestuff. In addition, the social marketing intervention model that this study proposes, aims to motivate the target audience to initiate domestic natural dyeing making use of their kitchen waste as natural dyestuffs. Onion is very versatile in the Mexican cuisine, at least 250 grams of onion is consumed per Mexican per week, or 13 kg per year (Ochoa Neira, 2012). Furthermore, fresh onion is available in Mexico throughout the year, due to its availability to be sown in the autumn-winter and spring-summer cycles (Ochoa Neira, 2012). This suggests that *Allium Cepa* (onion) skin could be part of the target audience kitchen waste. It should be noted that the experimental phase of this study was conducted in the UK and *Allium Cepa* (onion) was widely available there.

Moreover, to date, several studies such as, Rehman *et al.* (2013), Zubairu and Mshelia (2015), and Uddin (2014) have investigated the application of natural dyes extracted from onion skin to dye fabrics; this could be attributed to the textile industry's recent interest in natural dyes (Patel, 2011). However, this study does not aim to change the structure of cotton or modify the colour strength and colourfastness properties of the natural dyestuff extracted from onion skin by adding metallic chemical additives. In comparison to Rehman *et al.* (2013), who suggested changing the surface structure of cotton and the application of mordants (iron, alum). Similarly, Uddin (2014) in order to obtain different colour hues and improve the colour fastness properties of onion skin dye stuff used different metallic mordants and Zubairu and Mshelia (2015), who in order to improve the colour fastness of onion skin dye stuff investigated using metallic mordants (potassium dichromate, iron sulphate, copper sulphate, alum) and natural mordants (aloe vera and lemon). However, the study conducted by Zubairu and Mshelia (2015) concluded that iron sulphate, which is a metallic mordant, gives the best results in colourfastness in comparison with the rest.

This experimental phase of this study, investigates if sodium chloride (NaCl), better known as common salt:

1. Can improve the dye extraction process
2. Will change the dyeing process.

The technical motivation for using NaCl is to facilitate the dye extraction process and to improve the dye intake and colour yield of the onion skin dyestuff on the cotton fabric. According to KOH (2011), the dyeing rate and colour yield of direct dyes on cellulose fabrics are improved through the addition of inorganic salts, such as sodium chloride or sodium sulphate to the dyebath. Similarities between direct dyes and onion skin dyestuff will be described in section 4.1.8. In addition, as mentioned previously, the strategic tools of the social marketing intervention model that this study proposes, aims to motivate the target audience to initiate domestic natural dyeing and sodium chloride, due to its ease availability, could be used in a domestic situation.

Two different onion skin colour varieties were selected, brown and purple. In order to avoid the complex mixture of polluting substances, when compared to the synthetic dyeing process and consequently provide a lower ecological footprint textile dye alternative, NaCl was the only compound added during the extraction and dyeing process.

In order to evaluate the proposition, an ultraviolet-visible spectroscopy (UV/Vis) test was conducted with the onion skin extractions and the following standard tests for wearable textiles: fastness to washing, light, and dry cleaning were conducted; in order to stimulate the conditions to which the dyed cotton fabric would be subjected while in an environment of standard use.

### 4.1. Literature review

#### 4.1.1 *Allium Cepa* outer skin – The environmental impacts of this food waste

It is estimated that almost half a million tonnes of onion waste are disposed of into landfill sites each year in Europe (Emmett, 2003). In Mexico, 32% of onion production per year ends in landfills (gob.mx, 2013). This suggests that .448 million tons of onion ends in waste per year in Mexico. In the United Kingdom (UK), Holland, Italy and Spain most of this onion waste is its outer skin, since it does not have an application, not even considered suitable as fodder (Emmett, 2003). The particular aroma and the accelerated growth of phytopathogenic agents does not make onion suitable as an organic fertiliser (Waldron 2001, cited by Benítez *et al.*, 2011).

According to Moult *et al.* (2018), one of the best food waste disposal options for food retailers in the UK, which create less greenhouse gas emissions (GHGs), is its conversion to fodder. Conversely, landfill was ranked in the study conducted by Moult *et al.* (2018) as the disposal option with major impacts on GHGs. Moult *et al.* (2018) point out, that food waste in landfills produces primarily methane and carbon dioxide gases, during its decomposition. Although methane could be captured and used for other purposes such as an electricity generation, the authors state: "Landfill, even at a modern site capturing and utilising 70% of generated methane, is the worst option for all food types by a clear margin" (Moult *et al.*, 2018, p.57). Although, this study was conducted in the UK, it provides insight into the negative environmental impacts that food waste disposal into landfill may be generating in other countries. Therefore, if onion skin is not considered suitable as fodder, an application that could add value to this food waste is needed in order to reduce its disposal into landfills.

If onion skin, becomes social accepted as a natural dyestuff for wearable textiles without metallic chemical additives, this could contribute to a reduction of its disposal into landfills, and consequently to the reduction of GHGs. Although, its application as a natural dyestuff for wearable textiles does not ensure that it will not end in landfill, it could still be subsequently used in the food industry. According to Emmett (2003), once colour is taken out of the onion skin, this co-product could be used as a fibre source in food products such as yoghurts. "Onion fibre is so fine that it can be added to what are known as 'texturally-sensitive' foods like yoghurts and other dairy-based products" (Waldron, cited in Emmett, S., 2003, §3).

Moreover, this application as a natural dyestuff for wearable textiles without metallic chemical additives, could not only benefit the farmer's income by obtaining profits from selling this food waste, but also farmers could be positively impacted by cleaner waterways without the over use of harmful chemicals from the textile dyeing processes. However, these aspects are outside the scope of this study and it is only a possible scenario once the social marketing intervention model developed in this study is applied over the long-term."Water is a critical input for agricultural production and plays an important role in food security" (worldbank.org, 2020a, §1). According to Guadarrama-Brito and Galván Fernández (2015) the industrial wastewater discharges in Mexico have the potential to affect the population wellbeing since the contaminants migrate via different routes such as, agricultural irrigation and livestock.

The water situation of Mexico is generating serious problems in different sectors, since it is over exploited and polluted (Guadarrama-Brito and Galván Fernández, 2015). Moreover, it affects the Mexican population, since accessibility to clean water is limited (Investopedia, 2019).

According to Guadarrama-Brito and Galván Fernández (2015) agriculture is one of the economic sectors affected by Mexico´s water situation, since the principal use of wastewater in the country is in this sector. Wastewater in Mexico is defined as: [Translated to English] "Water of varied composition from discharges of municipal uses, industrial, commercial, service, agricultural, livestock, domestic, including housing and in general of any other use, as well as the mixing of them" (Comisión Nacional Del Agua, 2004, p.131).

Guadarrama Brito and Galván Fernández (2015), point out that in Mexico the volume of industrial wastewater that ends up in agricultural land without any prior treatment has increased significantly. This is the reason why, Guadarrama Brito and Galván Fernández (2015) conducted a test in the city of Tulancingo (Mexico), more specifically in the irrigation district 028-Tulancingo to evaluate the migration of metallic chemicals from industrial wastewater discharges to agricultural land and they discovered the presence of copper, manganese and zinc.

According to worldbank.org (2020b), agriculture, besides being a key sector for economic growth, contributes to better living conditions especially in least developed countries (LDCs). An analysis conducted in 2016, revealed that agriculture was the main economic support for almost 70% of working adults classed as living in poverty (worldbank.org, 2020b).

Therefore, it seems as discussed in section 2.5, the use of food waste as a natural dyestuff for wearable textiles could also improve the living conditions of people that live in rural areas.

### 4.1.2 Allium Cepa – Classification of natural dyestuffs

Natural dyes can be classified based on their: colour, chemical structure, origin, and methods of application, in contrast to earlier times in which the classification of dyes was mainly alphabetical (Patel, 2011). Onion, better known by its botanical name as *Allium Cepa*, is a natural source of flavonoid dyes (Patel, 2011). "Flavonoids are usually yellow in colour, except for anthocyanins with a spectrum of colours from yellow to red, violet and blue" (Stintzing and Carle, 2004 cited by Alihosseini and Sun, 2011, p.387).

According to Panche, Diwan and Chandra (2016, p.2) "Flavonoids can be subdivided into different subgroups depending on the carbon of the C ring upon which the B ring is attached and the degree of unsaturation and oxidation of the C ring". See Figure 12.

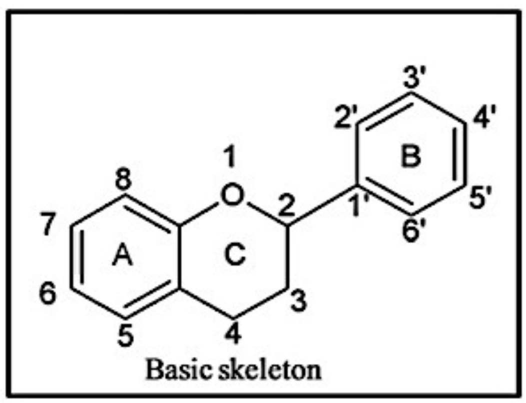



*Figure 12.Basic skeleton structure of flavonoids (Panche, Diwan and Chandra, 2016, p.3)*

Quercetin is the main flavonoid in onion skin (Mouri *et al.*, 2014), and part of the flavonols subgroup. The flavonoid chromophore is vulnerable to photochemical attack (Patel 2011). Therefore, the light fastness of flavonoids can be an issue. For example, in old textile museums, it has been observed that historical naturally dyed samples change colour from yellow to dull brown (Crews, cited by Patel 2011). The water solubility of quercetin is low at only 60 mg dm-3 (Seidell, A, 1941 cited by Drugbank, n.d.). "Quercetin-like structures have a UV spectrum with maximum absorption at 258, 278, 358 nm" (Siva, 2007, cited by Alihosseini and Sun, 2011, p.387). Figure 13 , visually represents the structure of Quercetin.

.

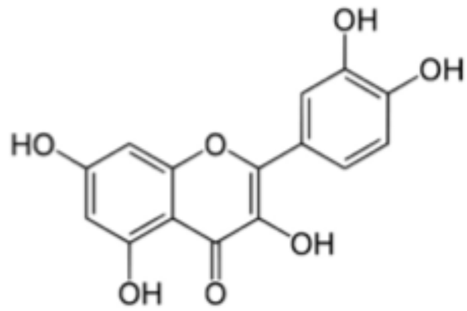
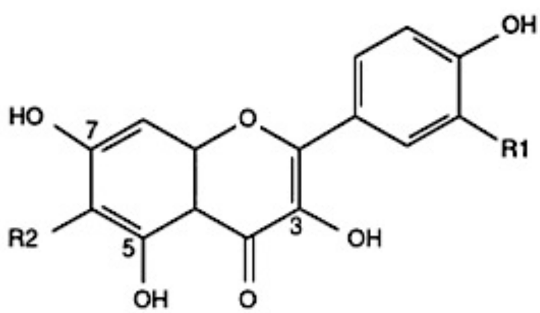


*Figure 13.Structure of Quercetin (Rehman et al. 2013, p.72)*




| | R1 | R2 | $M_w$ (Da) |
|---|---|---|---|
| Quercetin | OH | H | 302 |
| Kaempferol | H | H | 286 |
| Isorhamnetin | $OCH_3$ | H | 319 |
| Patuletin | $OCH_3$ | OH | 332 |

$\lambda_{max}$ = 372 nm (3-OH) $\lambda_{max}$ = 354 nm (3-O-substitute)

$\lambda_{max}$ = 360 nm (3-OH, 5-deoxy)

*Figure 14. Chemical structures of main flavonol colorants (Alihosseini and Sun, 2011, p.389)*

Onion skins are rich in yellow dyes better known as flavonols (3-hydroxyflavones) (Ferreira *et al.,* 2002). These dyes absorb light when in the presence of oxygen better known as photo-oxidation (Ferreira *et al.,* 2002). This photo oxidation causes the dyes to fade in strong light. However, if the 3-hydroxy group of a flavonol is glycosylated (conjugated to a sugar or other moiety), it becomes resistant to light-catalysed decomposition and stable to photo-oxidation (Ferreira *et al.*, 2002).

According to Mouri *et al.* (2014) quercetin is the main flavonol found in onion skin. The study carried by Lee and Mitchel (2011) on onion and likewise Mouri *et al.* (2014) point out that quercetin is the predominant flavonoid found in *Allium Cepa* with a percentage that varies from 70% to almost 90%. Within this overall percentage the following glycosylated quercetin types can be found such as quercetin 3,4´-O-diglucoside and quercetin 4´-O-glucoside (Lee and Mitchel, 2011) (Figure 15). 3,4´-O-diglucoside and quercetin 4´-O-glucoside are more soluble in water, since according to Martínez-Flórez, González-Gallego, Culebras and Tuñón (2002) when sugars join the flavonols structure these become more water-soluble creating O-glycosides compounds. Quercetin 3,4´-O-diglucoside and quercetin 4´-O-glucoside are natural compounds that are created through onion extraction processes and are highly soluble in water, these compounds have a UV spectrum with maximum absorption at 280 and 350nm (polyphenols.com, n.d.a, polyphenols.com, n.d.b).

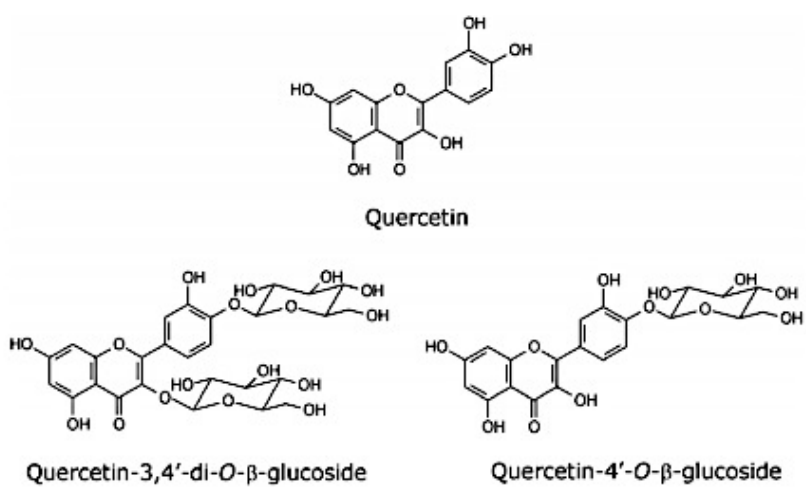



*Figure 15. Chemical structures of quercetin and its major glucosides in onions (Allium cepa L.) (Beesk et al., 2010, p.567)*

The second predominant flavonoid in onion skin is quercetin aglycone, which also has the highest-level present in the outer paper layers of all the *Allium Cepa* varieties investigated by Lee and Mitchell (2011). The increase of this flavonoid especially in the outer layers of onion could be attributed to the aging process, as a result of enzymatic hydrolysis (Lee and Mitchell, 2011).

The inedible layers, such as the skin, contain more flavonoids than the edible layers, 1478 mg/100 g DW (Dried weight) (Lee and Mitchell, 2011). This, could be as a result of the synthetisation of the flavonol glucosides in the onion skin, due to the high activity of phenylalanine ammonia-lyase in these layers (Hiroto, *et al.*, 1999, cited by Lee and Mitchel, 2011). Lee and Mitchel (2011, p.827) argue that "Flavonoids such as quercetin are nonpolar and are therefore linked with one or more water-soluble sugar molecules in plants (glycosides)".

However, the study of Lee and Mitchel (2011) was only performed in *Allium Cepa* with brown skin. The work of Uddin (2014) and subsequently Zubairu and Mshelia (2015) used *Allium Cepa* of purple skin and found out that pelargonidin dye is present in this case, see Figure 16.

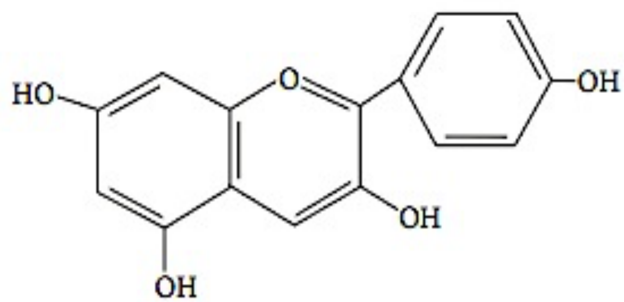
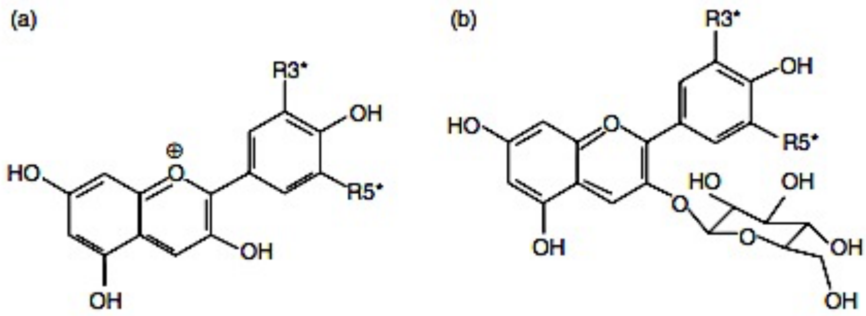



*Figure 16. Chemical structure of pelargonidin (Uddin, 2004, p.2)*

Pelargonidin as well as quercetin is part of the flavonoid family (Alihosseini and Sun, 2011). However, quercetin is a flavonol and pelargonidin is an anthocyanin (Alihosseini and Sun, 2011). According to Stintzing and Carle (2004) anthocyanins cover a variety of shades depending on their structure, for example pelargonidin covers orange to red colours, while delphinidin, covers blue to violet colours. Moreover, pelargonidin "is highly water soluble" (polyphenols.com, n.d.c, §2). See Figure 17 in order to observe that pelargonidin-has a maximum UV absorption from 516 to 520 nm depending on the charge and attached sugars.




| | R3* | R5* | (a) $\lambda_{max}$ (nm) | (b) $\lambda_{max}$ (nm) |
|---|---|---|---|---|
| Pelargonidin | H | H | 520 | 516 |
| Cyanidin | OH | H | 535 | 530 |
| Delphinidin | OH | OH | 546 | 543 |
| Peonidin | $OCH_3$ | OH | 532 | 536 |
| Malvidin | $OCH_3$ | $OCH_3$ | 542 | 546 |

*Figure 17. Chemical structure of anthocyanidine colorants (a) and their glycoside form (b) (Alihosseini and Sun, 2011, p.391)*

According to the results of Lee and Mitchell (2011), onion skin can be used in other economic sectors such as the cosmetic and food industry due to the antioxidant properties of quercetin. Moreover, it could be used as a natural dyestuff for wearable textiles. However, most of the natural yellow dyes from vegetable sources exhibit a lack of tinctorial value and vibrant shades (Patel, 2011). Some of the natural dyes of this group, such as onion, need metallic mordants such as chrome, iron and copper to maintain its tinctorial value (Patel, 2011). Further discussion of mordants and the negative impacts of their utilisation can be found in section 4.1.5.

### 4.1.3 Methods for the extractions of Allium Cepa natural dye stuffs for dyeing purposes

There are several extraction methods identified in the literature. Rehman *et al.* (2013) and Uddin (2014) pulverised the onion skin prior to the extraction process. Rehman *et al.* (2013, p. 72) “pulverized and sieved up to 20 mesh to obtain powder of uniform particle size”. Uddin (2014, p. 2) specifies that, the onion skins “were grinded into small units with the help of grinding machine”.

Rehman *et al.* (2013), Zubairu and Mshelia (2015), and Uddin (2014), extracted the dye stuff from the onion skin by applying an aqueous extraction process. The authors allowed the extraction to cool down followed by a filtration of the onion skin extract.

Zubairu and Mshelia (2015) Uddin (2014) performed their aqueous extraction for 1 hour at 100°C. However, Zubairu and Mshelia (2015) specified that they used distilled water, Uddin (2014) does not specify the type of water used.

The extraction methods of these authors were considered in order to inform the extraction process for this study. The extraction process utilised in this study was selected because it could be easily replicated in a domestic situation and this fits with the possible idea of consumers becoming co-designers by re-dyeing their garments at home with domestic food waste once initial colour fades.

### 4.1.4 Discussion of the technological approaches towards the performance enhancement of *Allium Cepa* skin dye on natural fibres

To date, several studies have been carried out in order to improve the colour strength and colourfastness properties of the natural dyestuff (quercetin and pelargonidin) extracted from onion skin and applied on natural fibres, mostly cotton. This section presents a summary of solutions proposed by different academics, aiming to highlight that the propositions are mainly technological based; therefore, they imply a modification in either the natural dye or the natural fibre and in some cases in both.

Rehman *et al.* (2013), suggested a gamma radiation process to change the surface structure of cotton and a gamma radiation process on pulverised onion skin to improve the colour strength and colourfastness properties of quercetin, a natural flavonol dye found on *Allium cepa* skin. Moreover, alum, which is considered a metallic salt, was used as a pre and post mordant auxiliary for the dyeing process. According to the authors of this scientific paper, when quercetin was extracted from irradiated pulverised onion skin and this colorant was used for dyeing irradiated cotton, the dyed irradiated fabric achieved a higher colour strength, when compared with the other samples: non-irradiated onion skin/ non-irradiated cotton, non-irradiated onion skin/ irradiated cotton, irradiated onion skin/ non-irradiated cotton. However, this was only achieved when the gamma irradiation process for *Allium cepa* skin and cotton were subjected to an absorbed dose of 4 kilogray (kGy). Moreover, good colourfastness properties (grey scale ratings of 4-5) were obtained in the following tests: washing, light, dry rubbing and wet rubbing. The excellent fastness properties were achieved through pre-mordanting and post-mordanting processes, in which alum was applied in a concentration of 10% and 6% respectively, using the irradiated dye extraction on irradiated cotton. According to Chakraborty (2011, p. 209) “fastness properties are tested by assessing the level of staining of an adjacent white sample alongside the simultaneous fading of the coloured specimen under test”. Therefore the 4-5 values indicate a slight change in colour and consequently a slight staining on other fabrics when being washed (Rehman *et al.,* 2013). Furthermore, the following optimal dyeing conditions: temperature of 60°C and a material to liquor ratio of 1:30 contributed to the colour strength and strong shades achieved on the dyed cotton fabric. In the study carried out by Uddin (2014) different metallic mordants were used such as: alum, ferrous sulphate and stannous (tin) chloride in order to obtain different colour hues and improve the colour fastness properties of onion skin dye stuff on silk. However, Uddin (2014) concluded that ferrous sulphate provides the most suitable option in order to obtain darker shades. According to Saxena and Raja (2014) iron is a metal salt that can be naturally found in the environment, therefore is considered an environmentally safe mordant. Further discussion about mordants and their safety can be found in section 4.1.5.

The technical solutions proposed towards the enhancement of the colour strength and colourfastness performance of this natural dye originated from a deep concern regarding the negative effects that synthetic dyes have created globally in the environment and the population, in order to propose an effective solution to the textile industry. However, these technical solutions have not yet created a considerable impact in the market acceptability of natural dyes from food waste resources, such as onion skin in the apparel industry. This could be attributed to their technical and innovation focus, without considering the importance of consumer education and marketing techniques on their studies. This is the reason why; the aim of this study is to influence the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives through the creation of a social marketing intervention model. In which, education in environmental awareness topics along with marketing and design tools influence a consumer behaviour change that could benefit in a longer-term the population's wellbeing.

In this study only sodium chloride is used enabling the process to be replicated in a domestic situation due to its ease availability, although the use of alum and iron are considered environmentally safe (Saxena and Raja, 2014) they are not common in a domestic setting. Moreover, as discussed in the earlier section, this aligns with the possible idea of consumers becoming co-designers through use of their kitchen waste to re-dye their garments once the initial colour fades without needing to buy alum or iron.

### 4.1.5 Discussion of mordants and the negative impacts of their utilisation

"In the textile field, a mordant is a substance that fixes a dye to a material. A mordant works by combining with the dye to form an insoluble complex that fixes the dye to the material. Mordants are metal atoms that attach to the dye at the oxygen and nitrogen atoms through formation of coordinate bonds" (Biermann, 1996, pp. 205-206). In natural dyes, according to Samanta and Agarwal (2009, p.389) "Mordanting is the treatment of textile fabric with metallic salts or other complex forming agents which bind the natural mordantable dyes onto the textile fibres".

Low colour fastness and limited colour shades are some of the limitations that have been attributed to natural dyes when compared to synthetic dyes, this is the reason why mordants have been used to overcome the performance limitations of natural dyes (Shahid, Shahid-ul-Islam and Mohammad, 2013). "Metal salts of aluminium, chromium, tin, copper, and iron were being used as mordants by traditional dyers" (Saxena and Raja, 2014, p.60). However, the use of these metallic mordants, especially in natural dyeing have been strongly argued in terms of the negative impact that they could bring to the environment (İşmal, 2017). Since according to İşmal "only a small amount of these metal salts gets fixed onto the textiles and the rest is discharged as effluent which leads to the contamination of land and water resources" (İşmal, 2017, p.776).

It is interesting to note that not all the metallic mordants have the same impact on the environment. According to (İşmal, 2017, p.776)… "alum, and iron are environmentally safe and these have not been restricted by any ecoregulations". Likewise, Saxena and Raja (2014) point out that alum and iron can be naturally found within the environment, therefore they can be considered environmentally safe mordants. Whereas the use of chromium has been restricted by eco-regulations (Saxena and Raja, 2014), since according to İşmal (2017) it is very toxic. In the case of copper, it is also toxic but compared to chromium it can be used as a textile mordant in small quantities (Saxena and Raja, 2014). "As eco-standards limit the content of extractable copper in textile materials to 3–100 ppm depending upon the standard and clothing type, it should be used judiciously in small amounts" (Saxena and Raja, 2014, p.61). Turning now to the last of the five traditional metallic mordants used in natural dyeing, according to Saxena and Raja (2014, p.60) "Tin is not restricted by many eco-labels but its presence in effluent is not desirable from an environmental viewpoint". However, this metal salt has been restricted by the Global Organic Textiles Standard (GOTS) and it can only be used below 0.2 ppm (Saxena and Raja, 2014). This indicates that the use of most of the metallic mordants described previously are not suitable for natural dyeing due to their negative impact on water and land pollution. According to the definition of Dictionary.com (n.d.) a pollutant is "any substance, as certain chemicals or waste products, that renders the air, soil, water, or other natural resource harmful or unsuitable for a specific purpose". Therefore, within the context of this study the following metal salts will be considered as polluting substances (chromium, tin, copper).

In this study cotton is used as the substrate for natural dyeing. According to Saxena and Raja (2014), this cellulosic fibre lacks amino and carboxyl groups, due to this cotton has limited capacity to form an insoluble complex between dye and mordant. This suggests that most of the mordants used in cotton get discharged as effluent, which depending on the type could lead to water and/or land pollution. In this study NaCl is the only compound added during the extraction of the natural dyestuff of *Allium Cepa* and in the subsequent dyeing process in order to avoid the use of metallic chemical additives that could affect Mexico´s waterways. The technical motivation for using NaCl is to facilitate the dye extraction process and to improve the dye intake and colour yield of the *Allium Cepa* skin dyestuff on the cotton fabric. However, it is important to consider some arguably less favourable points with regards to using NaCl. According to Harb *et al.* (2021) a high concentration of NaCl in freshwater not only affects its quality and microbiota but also could have an impact on human health. With regards to the latter, if freshwater reaches an euhaline condition, which is 35g/kg this could lead to a high exposure of diverse pathogens. (Harb *et al.,* 2021). In this study for the extraction process 10 grams of NaCl were dissolved in 200 ml of water, this respresents 50g/kg of saline effluent release. While in the dyeing process 2 grams of NaCl were dissolved in 200 ml of water, which represent 10g/kg of saline effluent release. However, it is possible to reduce the impact of the effluent release of the extraction process via dilution upon release. However, this study does not aim to influence the target audience to conduct a dyeing activity daily or on a commercial scale, but to accept the performance of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability.

Zubairu and Mshelia (2015) conducted a study to evaluate the use of natural dyestuff from onion skin with natural mordants in cotton such as lemon juice and aloe vera. The researchers evaluated them separately and compared their performance with samples treated with, iron, alum, copper, potassium dichromate and one devoid of mordant in three different techniques: pre-mordanting, which means applying the mordant before dyeing; simultaneous mordanting which means applying the mordant during the dyeing process and post-mordanting, which means applying the mordant after the dyeing process. The results of the study conducted by Zubairu and Mshelia (2015) were the following, lemon juice had a better performance under the pre-mordanting technique compared with iron and alum. However, the use of lemon juice was only 0.8 % better in wash off colour strength than the dyed sample without mordant. In the case of aloe vera the results showed that was the one with the worst pre-mordant performance of those evaluated. Turning now to the results of the simultaneous mordanting technique, aloe vera had a much better performance than lemon. The use of aloe vera was 14% better in wash off colour strength than the dyed sample without mordant. Moving on to the post-mordanting technique results, lemon juice had a much better performance than aloe vera. The use of lemon juice was 12 % better in wash off colour strength than the dyed sample without mordant. This work shows the potential relating to the performance of alternative natural mordants. Although the application of aloe vera under a simultaneous mordanting technique and lemon under a post mordanting technique have shown better results, the use of these would imply additional costs to Mexican families. Therefore, a possible area of future research would be to investigate natural mordants that could be easily available in Mexican homes.

### 4.1.6 Cotton – Why choose a natural fibre?

Cotton holds a strong position in the textile industry. According to Fao.org (2009a) cotton is the natural fibre most used globally. The softness property of cotton contributes to its popularity (Fao.org, 2009a). Cotton fibres are made of approximately 90% cellulose (KOH, 2011). According to KOH (2011), cellulose due to its availability globally is the most accessible polymer. Cotton is the plant fibre with the highest molecular weight (Hsieh, 2007 cited by KOH, 20111) this could be attributed to the cellulose chemical structure. See Figure 18.

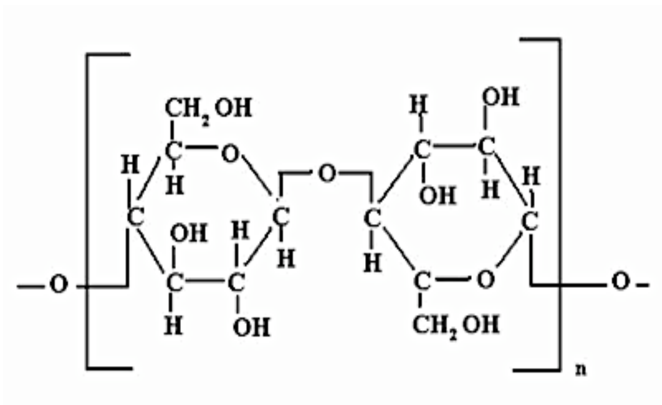


*Figure 18. Cotton chemical structure (Textile Learner, 2014)*

According to Rengasamy (2011, p. 211) one of the main problems of cotton is that it does not dry quickly, causing the wearer to experience a "sensation of wetness". Furthermore, cotton can be washed by machine but it has a poor wrinkle resistance (Hosseini Ravandi and Valizadeh, 2011). This means that although it can be machine washable, it will require an extra effort with regards to care since it will need to be ironed after being washed and dried. However, cotton fibres are very soft, absorbent and breathable (Hosseini Ravandi and Valizadeh, 2011). These properties make cotton suitable to wear in countries with warm temperatures such as Mexico. Since according to Ho *et al.* (2011, p. 167) cotton … "have been traditionally favoured for clothing in hot climates".

According to Fao.org (2009b) the production and commercialisation of natural fibres is a fundamental economic activity for developing countries. The major production of natural fibres occurs in these countries, through agricultural activity by small-scale farmers, whose income depends primarily on this activity (Fao.org, 2009b). However, nowadays the synthetic fibre alternatives represent a financially cheaper alternative when compared to natural ones, and consequently manufacturers and consumers have increased demand for synthetic fabrics, affecting the economy of these small-scale farmers all over the world (Fao.org, 2009b). However, in this study, cotton was selected as the natural fibre for the dyeing process because this study is based around Mexico and according to United Nations (2019) this country is considered a developing country. In addition, Cohen (2018b) argues that one of the main strengths of Mexico´s textile sector is the production of their own cotton. In 2016, Mexico had a cotton production of almost 488,000 tons, this production placed this country in the 13$^{th}$ position amongst the cotton producing nations (SAGARPA, 2017b).Therefore, increasing the consumer demand of cotton could contribute positively not only to Mexico´s textile sector but also to the economy of Mexican small-scale farmers.

### 4.1.7 Direct Dyes on Cellulosic Fabrics

These dyes are named direct, because they can be applied direct to cotton only by using NaCl or sodium sulphate ($Na_2SO_4$) (KOH, 2011). The dyeing rate and colour yield of direct dyes on cellulose fabrics are improved through the addition of inorganic salts, such as sodium chloride or sodium sulphate to the dyebath (KOH, 2011). Salts are used to allow the attraction between the cellulosic fibre and direct dyes as both are negatively charged; the function of sodium chloride or sodium sulphate is to facilitate the dye uptake by reducing the fibre charge (KOH, 2011).

The advantages of direct dyes are their low cost, easy application and availability in a full range of hues (KOH, 2011). The disadvantages are a lack of colour brilliance and poor wash fastness (KOH, 2011). A poor wash fastness can be defined as a high level of staining towards other garments while being in a washing machine and loss of colour during washing (Chakraborty, 2011). However, wash fastness can be improved by applying after treatments using cationic fixatives, formaldehyde, metal complex formation, resin and cross-linking agent; due to the fact that these treatments allow a slower diffusion and decrease its solubility (KOH 2011). Nevertheless, some of these treatments have a negative impact on the environment. According to the Australian Government - Department of Agriculture, Water and Environment, formaldehyde when released to the atmosphere creates formic acid and carbon monoxide, contributing consequently to air pollution (Npi.gov.au. 2009). Similarly, Toprak and Anis (2017) point out that formaldehyde is usually used in finishing textile treatments and as cross-linking resin, releasing formaldehyde vapour which is toxic, contributing to greenhouse gas emissions, affecting directly all living organisms due to the change in climate conditions caused by air emissions. According to Toprak and Anis (2017, p. 438) “The secondary important pollutant in the textile after waste disposal is the emission of gas”.

Moreover, all the treatments mentioned above could affect the light fastness in a negative way, and produce a change in hue, which will make it difficult to achieve shade correction and colour matching (KOH, 2011).

Direct dyes when applied to cellulosic fabrics, can lead to a variation in light fastness from poor to fairly good (KOH, 2011). If copper is used as a mordant, there will be improved light fastness performance (KOH, 2011). However copper, as mentioned in section (4.1.5) is toxic and can only be used as a textile mordant in small quantities (Saxena and Raja, 2014).

According to KOH (2011) the dyebath of direct dyes is heated slowly in order to allow the dye diffusion into the fibre. See Figure 19.

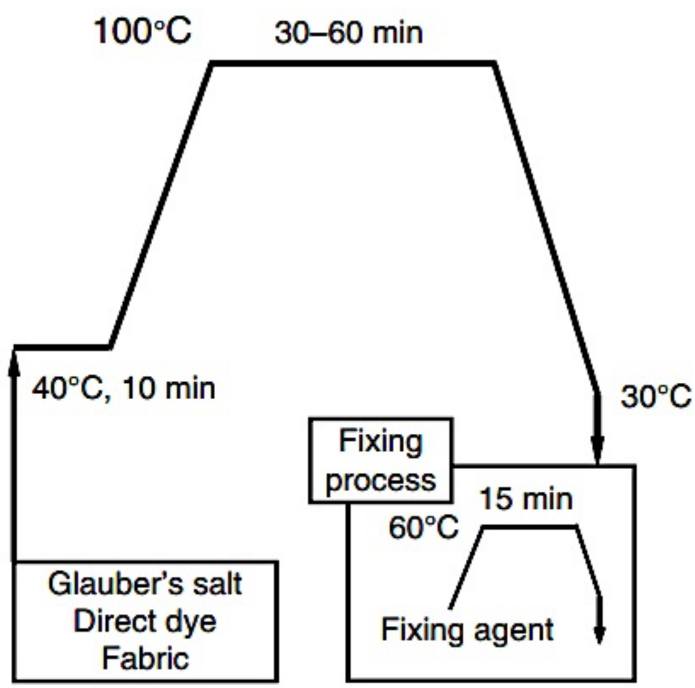



*Figure 19. Direct dyeing profile (KOH, 2011, P.136)*

### 4.1.8 Connections between onion dyestuff and direct dyeing method

Although the natural flavonoid dyes found in onion skin (quercetin, pelargonidin) are not classed as direct dyes, the dyeing method of the experiment carried out in this study follows a direct dyeing-based methodology due to the following reasons:

- Structural similarities: In this case C.I. Acid Blue 45 (Figure 20) was selected for comparison. It is easy to identify the heterocyclic compounds, the phenyl rings, the planar structure and the existence of protonable groups (OH), which can also be found in quercetin and pelargonidin. See Figure 21 and 22.

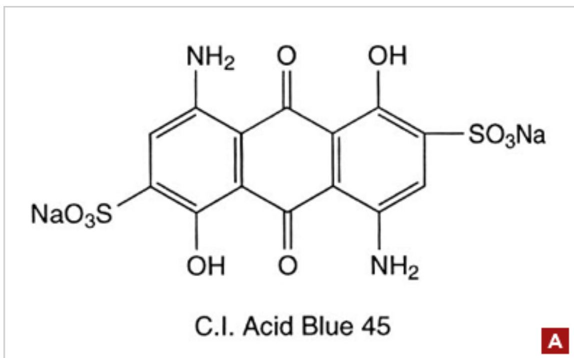



*Figure 20. C.I. Acid Blue 45 (Dharma Trading Co., 2019)*

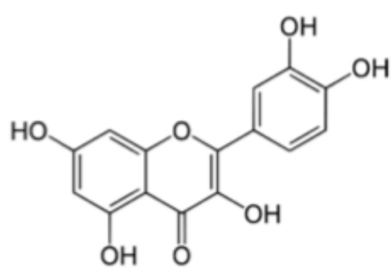


*Figure 21. Structure of Quercetin (Rehman et al. 2013, p.72)*

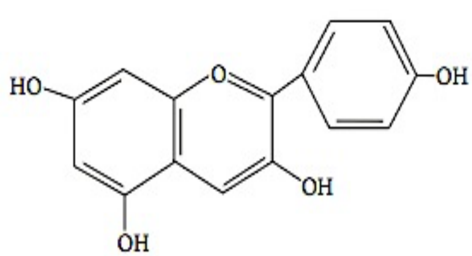


*Figure 22. Chemical structure of pelargonidin (Uddin, 2004, p.2)*

Another similarity between direct dyes and flavonoids (quercetin, pelargonidin) is its water solubility. Direct dyes are water- soluble (KOH, 2011). Pelargonidin "is highly water soluble" (polyphenols.com, n.d.c, §2). However, quercetin on its own has limited water solubility, thus it joins with a sugar to make it more polar and enable its solubility. According to Martínez-Flórez, González-Gallego, Culebras and Tuñón (2002) when sugars join the flavonols structure these become more water-soluble creating O-glycosides compounds, such as 3,4´-O-diglucoside and quercetin 4´-O-glucoside.

Considering direct dyes affinity to cellulose fibres such as cotton, according to (Lewis, 1998 cited by Sekar, 2011) the bonding is through hydrogen molecules and Van-der-Waals forces. This is the reason why salts ($NaCl$, $Na_2SO_4$) are used to allow the attraction between the cellulosic fibre and direct dyes as both are negatively charged; the function of sodium chloride or sodium sulphate is to facilitate the dye uptake by reducing the fibre charge (KOH, 2011). Since according to Saxena and Raja (2014), the cellulosic fibre lacks amino and carboxyl groups, due to this cotton has limited capacity to form an insoluble complex between dye and mordant. Therefore, in the direct dyeing method $NaCl$ or $Na_2SO_4$ are added as an electrolyte to enable the direct dye to transfer from the dyebath to the cellulosic fibre phase (Burkinshaw and Salihu, 2017).

## 4.2. Materials and Methods

### 4.2.1. Materials

Deionised water (DW) obtained from Applied Sciences laboratory at the University of Huddersfield, Sodium chloride obtained from Colourcraft (Sheffield, UK), 100% plain weave medium weight cotton bleached fabric was obtained from Whaleys (Bradford, UK) and used as received. Methanol was obtained from Sigma Aldrich. Sodium carbonate and non-ionic detergent (Ultravon) were obtained from Huntsman.

Two colour varieties of onion outer skin (brown and purple) were collected as a source of flavonol dye (Quercetin) and anthocyanin dye (Pelargonidin) from Lupe´s Cantina, a Mexican restaurant in Leeds, UK. The brown skinned onions were purchased from Improver and originated from Spain and the purple skinned onions were purchased from JWK Wiskerke and originated from Holland.

### 4.2.2. Scouring

The cotton was scoured prior to dyeing with a solution containing 2 g $dm^{-3}$ sodium carbonate and 1 g $dm^{-3}$ of non-ionic detergent (Ultravon) at 60°C for 15 min, after which time it was rinsed with cool water and air dried at room temperature.

### 4.2.3. Onion skin sample preparation

Onion skin was pulverized prior to the extraction process with a Russell Hobbs 3 in 1 hand blender up to 10 times, for 5 min per 100 g, to obtain onion skin flakes.

### 4.2.4. Extraction

Natural dyestuff was extracted from brown and purple onion skin flakes separately. Samples were made up as per Table 4 and were poured into dye tubes (300 $cm^3$ capacity, stainless tubes) which were then sealed. These were then placed in a Roaches Pyrotec3 machine. In order to investigate a possible change of colour, NaCl was added as an electrolyte to half of the samples during the extraction process at a concentration of 100 g $dm^{-3.}$ A detailed description of the sample tube's content is included in Table 4.

| Samples | Onion skin flakes Quantity & Colour | Deionised Water (DW) | Extraction Phase Sodium Chloride (NaCl) added |
|---|---|---|---|
| Sample 1 | 5 gr. of Brown onion skin flakes | 100 ml | 0 gr. |
| Sample 2 | 5 gr. of Brown onion skin flakes | 100 ml | 10 gr. |
| Sample 3 | 5 gr. of Red onion skin flakes | 100 ml | 0 gr. |
| Sample 4 | 5 gr. of Red onion skin flakes | 100 ml | 10 gr. |

*Table 4. Samples Content for Extraction*

The extraction process was based on a modified version of the extraction methodology of Zubairu and Madu Mshelia (2015) which suggested an aqueous extraction by heating the solution for 1 hour at 100°C followed by a filtration process. The extraction procedure is shown in Figure 23.

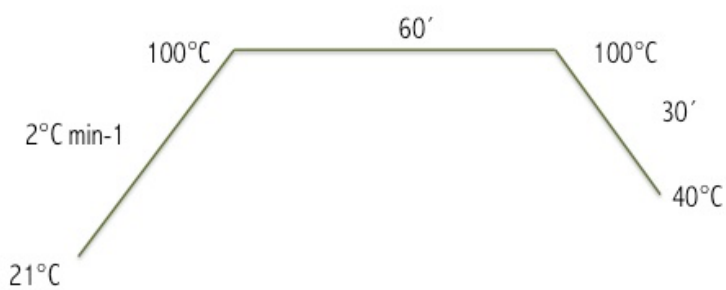



*Figure 23. Extraction machine method*

After the extraction process, the Pyrotec tubes were allowed to cool for 1 min under cold water, then were opened and the onion skin flakes were separated from the extracted solution by gravity filtration. The tubes were rinsed with distilled water (DW) and the resultant solution filtered. Onion skin flakes were rinsed with more DW, and the filtrate was added to a volumetric flask and made up to 250 ml with DW.

### 4.2.5. Dyeing

4 g of scoured cotton (21 x 13 cm), and 200 ml of the solution previously extracted and filtered were poured into 300 $cm^3$ capacity stainless dye tubes, 2g of NaCl were added only to the solutions in which NaCl was added during the extraction process. See Table 5.

| Samples | Onion skin flakes Quantity & Colour | Deionised Water (DW) | Extraction Phase Sodium Chloride (NaCl) added | Dyeing Phase Sodium Chloride (NaCl) added |
|---|---|---|---|---|
| Sample 1a | 5 gr. of Brown onion skin flakes | 100 ml | 0 gr. | 0 gr. |
| Sample 2a | 5 gr. of Brown onion skin flakes | 100 ml | 10 gr. | 2gr. |
| Sample 3a | 5 gr. of Red onion skin flakes | 100 ml | 0 gr. | 0 gr. |
| Sample 4a | 5 gr. of Red onion skin flakes | 100 ml | 10 gr. | 2 gr. |

*Table 5. Samples Content for Dyeing*

Figure 24 shows the temperature profile applied on the Pyrotec3 machine for the dyeing process.

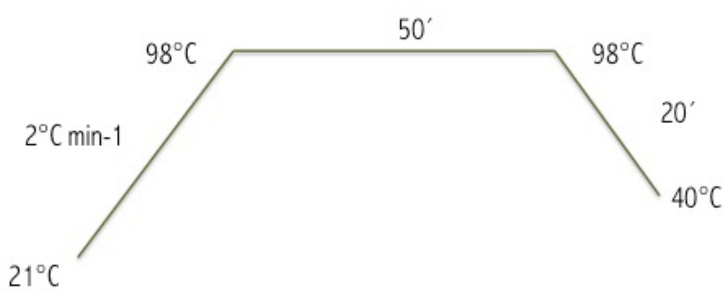



*Figure 24. Dyeing tube/ dyeing machine method*

At the end of the dyeing process, the dyed cotton fabric was removed from the dyebath, squeezed to remove excess dye liquor and rinsed under cold tap water for 1 min and then allowed to dry in ambient conditions. The dyeings were conducted three times per sample.

### 4.2.6. Experimental Tests on Dyed Cotton

Mean reflectance values were recorded using a Datacolor Spectroflash 600 reflectance spectrophotometer with an aperture size of 6mm from 360nm to 700nm at 10nm intervals and K/S values calculated. Colour differences were calculated using the CIE L*a*b* co-ordinates. The Ultraviolet–visible spectroscopy (UV-Vis) analysis was performed using a Jasco V-730 UV-Vis Spectrophotometer.

Wash fastness tests were carried out according to ISO 105-C06: 2010 method at 40°C using cotton pieces of 10 x 4 cm , light fastness tests were carried using the ISO 105-B02:2014 method at a BW4 level using cotton pieces of approximately 1.5x 1.5 cm and dry-cleaning fastness using the ISO 105-C06:2010 method with perchloroethylene using cotton pieces of 10 x 4 cm. These standard tests were carried out by an external company, SGS United Kingdom Ltd based in Leicester.

### 4.2.7. UV/Vis sample preparation

- Sample 1 and 3 (brown and purple onion skin without NaCl): 1 ml of the solution from the 250 ml dyestuff extracted of sample 1 and 3 respectively was added to 4 ml of (distilled water) and 5 ml of methanol, diluting by a factor of 10. The blank solution was: 50/50 DW and methanol in order to perform the analysis.

- Sample 2 and 4 (brown and purple onion skin with NaCl): 1 ml of the solution from the 250 ml dyestuff extracted of sample 2 and 4 respectively was added to 4 ml of (distilled water) and 5 ml of methanol, diluting by a factor of 10. The blank solution was: 2g of NaCl, 20 ml DW and 20 ml methanol, in order to perform the analysis. However, it is important to mention that only a proportion of the blank solution was used to fill the cuvette.

## 4.3. Results and Discussion

This study, evaluates the performance of onion skin as an example of a Mexican food waste resources for natural dyes in wearable textiles. However, the experiments conducted also evaluate if sodium chloride (NaCl), better known as common salt will impact on the extraction and dyeing process. The reasoning behind using 20gl$^{-1}$ of NaCl during the dyeing process was based on the study carried by Burkinshaw and Salihu (2017) in which this concentration of NaCl was used as an inorganic electrolyte to promote the uptake of direct dyes on cotton. Moreover, in order to avoid the complex mixture of polluting substances, when compared to the synthetic dyeing process and consequently provide a lower ecological footprint textile dye alternative, NaCl was the only compound added during the extraction and dyeing process. Two different onion skin colour varieties were selected, brown and purple. See Figure 25.

To evaluate the proposition, mean reflectance values were recorded using a Datacolor Spectroflash 600 reflectance spectrophotometer from 360nm to 700nm at 10nm intervals and K/S values calculated. Colour differences were calculated using the CIE L*a*b* co-ordinates. The Ultraviolet–visible spectroscopy (UV-Vis) analysis was performed using a UV-Vis Spectrophotometer. Moreover, the following standards tests for wearable textiles, such as, fastness to washing, light, and dry cleaning were conducted; in order to simulate the conditions to which the dyed cotton fabric would be subjected while in an environment of standard use.


*Figure 25. Samples with NaCl and without NaCl*

#### **4.3.1** Colour Strength – K/S Values

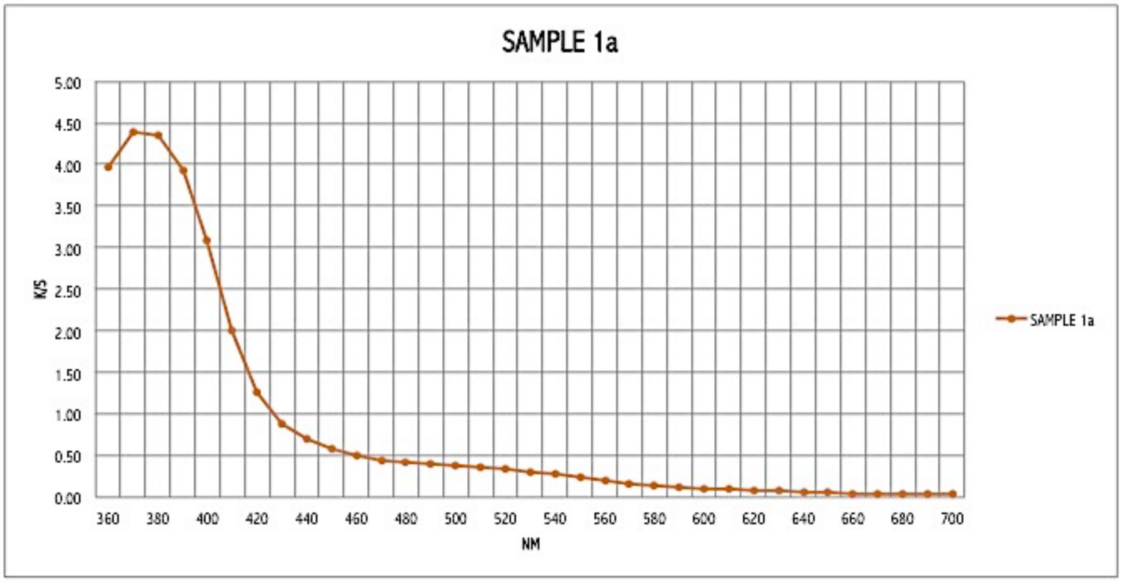



*Figure 26. K/S Values sample 1a – brown onion skin without NaCl*

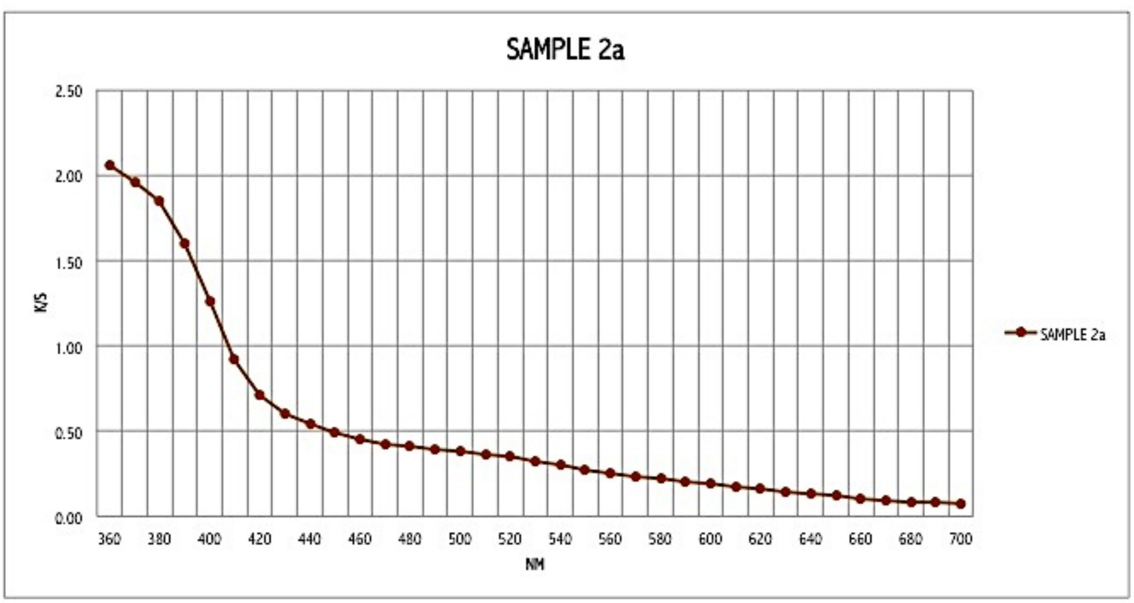



*Figure 27. K/S Values sample 2a – brown onion skin with NaCl*

Figure 26 and 27 show that sample 1a and sample 2a which were the ones in which brown onion skin was used; show its highest peak at 370 nm in sample 1a with a value of (4.39) and in sample 2a at 360 nm with a value of (2.06). According to Siva (2007, cited by Alihosseini and Sun, 2011, p.389) “Quercetin-like structures have UV spectrum with maximum absorption at 258, 278, 358 nm”. Therefore, the results indicate that quercetin is found in these onion chromophores. However, when sample 1a and 2a are compared at the visible point, which starts at 400 nm, sample 1a continues to show the higher colour strength with a value of 3.08 compared with a 1.26 value of sample 2a.

Moreover, both samples 1a and 2a show a second peak between the 500 nm and 520 nm. According to Alihosseini and Sun, (2011) pelargonidin-like structures have a maximum UV absorption at 516 - 520 nm. Therefore, this suggests that pelargonidin and quercetin are found on the chromophore of the brown onion skins used, because of the UV spectrum peaks found.

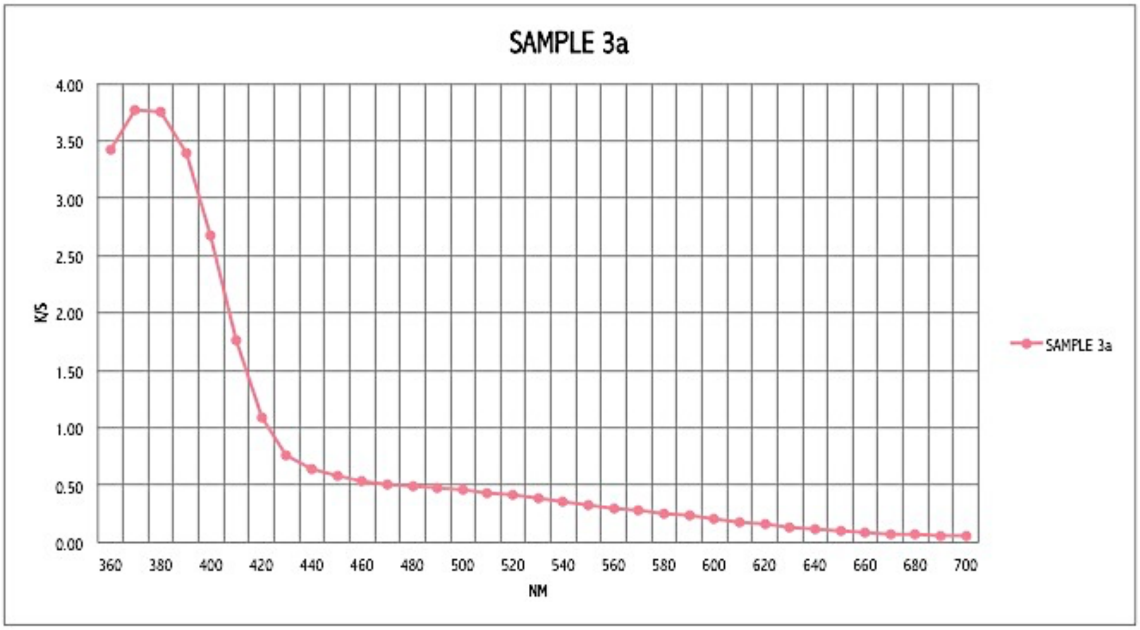



*Figure 28. K/S Values sample 3a –purple onion skin without NaCl*

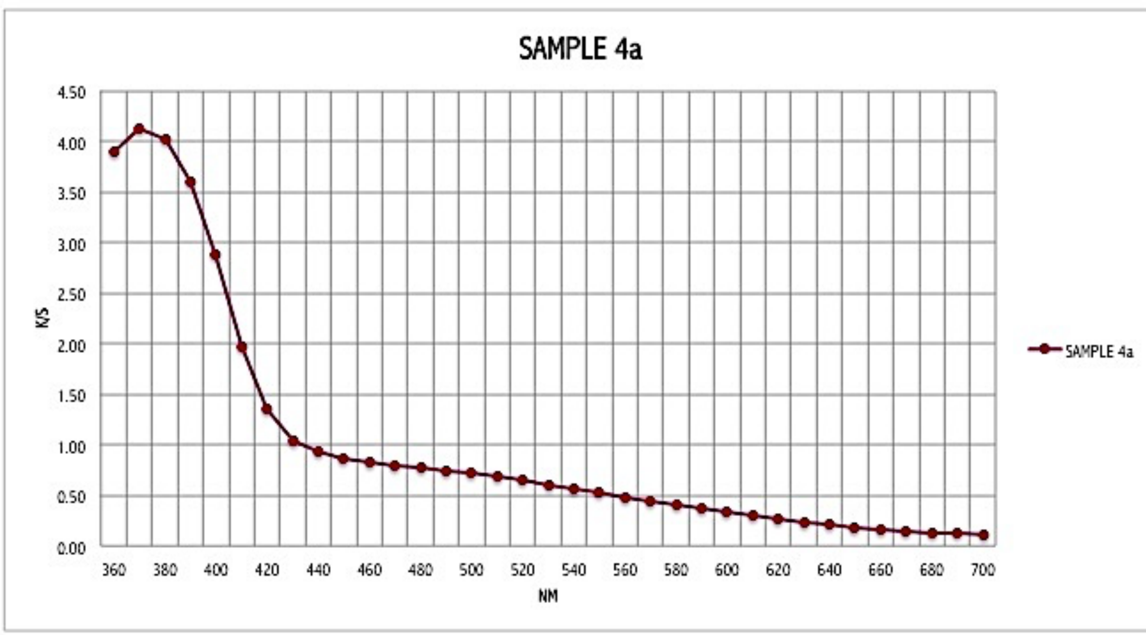



*Figure 29. K/S Values sample 4a – purple onion skin with NaCl*

Figure 28 and 29 shows that sample 3a and sample 4a which were the ones in which purple onion skin was used; show its highest peak at 370 nm in sample 4a with a value of (4.13) and in sample 3a with a value of (3.77). Similarly, to sample 1a and 2a the results suggests that quercetin is found in these onion chromophores. Since according to Siva (2007, cited by Alihosseini and Sun, 2011, p.389) “Quercetin-like structures have UV spectrum with maximum absorption at 258, 278, 358 nm”. Moreover, samples 3a and 4a also show a second peak, between the 500 nm and the 520 nm, similarly to sample 1a and 2a. According to Alihosseini and Sun, (2011) pelargonidin-like structures have a maximum UV absorption at 516- 520 nm. Therefore, this suggests that pelargonidin and quercetin are found on the chromophore of the purple onion skins used, because of the UV spectrum peaks found.

Furthermore, when sample 3a and 4a are compared at the visible point, which starts at 400 nm, sample 4a continues to show the higher colour strength with a value of 2.87 compared with a value of 2.68 from sample 3a. Similarly to sample 1a and 2a the addition of NaCl in sample 3a and 4a has no impact on the colour strength of the dyed fabrics since the K/S value of sample 3a at 520 nm is of 0.41 and the K/S value of sample 4a at 520 nm is of 0.65.

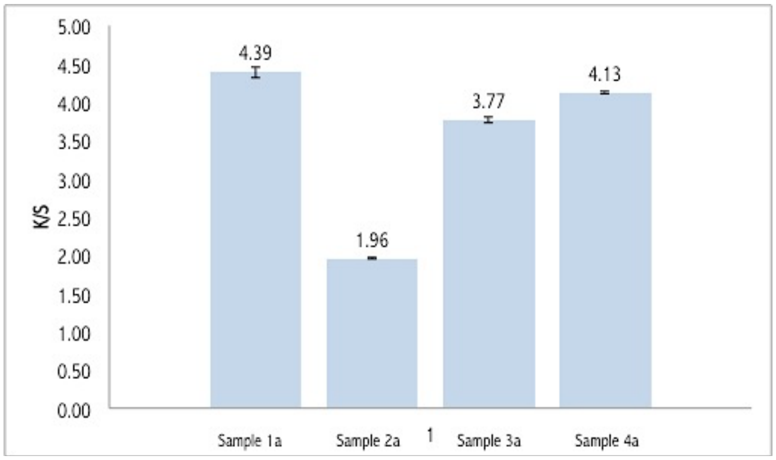


*Figure 30. K/S Values at 370nm*

Figure 30 shows that maximum (K/S) was achieved at 370 nm in which sample 1a had the highest value (4.39), this sample corresponds to brown onion skin without NaCl, followed by sample 4a, with a value of (4.13) which corresponds to purple onion skin with NaCl.

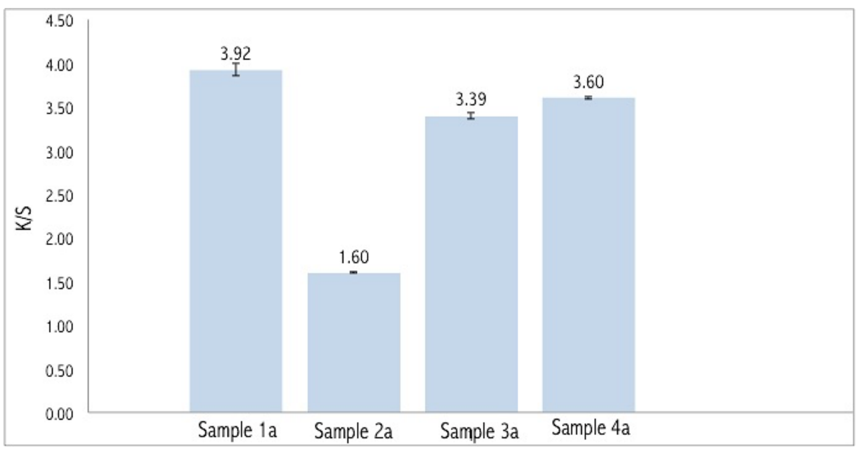


*Figure 31. K/S Values at 390nm*

Figure 30 shows a similar pattern of results as in Figure 31 in which the highest value was achieved by sample 1a (3.92), followed by sample 4a (3.60). However, values less than 400 nm will not show visible colour. These K/S absorbances are likely to appear due to dye moieties with sugars attached extracted during the process. According to Siva (2007, cited by Alihosseini and Sun, 2011, p.389) “Quercetin-like structures have UV spectrum with maximum absorption at 258, 278, 358 nm”. Therefore, the results indicate that quercetin is found in these onion chromophores.

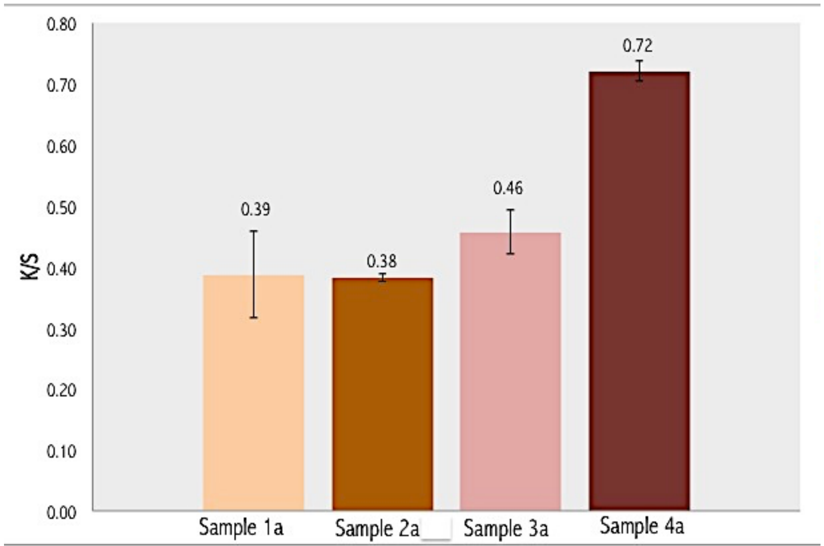



*Figure 32. K/S Values at 500nm*

Figure 32 shows colour strength of the samples at 500 nm because this is within the visible spectrum range where pelargonidin can be found. According to Alihosseini and Sun, (2011) pelargonidin-like structures have a maximum UV absorption at 516 - 520 nm. Figure 32 illustrates that sample 4a achieved the maximum colour strength (0.72), followed by sample 3a (0.46). Sample 3a and 4a correspond to purple onion skin. This table shows that it could be possible that the addition of NaCl has an impact on the colour strength when extracting flavonoids found on purple onion skin. Conversely in sample 1a and 2a from brown skin, the addition of NaCl does not seems to have an impact on the colour strength since the average K/S value of sample 1a at 500 nm is of 0.39 and the K/S value of sample 2a at 500 nm is of 0.38. Therefore, no significant colour difference exists between sample 1a and 2a.

Furthermore, these results suggest that pelargonidin is higher on purple onion skin than on brown onion skin. Since according to Alihosseini and Sun, (2011) pelargonidin-like structures have a maximum UV absorption from 516 to 520 nm.

### 4.3.2 (UV-VIS) Analysis

Sample 1 - Brown onion skin without NaCl

Although sample 1 in which brown onion skin was used without the addition of NaCl; does not show a distinct peak it indicates a broad absorbance from 420 – 520 nm (Fig. 33, 34), this suggests that more than one coloured species are present.  According to Brown (1980, cited by Alihosseini and Sun, 2011, p.387) "Some of the flavonoids, for example quercetin, have been reported to have over 70 glycosidic combinations". These suggests, that these colour species extracted from brown onion skin could be located under the 420-520 nm absorbance range.

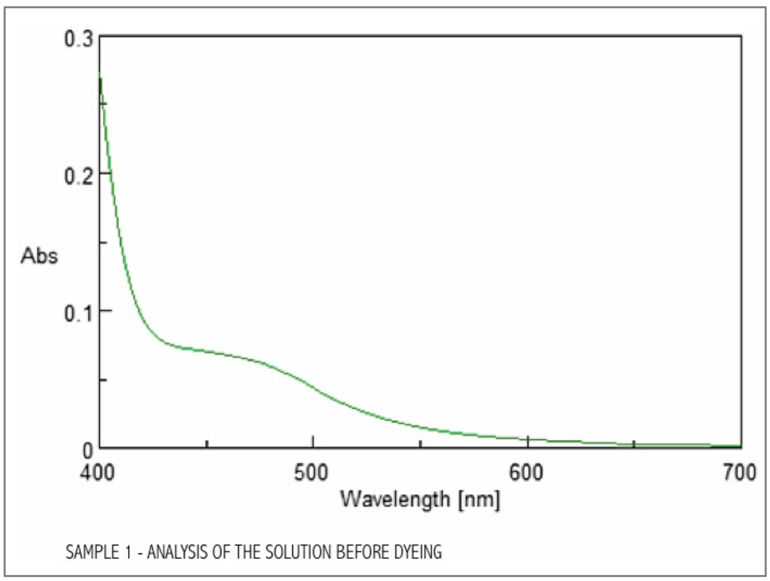



*Figure 33. UV/VIS Sample 1 - Solution before dyeing*

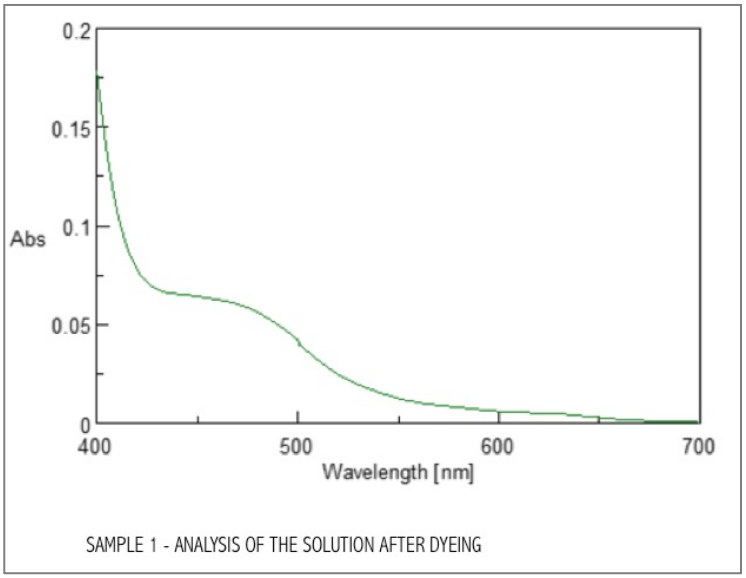



*Figure 34. UV/VIS Sample 1a - Solution after dyeing*

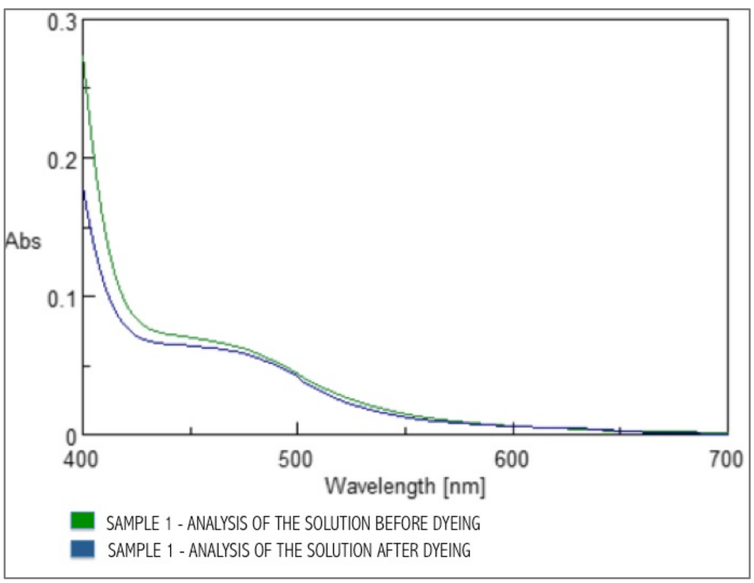



*Figure 35. UV/VIS Sample 1 - Solutions before and after dyeing*

As can be seen from Figure 35 lines do not interact between 400 and 500 nm, and 500 and 550. These suggest that the solution after dyeing has lost some of the colour compounds', which were transferred to the fibre stage during the dyeing process.

- Sample 2 – Brown onion skin with NaCl

Similar to sample 1, sample 2 does not show a sharp distinct peak. (See Figure 36, 37). Both sample 1 and 2 indicate a broad absorbance from 420 - 520 nm, which suggests that more than one coloured species is present. As mentioned before, quercetin can create up to 70 different sugar-dye complexes (Brown, 1980, cited by Alihosseini and Sun, 2011). Consequently, these suggest that more than one coloured species are present under the 420-520 nm absorbance range.

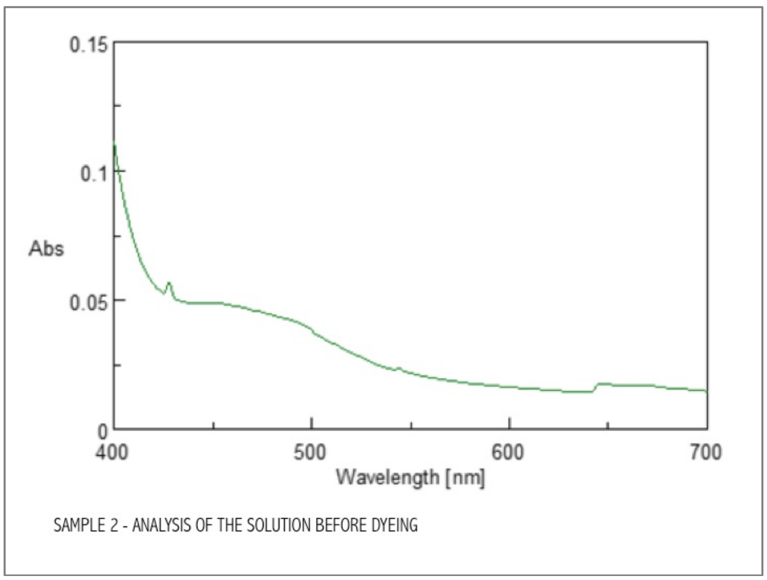



*Figure 36. UV/VIS Sample 2- Solution before dyeing*

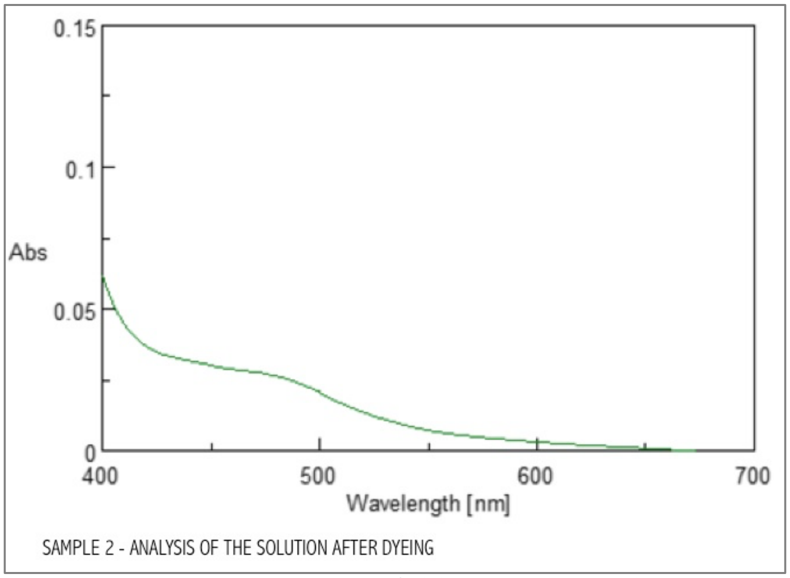



*Figure 37. UV/VIS Sample 2a- Solution after dyeing*

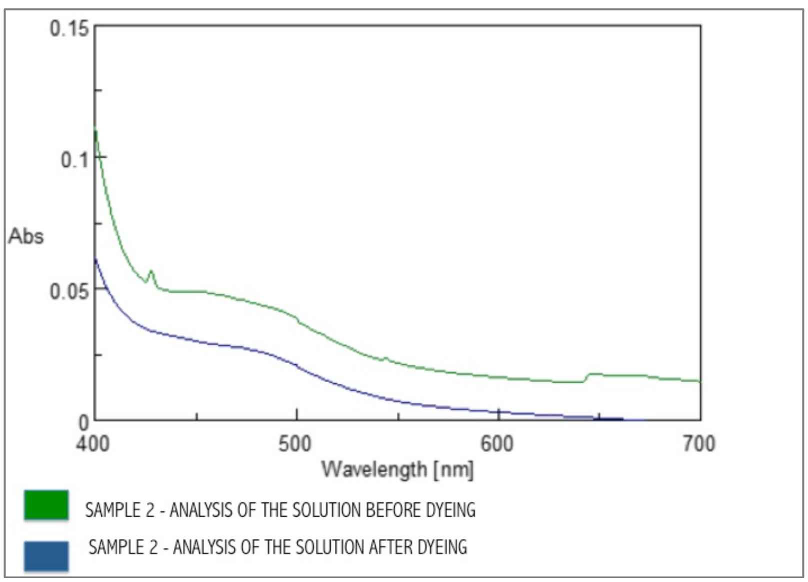



*Figure 38. UV/VIS Sample 2- Solutions before and after dyeing*

As can be seen from Figure 38, there is a difference in absorbance between 400 and 700 nm. This suggests that the solution after dyeing has lost some of the colour compounds', which were transferred to the fibre stage during the dyeing process.

- Sample 3- Purple onion skin without NaCl

Sample 3, in which purple skin was used, show similarly to sample 1 in which no NaCl was added, a broad absorbance from 420 – 520 nm. See Figure 39, 40.

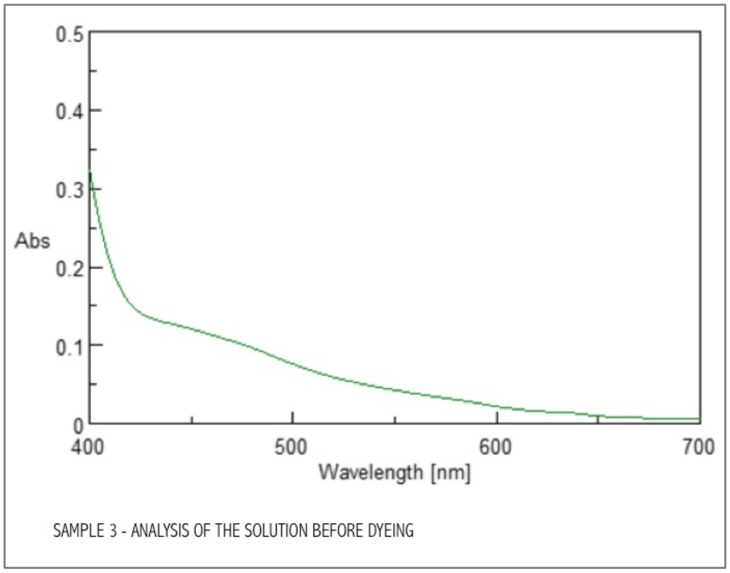
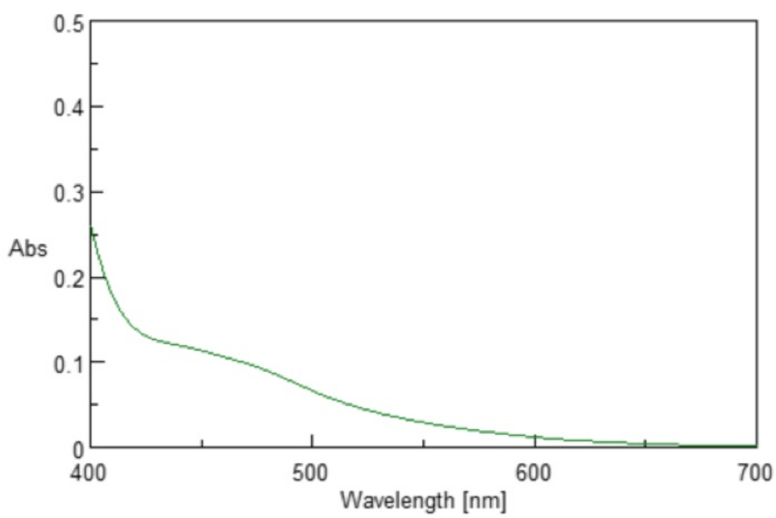



*Figure 39. UV/VIS Sample 3 - Solution before dyeing*




SAMPLE 3 - ANALYSIS OF THE SOLUTION AFTER DYEING

*Figure 40. UV/VIS Sample 3a- Solution after dyeing*

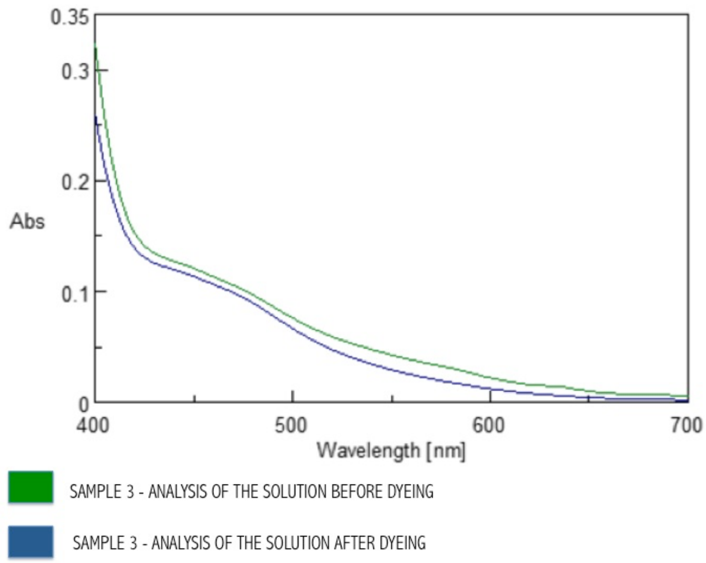



*Figure 41. UV/VIS Sample 3- Solutions before and after dyeing*

However, if the shape of the UV graphs in sample 3 is compared with sample 1, they show a differing profile indicative that there are different coloured species between them. See Figure 42.

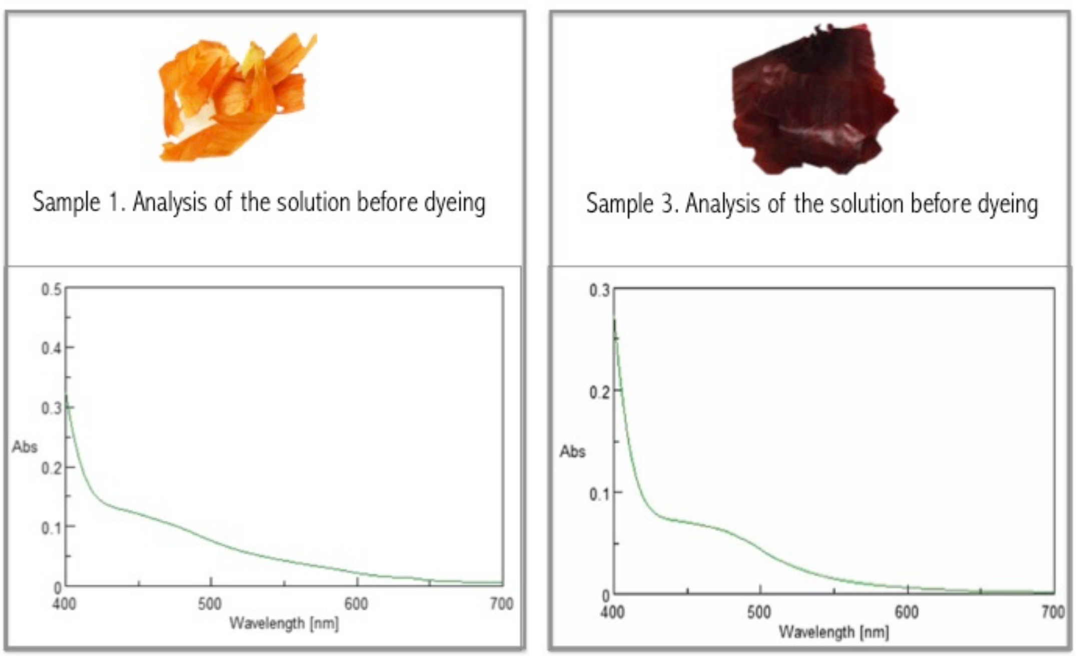



*Figure 42. UV/VIS Comparisons between sample 1 and 3 without NaCl*

- Sample 4 - Purple onion skin with NaCl

As shown in Figure 43 and 44 interestingly from 400 to 430 nm the lines do not merge, similarly between 500 and 580 nm indicating a reduction in the concentration of dye species which absorb in these areas between the solutions before and after dyeing.

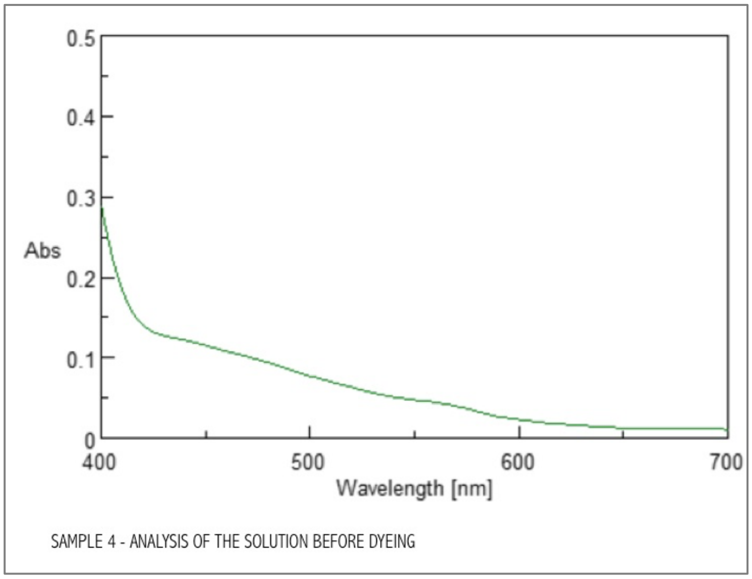



*Figure 43. UV/VIS Sample 4- Solution before dyeing*

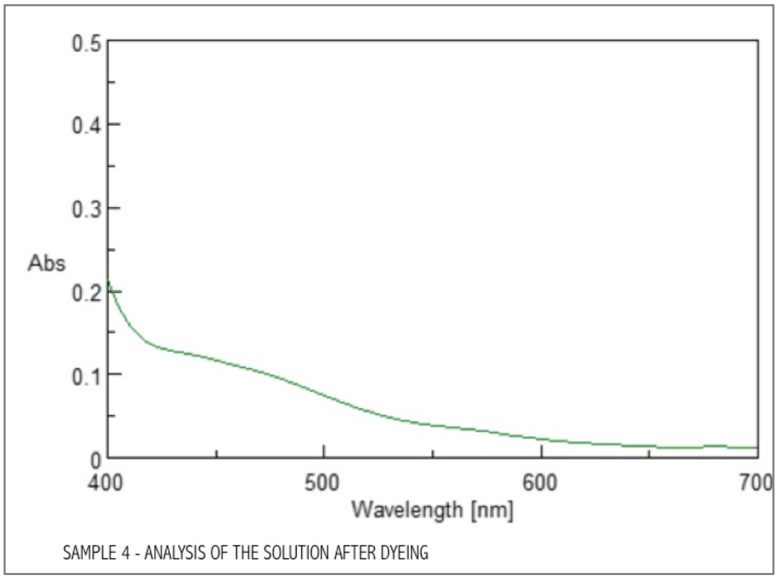



*Figure 44. UV/VIS Sample 4a- Solution after dyeing*

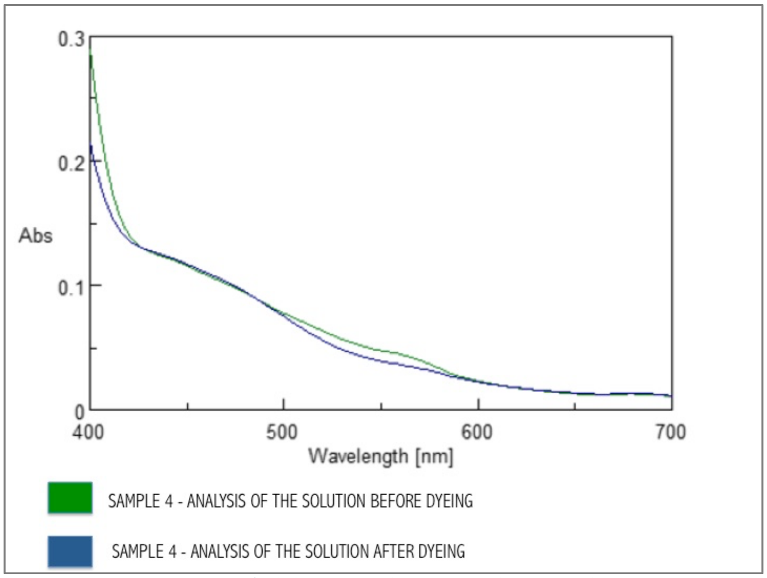



*Figure 45. UV/VIS Sample 4- Solutions before and after dyeing*

Moreover, if the shape of the UV graph in sample 3 is compared to the shape of the UV graph in sample 4, they show a different profile although they have similar coloured species, this could be due to the different extraction methods. See Figure 46.

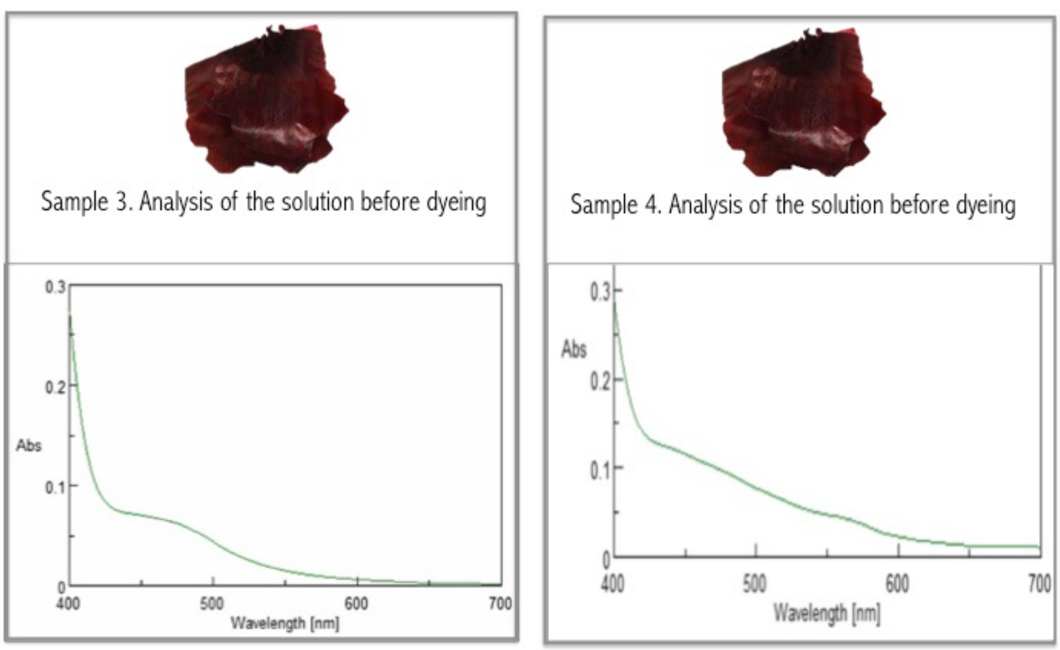



*Figure 46. UV/VIS Comparison between sample 3 and 4*

### 4.3.3 Colour Values - CIE L*a*b* co-ordinates

An average of three readings were taken per fabric, however an average of each, standard deviation and mean of values were calculated in order to show one result per fabric sample in order to be able to compare the results between samples. See Table 6 and Figure 47. According to Konica Minolta Sensing Americas (n.d.) L* indicates lightness, and it is calculated like this: (L* sample x - L* sample y) if the value turns out to be positive this indicates that the sample is lighter than the sample compared, conversely if the value turns out to be negative indicates that the sample is darker than the sample compared; a* is the coordinate that determines if the sample is red or green, and it is calculated like this (a* sample x - a* sample y) if the value is positive this indicates that the sample is redder than the sample compared, conversely if the value turn out to be negative, this indicates that the sample is greener than the sample compared; b* is the coordinate that determines if the sample is yellow or blue, and it is calculated like this (b* sample x - b* sample y) if the value turns out to be positive this indicates that the sample is yellower, if the value is negative, this indicates that the sample is bluer than the sample compared. To calculate the difference in colour between samples it is necessary to apply the following formula: $\Delta E^* = \sqrt{}\ (L^*x - L^*y)^2 + (a^*x - a^*y)^2 + (b^*x - b^*y)$.

| SAMPLE | L* | a* | b* |
|---|---|---|---|
| 1a | 78.52 +/- 0.84 | 9.13 +/- 0.50 | 21.94 +/- 0.33 |
| 2a | 75.87 +/- 0.51 | 5.63+/- 0.41 | 13.51+/- 0.80 |
| 3a | 74.55 +/- 0.34 | 7.42+/- 0.17 | 15.21 +/- 1.01 |
| 4a | 69.34 +/- 0.41 | 8.36+/- 0.26 | 15.25+/- 0.55 |

Table 6. Colour Values- CIE L*a*b* co-ordinates

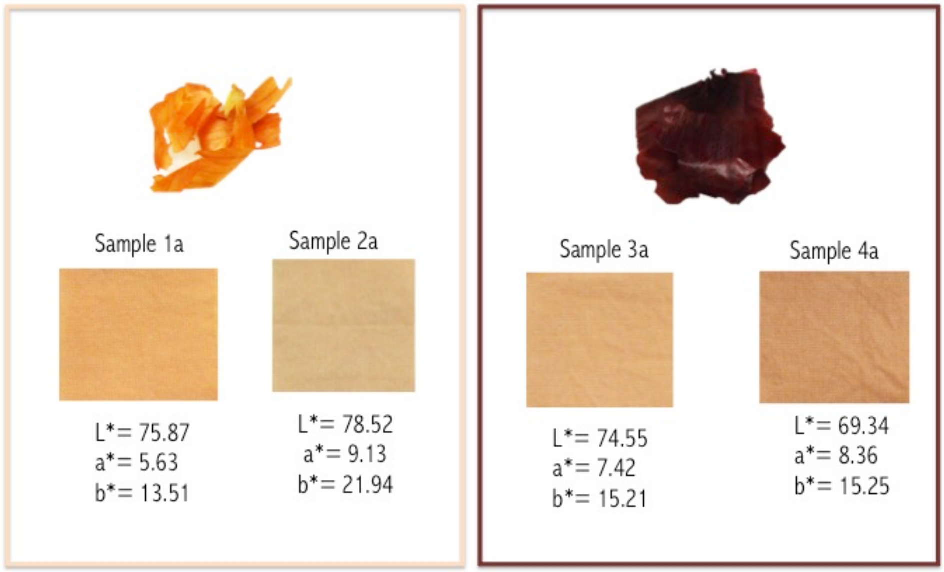


*Figure 47. Colour Values- CIE L*a*b* co-ordinates*

L*a*b* Colour Difference between Sample 1a and 2a

| | | | |
|---|---|---|---|
| $\Delta L^*$= (L* sample 2a -L*sample 1a)<br>$\Delta L^*$=(78.52-75.87)<br>$\Delta L^* = 2.65$ | $\Delta a^*$= (a* sample 2a -a*sample 1a)<br>$\Delta a^* = (9.13-5.63)$<br>$\Delta a^* = 3.5$ | $\Delta b^*$= (b* sample 2a -b*sample 1a)<br>$\Delta b^* = (21.94 - 13.51)$<br>$\Delta b^* = 8.43$ | $\Delta E: \sqrt{(2.65)^2 + (3.5)^2 + (8.43)^2}$<br>$\Delta E = \sqrt{7.0225 + 12.25 + 71.0649}$<br>$\Delta E = \sqrt{90.3374}$<br>$\Delta E = 9.50$ |

*Table 7. Colour difference between Sample 1a and Sample 2a*

Although we can determine that sample 1a and sample 2a are different in colour, the values from Table 7 allows it to be determined that sample 2a is lighter, redder and yellower than sample 1a. The total colour difference between samples is 9.50.

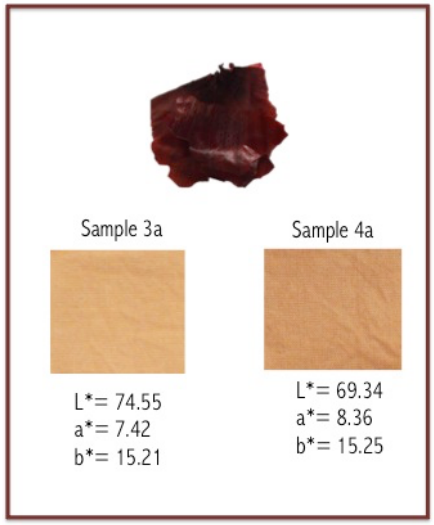



*Figure 48. Colour difference between sample 3a and 4a*

L*a*b* Colour Difference between Sample 3a and 4a

| | | | |
|---|---|---|---|
| ΔL*= -5.21 | Δa*= +0.94 | Δb* = +0.04 | ΔE= 5.29 |

*Table 8. Colour difference between Sample 3a and Sample 4a*

Conversely to sample 1a and 2a that were the samples dyed with brown onion skin, sample 3a and 4a, that were dyed with purple onion skin seem to be by visual inspection more similar in colour. (See Figure 48). However, the values from Table 8 allow it to be determined that sample 4a is darker, redder and more yellow than sample 3a. The total colour difference between samples 3a and 4a is 5.29.

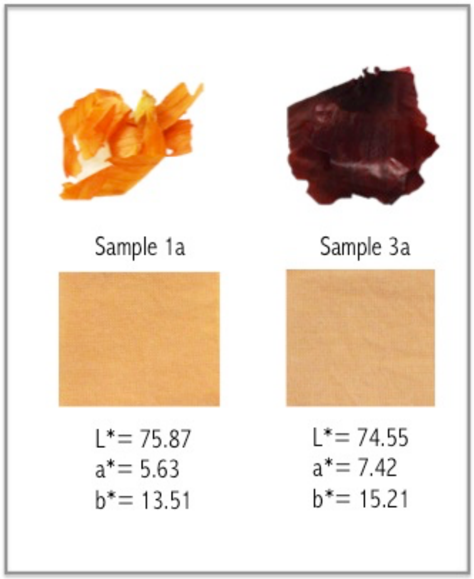



*Figure 49. Colour difference between 1a and 3a*

L*a*b* Colour Difference between Sample 1a and 3a - NaCl free

| | | | |
|---|---|---|---|
| $\Delta L^*= 1.32$ | $\Delta a^*= -1.79$ | $\Delta b^* = - 1.7$ | $\Delta E= 2.79$ |

*Table 9. Colour Difference between Sample 1a and 3a*

Although sample 1a and 3a are from different onion types (brown versus purple), they have something in common, both are dyed without NaCl making comparison appropriate. (See Figure 49). The values from Table 9 allows it to be determined that sample 1a is lighter, less red and less yellow than sample 3a. The colour difference between sample 1a and 3a is of 2.79.

If the colour difference between 1a and 2a samples is compared, which is 9.50, this means that sample 1a and 3a are more similar than 1a and 2a samples, although their onion skin colour source is different. This could mean that the lack of NaCl has an impact on the colour strength although the onion skins are from different colour varieties.

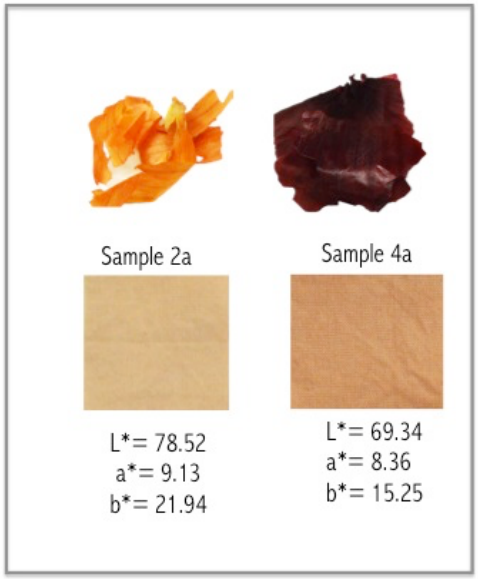


*Figure 50.Colour difference between 2a and 4a*

L*a*b* Colour Difference between Sample 2a and 4a- NaCl extraction

| | | | |
|---|---|---|---|
| ΔL*= 9.18 | Δa*= 0.77 | Δb* = 6.69 | ΔE= 11.38 |

*Table 10. Colour Difference between sample 1a and 2a*

Although sample 2a and 4a are from different onion skin colour, NaCl was added in both samples, this is the reason why it is interesting to compare their colour differences. (See Figure 50). The values from Table 10 allows it to be determined that sample 2a is lighter, redder and yellower than sample 4a. The total colour difference between the two samples is 11.38.

If the colour difference between 3a and 4a is compared (5.29), this means that sample 3a and 4a are more similar than 2a and 4a. This could mean that different colour compounds can be found when extracting brown onion compared to purple onion skin.

### 4.3.4 Washing fastness

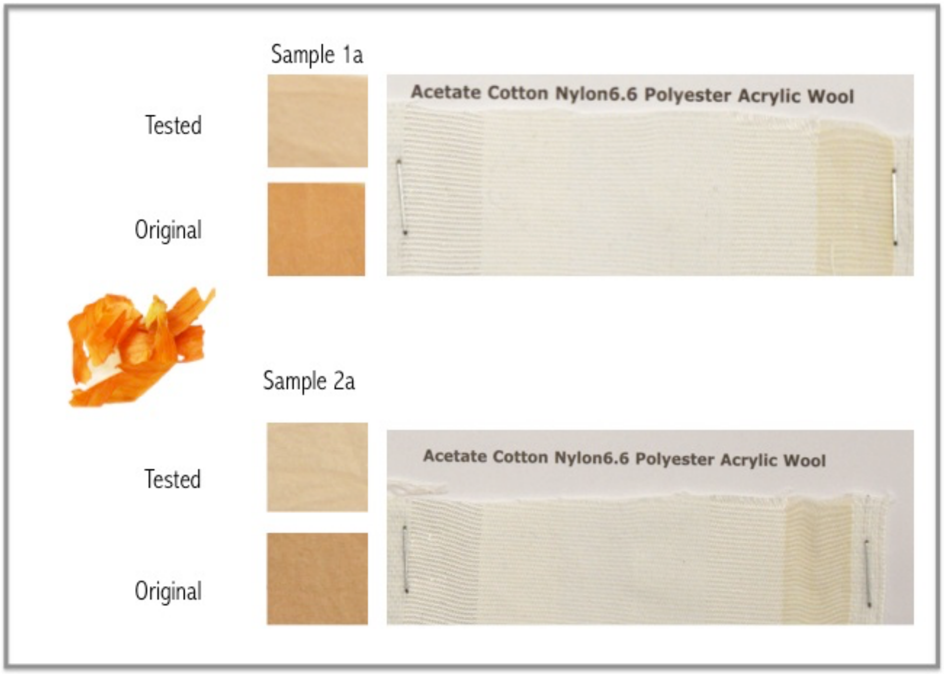



*Figure 51. Washing fastness sample 1a and 2a*


*Figure 52.Washing fastness sample 3a and 4a*

| Sample | COLOUR CHANGE | CELLULOSE DIACETATE | COTTON | NYLON 66 | POLYESTER | ACRYLIC | WOOL |
|---|---|---|---|---|---|---|---|
| 1a | 2-3 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 2a | 2-3 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 3a | 2 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 4a | 2 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |

*Table 11. Washing fastness values during household laundering*

Table 11 shows poor colour change results; the colour change is high between all the samples; sample 1a and 2a has less change compared with sample 3a and 4a. Moreover, these results, suggest that the samples that were dyed with the purple onion skin extraction, experience a more significant colour change, than the samples that were dyed with the extraction of brown onion skin.

The results from Table 11 indicate a high colour change when washing. This could be because as Patel (2011) said, metallic mordants such as chrome, iron and copper are needed in order to maintain the tinctorial value of the flavonoids found on onion, However, good (4-5) values with regards to staining were obtained, meaning that the dye does not create any bonding with any of the test fabric samples. This also could be attributed to the lack of metallic mordants, which means that no charge is added to the dyebath; therefore, the flavonoids dyes are not strongly bonded to the fibres. Since, according to Chakraborty, (2011, pg.212) “The final structure of the dye must be big enough to be trapped *in situ* within the fibre. This may be achieved by allowing aggregation of dye”.

### 4.3.5 Light fastness

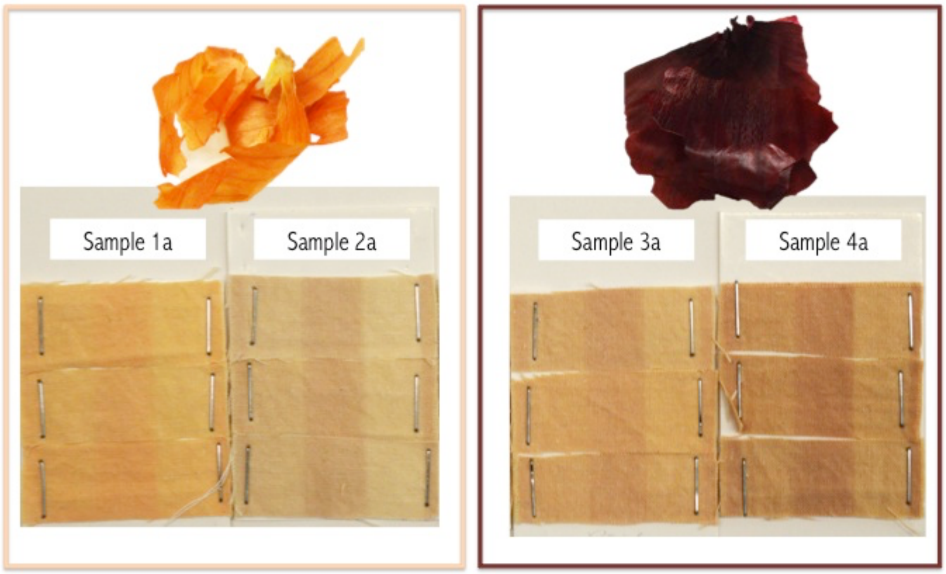



*Figure 53.Light fastness test*

| BS EN ISO 105-B02:2014 | | | | |
|---|---|---|---|---|
| SAMPLE | 1a | 2a | 3a | 4a |
| COLOUR CHANGE | 2-3 | 2-3 | 2 | 2 |

*Table 12. Light fastness values*

Table 12 shows poor light fastness results; poor results in this context, mean that the colour change is high when exposed to light (equivalent to BW4). See Figure 53. However, the samples that have exhibited slightly less colour change (2-3) were sample 1a and 2a, which correspond to the fabrics that were dyed with the extractions from brown onion skin when compared to samples 3a and 4a which were the fabrics dyed with the extractions from purple onion skin. This could suggest that dye molecules extracted from brown onion skin are more stable to light than the ones extracted from purple onion skin. The flavonoid dyes are not showing good light fastness because as Patel (2011) argues, the flavonoid chromophore is vulnerable to photochemical attack. Therefore, this means that flavonoids when exposed to light, fade gradually. However, Patel (2011) indicated that flavonoids could become resistant to fade when exposed to light if it becomes conjugated to another moiety, which could be a metallic mordant. However, the approach of this study is to embrace these natural changes, such as total colour fading and use other strategies to make it socially accepted.

### 4.3.6 Dry Cleaning fastness


*Figure 54.Dry Cleaning fastness - Sample 1a and 2a*

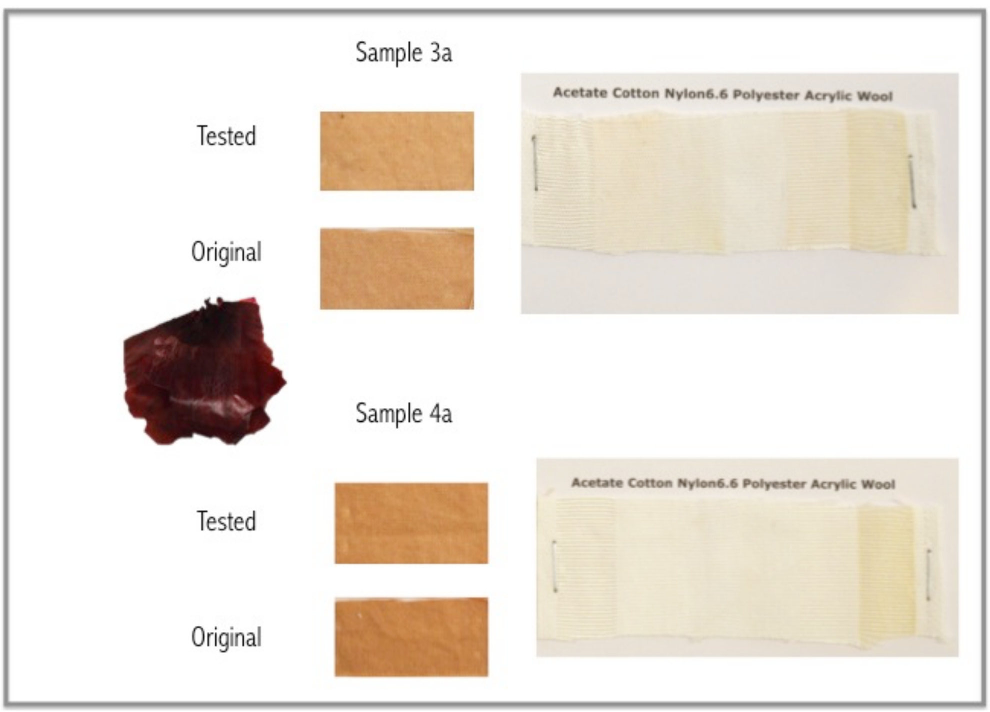



*Figure 55.Dry Cleaning fastness - Sample 3a and 4a*

| COLOUR CHANGE | CELLULOSE DIACETATE LYOCELL | COTTON | NYLON 6-6 | POLYESTER | ACRYLIC | WOOL |
|---|---|---|---|---|---|---|
| SAMPLE 1a | STAIN | | | | | |
| 4- 5 | 4-5 | 4 | 4 | 4-5 | 4-5 | 4-5 |
| 4- 5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 2 | 4 | 3-4 | 4 | 4-5 | 4 | 4-5 |
| SAMPLE 2a | | | | | | |
| 3- 4 | 4-5 | 4- 5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 4 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 3-4 | 4 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| SAMPLE 3a | | | | | | |
| 4 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 2- 3 | 4 | 3 | 4 | 4 | 3-4 | 4 |
| 3- 4 | 4 | 3-4 | 3-4 | 4 | 4 | 4 |
| SAMPLE 4a | | | | | | |
| 4 | 4-5 | 3 | 4 | 4-5 | 3-4 | 4-5 |
| 3- 4 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| 4- 5 | 4-5 | 3-4 | 3-4 | 4 | 3-4 | 4 |

*Table 13. Dry Cleaning fastness*

In this case, obtaining an average of the dry-cleaning fastness results for each of the samples was not appropriate, due to the spread of values obtained. For example, sample 1a shows in the first two dyed fabrics a colour change of (4-5) which means that the change of colour was slight however the third shows a bigger difference of colour (2). This change of colour could be because in the dry cleaning, solvents are added and the flavonoid dyes found on *Allium cepa* could be soluble on the solvent used. According to Johnson (1974 cited by Chakraborty, 2011. pg. 209) “dry-cleaning may also cause fading or a change in colour due to the solubility of colour in solvent “. The use of onion skin as a natural dyestuff implies a variation in colour due to its nature and thus all dye baths would be different, providing different colour shades. In this case, the spread of values during the dry-cleaning fastness test highlights the variability in the process, which is key to the initial individuality and variation over the garment lifetime that this study aims to boost, through the acceptance of a constant colour change.

The most obvious finding to emerge from Table 13 is that cotton shows the greatest staining amongst all. This is not surprising as the original dyed sample is cotton, so the dyes have already demonstrated an affinity for cotton. Another important finding is that sample 2a shows more consistency with regards to colour change between the three dyed fabrics, it could be said that from all the samples, this one has the smallest change on colour; this stability could be attributed to the addition of NaCl. Likewise, sample 4a has more consistent results with regards to colour change when compared to sample 1a and 3a; this could be attributed to the addition of NaCl, however the stain on fabric is moderate. However, it is somewhat surprising since sample 2a and 4a which show more consistent results to colour change are from different onion skin varieties and consequenlty it was expected to react different during dry-cleaning due to the different dye compounds.

Moving on now to consider the staining of the dyed samples on the multi fibre strip, Table 13 shows that sample 1a and 2a which were the samples of brown onion skin show significant better results when compared to the samples of purple onion skin (3a, 4a) since 83% of the values were (4-5) meaning that the dye from brown onion skin create almost a null bonding with the other fabrics under test, providing consequently a minimum of bleeding. This finding suggests that different dye molecules could be involved in brown and purple onion skin, thus they will naturally interact in different ways with the cotton fabric and show varying degrees of stability to dry cleaning. In this case the purple onion skin exhibited a higher degree of staining of the multi-fibre strip than brown onion skin.

If Table 13 is compared to Table 11 , which corresponds to normal washing, the fastness profiles indicate that the colour change is less under dry cleaning but the staining is less under normal washing. However, it is clear from the two fastness profiles that the colour change is unavoidable, and this is to be expected since no mordant was used to fix the natural dyestuff, therefore this study aims to get consumers to embrace this natural process in which they could become co-designers by re-dyeing their garments at home with domestic food waste once initial colour fades.

Moreover, not all the population in Mexico utilise dry cleaning services, since the cost is higher when compared to normal washing. According to Meza Orozco (2018) the energy price in Mexico is increasing and consequently impacting on dry cleaning prices, since this service relies on the use of electrical machines. This is the reason why, according to Meza Orozco (2018) the higher socio-economic groups in Mexico are the ones that mostly use to the dry-cleaning service. According to the report conducted by Mercawise (2014) in Mexico, the age range of people that more use dry-cleaning services are between 25 to 34 years and the type of garments that they mostly dry clean are suits and coats. Taken together, this information suggests that dry-cleaning is not an appropriate laundering method to include in this model due to the higher cost that this service imposes on the

Mexican population. Moreover, Mexicans tend to use this service only for formal clothing such as suits and coats, therefore normal washing would be more appropriate and accesible to more people, although more colour change is experienced through this method than under dry-cleaning. However, as mentioned earlier, this study aims to get consumers to embrace this natural process of colour change and colour fading in which they could become co-designers by re-dyeing their garments at home with food waste once initial colour fades.

## 4.4. Summary

The experimental work using *Allium Cepa* (onion) as a natural dyestuff on cotton indicates there are limitations to the wearable textiles applications. For example, there is less colour change when the samples were subjected to dry cleaning than to a normal washing process, conversely there is less staining to other fabrics when samples were subjected to normal washing process than to a dry-cleaning process. This could mean that when using natural dyestuff with no metallic chemical additives it is more suitable to wash the textiles following a normal procedure than a dry cleaning. Although the colour change is higher under normal washing conditions, this can be exploited in order to engage with the customers through co-design in which they could re-dye their garments with available domestic food waste at their house and use normal washing procedures without staining other garments, since the natural dyestuff does not fix to other types of fabrics. Poor light fastness results were achieved, meaning that the colour change is high when exposed to light, since flavonoids when exposed to light, fade gradually. However, the approach of this study is to re-frame the design problem regarding the market acceptance of natural dyes without metallic chemical additives, challenging what has previously been considered to be suitable to market with regards to natural dyed textiles such as colour strength and colour fastness. This work has highlighted the limitations in the use of natural dyes, such as lack of colour strength, standardisation and durability when compared to synthetic dyes. However, this provides a design opportunity, co-design and customisation which allows the consumer to be part of the creation process of their garment, by dyeing and re-dyeing their garment with unique colour characteristics, this will be further explored and discussed in Chapter 5 of this thesis.

# Chapter 5. Exploration of design routes that could facilitate the social acceptance towards natural dyes from domestic food waste resources without metallic chemical additives

This study investigates whether rather than using metallic chemical additives that could affect Mexico´s waterways adversely, instead consumers (exemplified by a subset of Mexican females) are open to accept natural dyed textiles with limited colour strength and colour fastness, embracing the limitations of the process as an opportunity to personalise the end garment and take ownership of the creative process. Transition design, co-design, wabi sabi aesthetic, and emotional attachment approaches are explored in order to identify strategies that could facilitate the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

The barriers towards the market adoption of natural dyes include poor fastness properties, colour yield and colour variations. This research aims to challenge these apparent barriers, identifying routes through design that could influence a desirable consumer product experience.

## 5.1. Transition Design

According to Tonkinwise (2015), art and science are combined in design in order to make useful things, however designers are in charge of not only creating material things but also enabling social activities. As Tonkinwise (2015) points out, design outcomes are not merely physical but also social, based on the fact that design leads to the creation of physical objects, which become elemental in people´s lives. Marchand and Walker (2008) also suggest, that design can contribute towards changing individual lifestyles

In this century, designers had been encouraged to shift to a different kind of thinking, in which complex societal problems could be addressed through a deep understanding of the problem and all the stakeholders involved within, in order to not only address a complex problem through a holistic systematic approach process but also to give equal importance to all the parts and parties involved (Tonkinwise, 2015; Irwin, 2018). This challenges the traditional design approach, in which a problem can be solved through an end product (Tonkinwise, 2015) or through a… "short-term, one-off solutions" Irwin (2018, p.969). According to Tonkinwise (2015) transition design offers a new thinking framework of designing contextual interventions based on an open system in which there is not a final solution but rather an open window to subsequent opportunities. This is the reason why, Irwin (2018, p. 969-970) highlights that "[t]ransition [d]esign draws on approaches from the social sciences to understand the social roots of wicked problems and places stakeholder concerns and co-design/collaboration at the heart of the problem-solving process".

"The kinds of expanded social fields in which design now aids innovation and change are precisely ones in which humans need to be acknowledged as being more complex than marketing´s notion of consumers" (Tonkinwise, 2015 p.88). The impacts of climate change are an example of a complex problem that all humans around the world are experiencing, such as longer heatwaves, rising sea levels, reduction in fresh water supplies and disruption of natural ecosystems (Steffen and Hughes, 2013). Immediate global societal action is needed in order to reduce the emissions of carbon dioxide produced by human activities, through the combustion of fossil fuels (Steffen and Hughes, 2013). If the global temperature rises beyond 2°C … "[s]ocieties will have to adapt to even more serious impacts" (Steffen and Hughes, 2013, p.87). "The global mean temperature in 2019 was estimated to be 1.28°C (2.31 °F) above the average temperature of the late 19th century, from 1850-1900, a period often used as a pre-industrial baseline for global temperature targets" (berkeleyearth.org, n.d.). From

2013-2019 in relation to 1981- 2010 the average global mean temperature increase has increased from 0.24 ± 0.05°C to 0.54 ± 0.05°C (berkeleyearth.org, n.d.). Therefore, this suggests that actions taken to reduce carbon dioxide emissions have not been successful.

In addition, a new complex societal problem emerged in 2019; the COVID-19 pandemic, which according to United Nations (2020, p.5) is… "more than a health crisis; it is a socio-economic crisis, a humanitarian crisis, a security crisis, and a human rights crisis". This human crisis has not only caused the death of hundreds of thousands of people around the world but has also disrupted people´s lives globally, impacting directly on their social and economic activities due to regional lockdowns (United Nations, 2020). "Initial indications show that women are more likely to lose their jobs or sacrifice their work to take on the additional burden of care in the home…"(United Nations, 2020, p.49). This suggests that other problems may arise, due to restricted outdoor activities. According to United Nations (2020), this pandemic has impacted on the mental health of people around the world causing psychological distress. In the same vein, the World Health Organization (WHO) points out, that people around the world are facing an emerging reality in which fear, worry and stress are affecting their daily lives due to the COVID-19 pandemic (Who.int, n.d). United Nations (2020, p.54) stress that "Good mental health is critical to the functioning of society at the best of times". Therefore, this complex and multifaceted societal problem suggests, that design could contribute towards the generation of activities at home that could bring joy especially to women in order to support the maintenance of good mental health. A co-design activity could contribute to good mental health of Mexican women, who due to COVID-19 are spending more of their time at home. Co-design will be explained in detailed in section (5.3).

Due to societal urgencies, Tonkinwise (2015) believes that transition design could contribute towards the creation of a more sustainable future through social change via systematic design interventions. Since, researchers in the sustainable design field have recognised that design should have its focal point in creating a change on a system-level rather than on impact reduction (Tonkinwise, 2015). Similarly, Gaziulusoy and Erdoğan Öztekin (2019, p.2) point out, that transition design requires… "systemic changes at societal level". Therefore, this suggests that transition design could contribute to the existing complex societal situations that the world is currently facing such as, the reduction of carbon dioxide emissions, COVID-19 and the reduction of pollution in Mexico´s waterways through the design of programmes that could impact on a systematic social change.

According to Irwin, Tonkinwise and Kossoff (2013) the transition design framework consists of four main areas, and they describe it as follows:

1. Vision for Transition:

- Flexible, meaning that should be open to a constant change.
- Future-oriented, meaning that it should inspire and direct the design projects, acknowledging possible scenarios that current life-styles may be generating.

2. Theories of change:

- Multidisciplinary, meaning that designers should acquire new knowledge and collaborate with other disciplines in order to propose new design ideas.

3. Mindset and Posture:

- Holistic worldview, meaning that designers should integrate and interact with other disciplines in order to not only understand the dynamism of a context but also to generate new situated design solutions.

4. New Ways of Designing:

- Re-frames current social and environmental problems.
- Facilitates a design thinking open to make connections between different fields in order to generate design interventions.
- Open, meaning that it enables a design system open to change and enables the stimulation of new knowledge.
- This area will be the causality of the other areas (vision for transition, theories of change, mindset and posture).

Irwin (2015) points out that designers could become agents of change if they possess a clear understanding of the system that requires improvement, in order to determine which multidisciplinary approach/new knowledge is needed for the development of a design intervention.

This study re-frames the design problem; challenging what has previously been considered to be suitable to market with regards to natural dyed textiles such as colour strength and colour fastness and proposes a social marketing intervention model for consumer education and behaviour change to accept natural dyes from domestic food waste resources without metallic chemical additives.

Transition design as an open system approach could be applied as a facilitator towards the consumers acceptance of natural dyes from domestic food waste resources without metallic chemical additives, through a co-design engagement experience enabling them to embrace the limitations of the use of natural dyes from domestic food waste resources without metallic chemical additives, such as lack of colour strength, standardisation and durability when compared to synthetic dyes.

## 5.2. The importance of co-creating value in a complex and dynamic market

The current economy is complex due to a dynamic market in which fragmentation is high and standardisation is an obstacle towards differentiation, therefore businesses need to reinvent regularly in order to adapt to emerging markets (Humphreys *et al.*, 2019). Companies at the same time have to deal with more informed consumers that have greater access to their information, regarding their products price, quality, technology and performance globally (Prahalad and Ramaswamy, 2004, Humphreys *et al.*, 2019). On the other hand, social networks have allowed consumers to build powerful thematic communities sharing their product opinions no matter their geographical location, therefore consumers not only have more power over the companies due to their independence from it, but also make more informed purchase decisions (Prahalad and Ramaswamy, 2004).

The emerging reality is that contemporary consumers are not satisfied despite the enhancement of the market product choices in the twenty first century (Prahalad and Ramaswamy, 2004). Open access to information and the existence of global consumer communities have empowered and have impacted on the passive-active consumer transformation, that demands not only participation in the business system, such as for example getting involved in the product design, production process and marketing communications, but also in the transformation of existent markets (Prahalad and Ramaswamy, 2004, Humphreys *et al.*, 2019). Therefore, nowadays companies are challenged to offer personalised consumer experiences (Humphreys *et al.*, 2019). Moreover, technological advances, innovation and new production methods of companies has enabled and stimulated a higher participation and collaboration between the stakeholders within the system, including consumers (Humphreys *et al.*, 2019).

In addition, it is important to point out that due to an informed, connected and active contemporary consumer, companies need to shift from a value creation centred on the company in which the market was in charge of exchanging the intrinsic value of a product/service from the producer to the consumer towards a new approach in which the consumer becomes a stakeholder within the system to co-define and co-create unique value (Prahalad and Ramaswamy, 2004). Moreover, according to Humphreys *et al.* (2019, p.04)…"co-creation offers a highly promising and more holistic, approach to value creation".

Therefore, co-creation, is highly related with the transition design framework and approach. Since the transition design framework has a holistic worldview (Irwin, Tonkinwise and Kossoff, 2013) and the transition design approach relies on the collaboration between all the stakeholders within a system to deal with contemporary complex challenges (Irwin, 2018).

Within this new frame of reference for the value creation process (See Figure 56), the consumer and the producer are jointly in charge of exchanging value through an interaction that generates the co-creation of valuable products and services, in which the value of the product/service relies on the consumer experience being part of the creation (Prahalad and Ramaswamy, 2004).

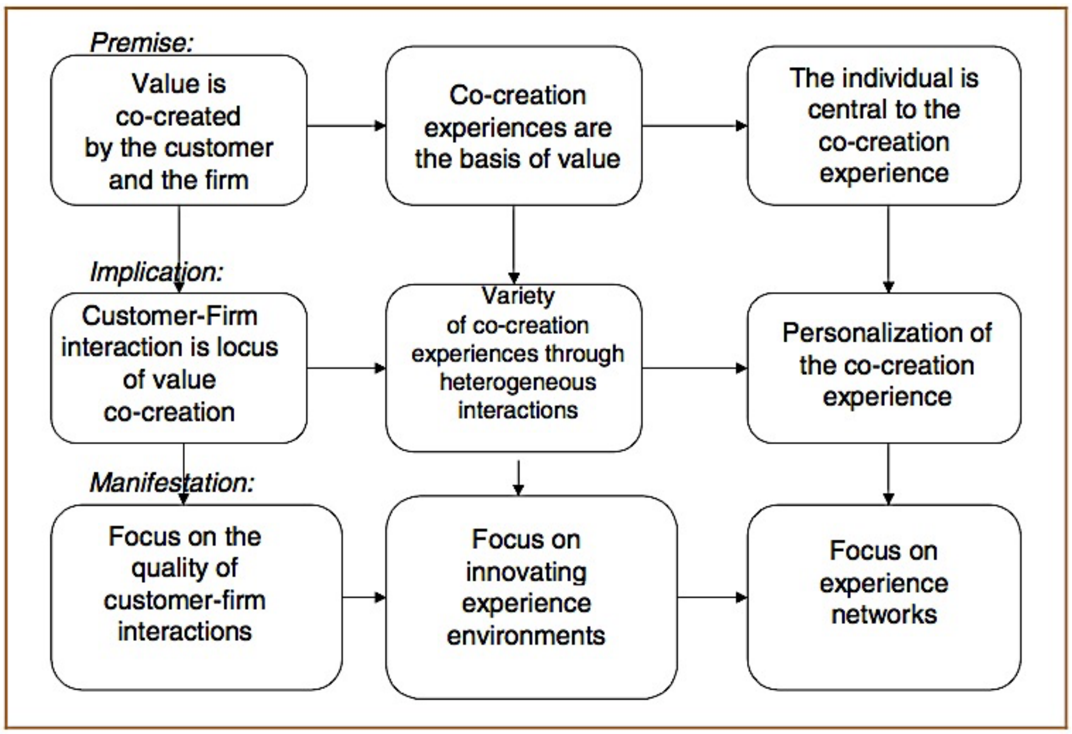



*Figure 56. The new frame of reference for value creation (Prahalad and Ramaswamy, 2004, p.5)*

According to Prahalad and Ramaswamy (2004, p.5) "The use of interaction as a basis for co-creation is at the crux of our emerging reality". Therefore, the future market competition may be encouraged to follow an unconventional approach …"based on an individual-[centred] co-creation of value between consumers and companies" (Prahalad and Ramaswamy, 2004, p.5). In the same vein, Humphreys *et al.* (2019, p.04) points out … "co-creation cannot be safely ignored by companies who want to succeed in today's marketplace". In which each consumer co-creation process and experience will be unique due to its intrinsic individuality (Prahalad and Ramaswamy, 2004).

Therefore, co-creation represents an alternate approach to a market need of a non-satisfied consumer by offering a unique value that is not grounded on the resultant service or product from co-creating, but on an emotional and personal co-creation interaction experience (Prahalad and Ramaswamy, 2004). “The market begins to resemble a forum organized around individuals and their co-creation experiences rather than around passive pockets of demand for the firm's offerings” (Prahalad and Ramaswamy, 2004, p.6). Co-creation generates unique value to a specific person focusing on a personalised consumer experience, which in the emergent competition economy represents an alternate way of innovation and growth (Prahalad and Ramaswamy, 2004). In the section that follows, the difference between co-creation and co-design will be discussed in more detail.

## 5.3. Co-design - The relationship with co-creation and its relevance in the study

Sanders and Stappers (2008) point out, that the co-creation and co-design approaches have been developed within the participatory design field. "The terms co-design and co-creation are today often confused and/or treated synonymously with one another" (Sanders and Stappers, 2008, p.6). However according to Sanders and Stappers (2008) co-creation refers to a collective performance of creativity that could be applied in any field. In contrast to co-design, which only takes place within a design process and refers to …"the creativity of designers and people not trained in design working together in the design development process" (Sanders and Stappers, 2008, p.6). This suggests that co-design is a collective creativity that occurs within the design field and in which at least one designer is involved. Hence "co-design is a specific instance of co-creation" (Sanders and Stappers, 2008, p.6).

Therefore, for the purpose of this study co-design is more appropriate than co-creation; since this research aims to involve the demographic of the study in the design process of their natural dyed garment. However, it is important to highlight that co-design also refers to a collective creativity as does co-creation. In this case, it is expected that the demographic of the study transfer part of themselves (personal narratives of value) towards their natural dyed garments. Because of this, it is important to consider how the design discipline has been evolving in order to consider the consumer as a stakeholder within the design process of their product/service.

Through time, design has moved closer towards the future user, notably in fields that are under constant evolution, such as technology (Sanders and Stappers, 2008). Therefore, design has a variety of approaches and the existents stimulate the creation of new ones and the evolution of design (Sanders and Stappers, 2008). For example, the user centred design approach in which the user is considered as the topic for the design creation and the participatory approach in which the user takes part in the design creation; despite their differences, are actually starting to impact on each other in the contemporary human-centred design panorama (Sanders and Stappers, 2008). Since in the contemporary practice of the design process, designers have been increasing the emphasis on the pre-design phase (front end) as they approach the future user (Sanders and Stappers, 2008). In this phase various activities occur …"in order to inform and inspire the exploration of open-ended questions"… (Sanders and Stappers, 2008, p.6, 7). For example, designers devote more attention to exploring and understanding users and their contexts, guiding the designer to an open thinking in which they could determine what kind of design solution suits the user's needs better (Sanders and Stappers, 2008). This user centric approach suggests that the designer could decide if the user needs a product, a service, or an intervention. Since, Sanders and Stappers (2008, p.7) point out that in this phase… "it is often not known whether the deliverable of the design process will be a product, a service, an interface, a building, etc.". This future oriented and open thinking is in the same vein as transition design framework enabling the stimulation of new knowledge (Irwin, Tonkinwise and Kossoff, 2013).

According to Sanders and Stappers (2008) in order to address the forthcoming worldwide challenges, design should arguably not only continue its further transition to a purpose-based approach, shifting from the design "of" to the design "for" (Figure 57), but also integrate two perspectives; the identification of new positive design opportunities but also the negative consequences that the new design outcome may generate. This is highly related with transition design, as Tonkinwise (2015) pointed out in section (5.1) nowadays design has to lead with complex worldwide problems, and consequently with a consumer which is within a challenging context that is constantly under change.

| The traditional design disciplines focus on the **designing of** 'products' … | … while the emerging design disciplines focus on **designing for** a purpose |
|---|---|
| visual communication design | design for experiencing |
| interior space design | design for emotion |
| product design | design for interacting |
| information design | design for sustainability |
| architecture | design for serving |
| planning | design for transforming |

*Figure 57. A snapshot in time and emerging design practices (Sanders and Stappers, 2008, p.11)*

Sanders and Stappers (2008) believe that the design evolution from a classical user-centred design approach in which the user was only as a passive object of study towards a co-design approach in which the user becomes an active stakeholder within a design process, could contribute towards the creation of a more sustainable future. Therefore, co-design could be considered as a fundamental aspect of the transition design approach. Since, according to Irwin (2018, p.969-970) …"co-design/collaboration [is] at the heart of the problem-solving process" within the transition design approach. Moreover, Tonkinwise (2015) believes that transition design could contribute towards the creation of a more sustainable future. Therefore, this suggests that co-design and transition design share the same aim, which is the creation of a more sustainable future.

In the same vein, Steen (2013) suggests that current worldwide complex challenges could be addressed through a co-design process that promotes reflexivity within the participants. " By becoming more aware of their involvement, participants can organi[s]e their co-design more effectively, so they can jointly learn and jointly create" (Steen, 2013, p.28).

In addition, Prahalad and Ramaswamy (2004) argue that nowadays the collaboration between end-users and companies is a powerful approach to compete in saturated markets, through personal added value. An example of a creative collaboration between end consumers and company in the design process of a product (co-design) is the Techno PORTA pilot line of the Porta KMI Poland Company that has been in the door industry for 25 years (Pędzik *et al.*, 2020). This pilot line aims to meet the specific needs of end consumers by involving them in the door design process, in which they can specify dimensions, select locks and handles (Pędzik *et al.*, 2020). Moreover, this product line has an automated production process driven by technological innovation (Pędzik *et al.*, 2020).

According to Pędzik *et al.* (2020) the door industry is characterised as a variable and complex market, due to high competition, and a constant change of trends which causes dynamic consumers preferences. Therefore, Pędzik *et al.* (2020) point out that customisation is a competitive advantage that allows companies to maintain/increase their competitiveness and profits by attracting customers towards a personalised product.

In contrast, Prahalad and Ramaswamy (2004) argue that, in the emergent economy the competitive advantage of a company does not rely on the customisation of products/services but on the consumer experience of being involved in the creation process of their product/service. Therefore, these suggest that customisation could be a connective tool towards a co-design experience allowing consumers to transfer personal narratives to their product/ service.

In the same vein, Sanders and Stappers (2008) point out, that nowadays companies are focusing more on the user experience and the user context than on the product since the current market competition is centered on new ways to keep up the interest of the user outside of the traditional market competition such as technology, quality and price. However, the example of Porta KMI Poland Company, discussed previously indicates that technology for example is still crucial to compete in a complex market. Therefore, this suggests that technology, quality and price are still important factors for market competition. However, nowadays other competitive advantages are needed to maintain/increase company's competitiveness, such as co-design. In addition, Prahalad and Ramaswamy (2004) point out, that company managers must not only keep track on their products and processes quality but mainly on the quality of the interaction experience between consumer and company grounded on the ability to generate diverse experiences.

For example, it is hard for natural dyes to compete with synthetic dyes in the traditional market competition such as quality, price and colourfastness properties. This is the reason why, this study looks outside the product and focuses on the user experience. In which the co-design approach along with customisation could generate added value to the demographic of the study in order to embrace the use of natural dyes from domestic food waste resources without metallic chemical additives. Moreover, considering the point of view of Steen (2013, p.28) about ..."promoting reflexivity: by helping co-design participants to be more aware of their thoughts and feelings, and of their own roles and interests". If the demographic of the study, becomes aware of the negative effects of the metallic chemical additives in the environment before being involved in a co-design experience of natural dyeing, they could understand the relevance of doing. Hence, this could not only enhance their co-design experience due to the new knowledge acquired but could also increase their awareness of the importance of their clothing purchase decision, which could hopefully lead towards more informed consumers that could, in turn, demand more sustainable dyeing practices within the textile industry. The importance of educating consumers about: The negative effects that a high clothing consumption rate has on the environment, the negative environmental impact that metallic chemical additives in the textile dyeing activity have on the environment and the difference between natural and synthetic dyes in order to make a shift in their behaviour will be considered in the social marketing intervention model, which is discussed in Chapter 7.

In addition, this study aims to apply the wabi sabi aesthetic to support the co-design experience. In the section that follows, it will be explained wabi sabi.

## 5.4. Wabi sabi - Ancient aesthetic from Japan

According to Prusinski (2012) the wabi sabi aesthetic emerged from Japan´s Heian era, which corresponds to 794 A.D. to 1185. In this era the Japanese… "revitali[s]ed its focus on the natural world, embracing its unpredictable fluctuations and adopting a sensitivity to and appreciation for nature" (Prusinski, 2012, p.25). In addition Prusinski (2012, p.49) points out that this high appreciation of nature from the Japanese culture has enabled the recognisition that "technology cannot eliminate nature". This suggests that Japaneses are aware of the importance of nature in their lives although technology continues evolving."[Wabi sabi] means treading lightly on the planet and knowing how to appreciate whatever is encountered, no matter how trifling, whenever is encountered" (Koren, 2004, p. 186). According to Koren (2004, p.186) "[Wabi sabi] is a beauty of things imperfect, impermanent and incomplete". Similarly English (2016) points out, that wabi sabi embraces impermanence and imperfection. Therefore this suggests that wabi sabi is an aesthetic in which impermanence, imperfection and incompleteness constitute something valuable.

Koren (2004) describes a wabi sabi thing, as something unique, simple, in balance with the environment, made of natural materials and emotionally warm. Prusinski (2012) suggest that a wabi sabi thing possess a raw quality. This latter thinking could be related to its composition of natural materials. " Things [wabi sabi] have no need for reassurance of status or the validation of market culture" (Koren, 2004, p. 186). In addition, Koren (2004) suggest that, direct contact with a wabi sabi thing enables the appreciation of its essence. Therefore, this suggests that a wabi sabi thing is sensous, indulging for example the sight and touch senses. "[Wabi sabi] is a nature-based aesthetic paradigm" …(Koren, 2004, p.186). In the same vein Prusinski (2012, p.29) point out that … "*wabi* and *sabi* are often combined to describe richly an event or object that contains strong power in its often faded or raw outward appearance".

Therefore, wabi sabi may be an additional connective tool in a co-design experience, in which the demographic of the study could appreciate the impermanent nature of natural dyes and the imperfection of using it without metallic chemical additives, enabling their involvement in the design process of their garment. In addition, wabi sabi has an important connection with transition design and co-design, aims towards a more sustainable future (Tonkinwise, 2015; Sanders and Stappers, 2008). Due to wabi sabi appreciation of nature and as Koren (2014) points out, a balance with the environment. This latter could refer to something that does not alter the environment. The section that follows shows an example of the incorporation of wabi sabi in the design field.

## 5.5. Wabi sabi in the design field

Tsaknaki and Fernaeus (2016) discuss how wabi sabi could be approached as a conceptual resource in the design field to guide contemporary interactive solutions. According to Koren (2004,p.186) "[Wabi sabi] is a beauty of things imperfect, impermanent and incomplete". The discussion of Tsaknaki and Fernaeus (2016) is mostly centred on the human-computer interaction (HCI) context, nevertheless they developed three principles around the themes of impermanence, incompleteness and imperfection with the aim of facilitating the application of wabi sabi in a design project or as an analytical tool to reflect on an interactive product/system. The design principles are the following:

1. "Design for long-term interaction through conscious use of impermanent materials and media" (Tsaknaki and Fernaeus, 2016, p. 5977).

2. "Approach perfection through explicitly unfinished designs" (Tsaknaki and Fernaeus, 2016, p. 5977).

3. "Engage with the richness of interactive expressions by embracing limitations in current technology" (Tsaknaki and Fernaeus, 2016, p. 5977).

Tsaknaki and Fernaeus (2016) propose the application of the impermanence concept of wabi sabi in an interactive design system/product as an opportunity to enable a long-lasting life through an open modification opportunity while acknowledging the impermanent material reality. The impermanent reality… "might inspire new design directions and practices that treasure the ephemeral" (Tsaknaki and Fernaeus, 2016, p. 5977). For example, Snapchat is a media application in which users interact with their friends by sharing videos/photos (stories) that last only 24 hours (support.snapchat.com, n.d.). This application exemplifies impermanence as a design opportunity that can enable a long-term interaction and engagement between product/system-user embracing a temporal value (Tsaknaki and Fernaeus, 2016). In addition, this impermanence theme has a connection with the vision of the transition design framework, which is open to a constant change (Irwin, Tonkinwise and Kossoff, 2013).

According to Tsaknaki and Fernaeus (2016), a material entity is under a constant change, which could lead to an open design that embraces the incompleteness, as an approach to meet within a variety of user's personal needs by adapting a material object via customisation. This incompleteness theme has a connection with transition design, since according to Tonkinwise (2015), this type of design provides a thinking framework of designing based on an open system in which there is not a final solution, but rather an open window to subsequent opportunities. Incompleteness could be approached as a design resource to offer personalised interactive experiences, embracing a constant change in a product/system (Tsaknaki and Fernaeus, 2016). Moreover, customisation can enable users to express their personal identity into an object (Haines-Gadd *et al.*, 2018).

According to Tsaknaki and Fernaeus (2016), the traditional design ideals of perfection were associated to mass-produced objects with uniformity and symmetry. However, nowadays some designers and makers have shifted from these traditional ideals of production towards a crafting production of products/systems with a uniqueness essence (Tsaknaki and Fernaeus, 2016). "Variability in crafted products is a central source of value"…(Pedgley, Şener, Lilley and Bridgens, 2018, p. 25) Therefore, these suggest that imperfection (variability) could be used as a design resource towards a unique product/system. For example, according to the study conducted by Odom and Pierce (2009) the imperfections of things due to wear and tear, were seen as positive (unique) because of the personal narratives that were transferred towards their objects. Therefore, this suggests that if individuals transfer personal narratives towards their objects, they may embrace the imperfections of an object due to wear and tear. In addition, Tsaknaki and Fernaeus (2016) point out, that perfection ideals are constantly changing in which: practice, fashion and technological advances impact directly on it. "The notion of perfection also relates on a deep philosophical level to how user experience can be understood and approached by designers"… (Tsaknaki and Fernaeus, 2016, p.5972). Therefore this suggests that if designers acknowledge the subjectivity of perfection, they could use it as a design approach, in which users can be part of the design process of their product/system. This involvement in the design process between designer-user is also known as co-design (Sanders and Stappers, 2008). In addition, allowing users to become become "producers" contructs an engaging relationship between product-user (Haines-Gadd *et al.*, 2018, p.12).

The findings of the study of Tsaknaki and Fernaeus (2016) suggest that the impermanence, incompleteness and imperfection themes from wabi sabi can be used as an open design opportunity in which users can have a long-term interaction and a long-term engagement with their products through a co-design experience.

Moreover, the capacity of interactive design products to customise, repair/re-design represent a sustainable alternative to not buy a new product, which is also a challenge due to the idealised look of new, imposed by industries who focus on selling more (Tsaknaki and Fernaeus, 2016). Furthermore, co-design is a central part of the transition design approach (Irwin, 2018). Tonkinwise (2015) believes that transition design could contribute towards the creation of a more sustainable future. Therefore, this suggests that the impermanence, incompleteness and imperfection themes from wabi sabi coupled with a co-design experience could guide users towards a more sustainable consumption.

In this study the impermanence, incompleteness and imperfection themes from wabi sabi coupled with co-design and customisation can be adapted in order to:

1. Embrace the impermanence of natural dyes from domestic food waste resources without metallic chemical additives, giving value to an ephemeral garment colouration. In which, users can build a long-term interaction (relationship) with their garment becoming co-designers by re-dyeing their garments at home with domestic food waste once the initial colour fades.

2. Embrace the incompleteness of natural dyes from domestic food waste resources without metallic chemical additives, using it as a design opportunity to invite users to self-express through a co-design experience, in which users can customised their garment through colour design.

3. Embrace the imperfection of natural dyes from domestic food waste resources without metallic chemical additives, using its standardisation limitation as a co-design experience opportunity that allows users to perceive a personal value through a unique coloured garment.

## 5.6. Emotional product attachment – Design strategy towards the acceptance of more sustainable dyeing techniques and more sustainable clothing consumption

*1. Emotional attachment*

"The use of emotional attachment as a design strategy may enhance the sustainable consumption of clothing, but contextual understanding is needed" (Armstrong, Niinimäki and Lang, 2016, p.159-160). Similarly, Lobos and Babbitt (2013) suggest that emotional attachment can be used as a design strategy to address sustainability. Therefore, it can be deduced that prior to implementation of emotional attachment as a design strategy it is necessary to gather information about the demographic cohort in which the strategy will be implemented.

Ball and Tasaki (1992, p. 158) propose the following definition to attachment: "The extent to which an object which is owned, expected to be owned, or previously owned by an individual, is used by that individual to maintain his or her self–concept". This definition suggests that attachment does not necessarily involve emotion. According to the study findings of Ball and Tasaki (1992, p.187) "Emotional significance reflects important memories, which cannot be present before acquisition, and require time to accumulate". Therefore, this suggests that an individual could have an emotional attachment towards an object only if:

1. The object is owned.
2. The object supports the owner personal identity.
3. Memories have been created due to a high-interaction between individual (owner) - object.

Belk (1988) points out that, personal possessions contribute towards the reflection of a personal identity. Similarly, Schultz, Kleine and Kernan (1989) claim that material possessions represent an individual self-identity. However Belk (1989, p.160) says that "Self-extension occurs through control and mastery of an object, through creation of an object"... This suggests that in order to consider a product as an individual self-extension, the individual should be involved in the product creation process. Therefore, it can be argued that co-design can support emotional attachment due to the involvement between garment-user and consequently contribute towards more sustainable clothing consumption. Since, self-extension is a central construct of consumer behaviour (Belk, 1989). However as mentioned earlier, an emotional relationship between user(owner)- object is crucial for an emotional attachment.

*2. Emotional attachment- Customisation*

“Identity is the central concept in understanding the person, and attachment is the central construct in understanding the role and meaning of possessions to their owners” (Ball and Tasaki, 1992 p.170). Therefore, customisation could support emotional attachment, since according to Ball and Tasaki (1992) during a product customisation process an individual transfers its personal identity to the product.

However if a customised object does not support the owner identity due to deterioration for example, disposal is expected (Ball and Tasaki, 1992). Similarly, Schultz, Kleine and Kernan (1989) argue that positive feelings towards an object may change through the owner lifetime. This could be because as Ball and Tasaki (1992) point out individuals have a changing nature. An example of this could be that human beings are under constant evolution; therefore tastes may change from adolescence to adulthood. However, this constant change can be used as a design opportunity. According to Tsaknaki and Fernaeus (2016), a material entity is also under a constant change, and this latter can lead to an open design as an approach to meet within a variety of user’s personal needs by adapting a material object via customisation. Therefore, it can be ascertained that customisation could support emotional attachment as a design strategy towards more sustainable clothing consumption. Since, the capacity of interactive design products to customise represents a sustainable alternative to not buy a new product (Tsaknaki and Fernaeus, 2016).

*3. Emotional attachment- Lasting enjoyment of clothing*

A common barrier towards long-lasting enjoyment of clothing is boredom (Kwon, Choo and Kim, 2019). Armstrong, Niinimäki and Lang (2016, p.175) propose “designing for continued engagement” as a strategy towards more sustainable clothing consumption. Therefore, Armstrong, Niinimäki and Lang (2016, p.175) suggest that “[c]reating opportunities for consumers to continue engaging or to re-engage with garments over time is an important design consideration”. This re-engagement could also refer to the Tsaknaki and Fernaeus(2016) proposition of the capacity of interactive design products to be re-designed according to the individual changing needs, which may impact in the reduction of clothing disposal and in the reduction of new clothing purchases, becoming an environmental benefit.

Armstrong, Niinimäki and Lang (2016) use modular design as a re-engagement example between user and garment, in which the user can become involved in the design of its garment by changing its appearance. Therefore, this suggests that the incompleteness theme from wabi sabi can be incorporated in a garment design, in which the user is invited to be part of the design/re-design of its garment. This may provide continual engagement and more lasting enjoyment due to providing a sense of newness while keeping the same garment.

According to the findings of the study conducted by Kwon, Choo and Kim (2019) the main drivers of clothing boredom are the following:

1. Oldness of clothing. This refers to clothing boredom due to a lack of aesthetic attributes as time passes, such as no longer attractive, nor interesting (Kwon, Choo and Kim, 2019). This is the reason why Armstrong, Niinimäki and Lang (2016, p.175) point out that "[c]reating opportunities for consumers to continue engaging or to re-engage with garments over time is an important design consideration". Therefore, this suggests that oldness of clothing may be tackled by applying co-design coupled with the impermanence theme of wabi sabi. Via this mechanism, users can build a long-term interaction (relationship) with their garment becoming co-designers and change the appearance of the garment once is no longer attractive.

2. Change in trends. This refers to clothing boredom due to fashion trends (Kwon, Choo and Kim, 2019). In this case as mentioned earlier the incompleteness wabi sabi theme can invite users to reinvent their garment through a co-design experience in which they can re-dye their garments based on new colour fashion trends. This customisation may provide to users a sense of newness while keeping the same garment.

3. Decreased social fit. "A decreased social fit refers to clothing that does not reflect one's social standing or age" (Kwon, Choo and Kim, 2019, p.8). Schultz, Kleine and Kernan (1989) argue that positive feelings towards an object may change through the owner lifetime. This could be because as Ball and Tasaki (1992) point out individuals have a changing nature. Therefore, this suggests co-design coupled with the imperfection theme from wabi sabi can invite users to customise and re-design their garments in order to meet their changing needs.

4. Purchase of new clothing. This refers to clothing boredom due to replaceability (Kwon, Choo and Kim, 2019). …"purchasing new clothing can undermine the appeal of already-owned clothing" (Kwon, Choo and Kim, 2019, p.8). This is the reason why, Armstrong, Niinimäki and Lang (2016, p.175) propose "designing for continued engagement" as a strategy towards more sustainable clothing consumption. In this case a co-design experience in which users can re-dye their garments (change its appearance) can provide a sense of newness to the users while keeping the same garment.

Kwon, Choo and Kim (2019, p.8) point out that this four drivers towards boredom clothing can be interconnected, "for example, a social fit of the clothing is likely to change over time, which may also reflect fashion changes and wear and tear of the clothing". Therefore, it can be construed that the incorporation of emotional attachment design strategies may overcome this interconnected boredom drivers.

Marchand and Walker (2008, p.1168) point out …"people's capacity to make changes in their lifestyles and product choices are, among other things, constrained by product availability". Therefore, design can contributes towards more sustainable consumer lifestyles, by developing alternatives in which the consumer can be attracted not only because of its environmental benefits but also from a personal angle (perceived value) (Marchand and Walker, 2008). In this case impermanence, incompleteness and imperfection themes from wabi sabi coupled with a co-design experience may help to overcome clothing boredom and consequently guide users towards a more sustainable clothing consumption model, in which consumers also obtain personal value from their consumption. Moreover, this suggests that interaction is needed between user-object in order to enable the transference of personal narratives towards an object.

This study aims to influence the acceptance of natural dyes from domestic food waste resources without metallic chemical additives to the demographic cohort. Therefore emotional attachment coupled with customisation, and lasting enjoyment of clothing could be used as design strategies not only to influence the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives but also in the longer term could influence more sustainable clothing consumption behaviour.

In this study, natural dyes from domestic food waste resources without metallic chemical additives could through its unique aesthetic characteristics (variability) keep surprising the user. Moreover, users could be able to transform their colour garment once the initial colour dye fades, offering a more active life to the garment. Moreover, DIY activities could be incorporated in order to allow the user to keep transferring new meanings and positive feelings to their garment. Additionally co-design would allow the user to be part of the design process increasing their product satisfaction. This customisation would arguably be reflected as a deeper emotional bond between user-garment that not only allows them to reflect their identity but also to create new meanings throughout their lifetime and the lifetime of the object.

## 5.7. Summary

It is clear that the transition design framework guides this chapter and the study in general aims to provide a holistic posture in which different themes are integrated in order to develop strategies towards the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives, for Mexican females with an age range of 18-33 years.

This chapter has examined new design routes towards the social acceptance of natural dyes from domestic food waste resources without metallic chemical addtives. Transition design, wabi sabi aesthetic (impermanence, incompleteness, imperfection), co-design and emotional product attachment are strategies that could enable designers to look beyond the natural dyes without metallic chemical additives barriers such as poor fastness properties, colour yield and colour variations in order to influence a desirable consumer product experience.

To sum up, this chapter aims to reflect that the use of natural dyes from domestic food waste resources without metallic chemical additives follows a sustainable dialogue of using available food waste, allowing unique and unpredictable results due to its impermanent nature. This study aims to influence a dynamic process in which the demographic do not only accept and embrace the performance limitations of natural dyes without metallic chemical additives but also become co-designers of their own clothing, which could lead to an emotional attachment bond between user-garment through co-design and customisation. The design strategies discussed will be considered in the social marketing intervention model, which can be found in Chapter 7.

# Chapter 6. Data Collection and Analysis – Review of the acceptance of natural dyes from domestic food waste resources and co-design and emotional approaches

Based on the lack of colour strength, standardisation and durability when using *Allium Cepa* (onion) skin as a natural dyestuff without metallic chemical additives on cotton (Chapter 4). The next step was to validate the hypothesis with the possible users. The hypothesis is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes. However, as mentioned in Chapter 4 (Section 4.1.5- Discussion of mordants and the negative impacts of their utilisation) not all the metallic chemical additives used in textile dyeing have the same impact on the environment. Therefore, within the context of this study the following metal salts will be considered as polluting substances (chromium, tin, copper).

The natural dyes' characteristics were included in the questionnaire topics along with probing participant's responses to ideas of co-design and generating emotional connections to their garments via qualitative questions. The survey questionnaire was generated using a Google form; the full questionnaire in Spanish is available in Appendix 1 and in English in Appendix 2. The survey was conducted by sharing the link through Instagram. The method of sharing could influence the response demographic, because most of my followers on Instagram are Mexican females from Aguascalientes and fall between the age bracket of 25 to 30 years old. However, 37.70% of the participants corresponded to the bracket age of 22-25 years, followed by 28.10% from the bracket age of 18-21. A possible explanation for this could be that other participants were reached through a snowball sampling strategy, sharing the link between followers of followers. This strategy is discussed in Chapter 3.

Prior to answering the survey, the participants received the following information in Spanish about the project research; here is the English translation of these instructions: "The questions presented are part of a PhD project-taking place in England at the University of Huddersfield, the research aims to analyse the relationship we have with our clothes to provide a sustainable colouring alternative and at the same time a rewarding experience. Implications: Participation in this study is entirely voluntary; so do not feel compelled to participate. All information collected will be strictly confidential and anonymised before data is submitted in any work, in accordance with data protection law and ethical research guidelines and principles. You will not receive payment for participation, however, if you would like a copy, please contact the researcher. The data collected will be used to generate a general statement of all participants and will be stored on a secure disk on the Huddersfield University server”. In case they decided to participate after reading the information and the implications, they had to give their consent.

The survey was only for Mexican females from 18-33 years old. This target demographic was selected because the Mexican female population is 2.8% higher than the Mexican male population (inegi.org.mx, 2015). Moreover, considering the information of inegi.org.mx (2015) with regards to the percentages of the female population by age brackets, making a projection to 2020 the age bracket of 18-33 represents on average 4.4% of the female population. In addition, this demographic group has more access to social media and consequently this suggested that a higher engagement could be achieved in order to conduct the online questionnaire. According to (INEGI, Secretaría de Comunicaciones y Transportes, Instituto Federal de Telecomunicaciones, 2019) Mexico has 74.3 millions of Internet users, from which 51.5 % corresponds to females. Furthermore, the most active Internet users in Mexico correspond to the age range of 25 to 34 years (INEGI, Secretaría de Comunicaciones y Transportes, Instituto Federal de Telecomunicaciones, 2019). The survey was translated and delivered in Spanish because it is Mexico´s native language.

The initial design of the questionnaire was delivered as part of a presentation about natural dyes from food waste, to Greenhead college students and teachers as a pilot test in December 2019 in United Kingdom (UK). During this presentation the students were shown pictures of cotton fabrics dyed with onion skin without chemical additives. The students were interested in the project, especially because some of them had done some natural dyeing during a class module. After the presentation, the following questions were asked to the students:

- Why do you think colour is so important for clothing?
- What view do you have from natural and synthetic dyes? Do you have a preference? Why?
- Which are the main barriers for you to wear naturally dyed clothes?
- Will you wear naturally dyed clothing, knowing that its colour may fade quite quickly?
- Do you prefer to wear the same colour clothes that your friends or something different?
- Will you be interested in being part of the colour design of your clothes?

The students were very open to participate and decided to make teams of three to discuss the questions and answers between them. At the end of the session each team shared their compilation of their answers with the rest. In response to this pilot study, it was identified that some of the questions required reframing. Moreover, the participants said that they would prefer to have a set of possible answers in order to be able to select the one that matches their point of view. Interestingly they showed a keen interest in personalisation and in the uniqueness that a natural dyeing without metallic chemical additives gives to clothing.

The pilot test provided useful technique improvements in order to develop a questionnaire in which they could select most of the answers from pre-determined options and just leave two open questions. Based on this improvement, a final draft was developed in January 2020. This final draft was delivered to 3 women with different ages and different backgrounds but relevant to the survey target demographic, in order to confirm that the questions were easy to understand. The responses indicated minimal changes, a final questionnaire was developed by the end of January and the survey was open for 5 days, starting from the 12$^{th}$ of February of 2020, 310 participants were reached.

## 6.1. Demographics - Data collection

- Age group

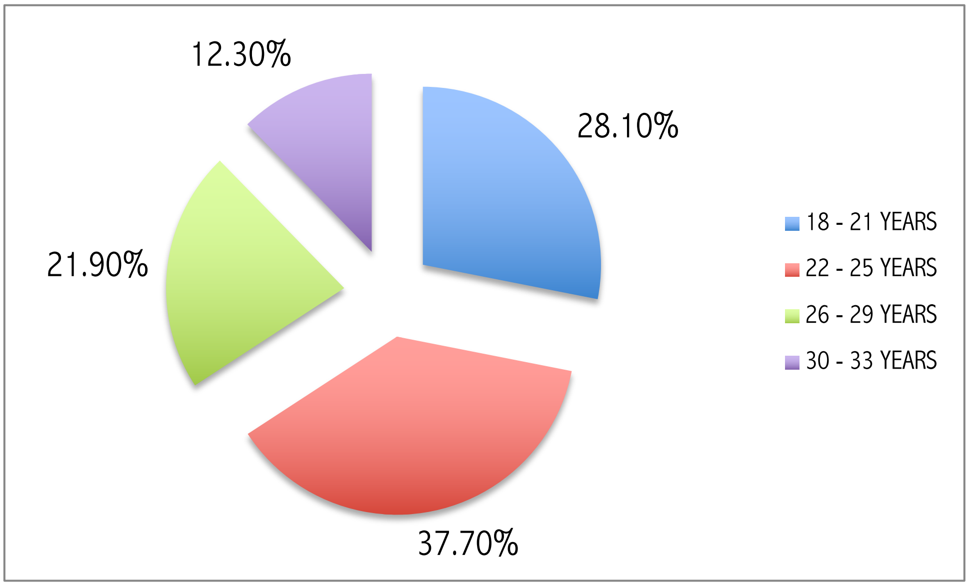



*Figure 58. Respondents by age group*

| Age group | Number of Participants |
|---|---|
| 18-21 years | 87 |
| 22- 25 years | 117 |
| 26-29 years | 68 |
| 30- 33 years | 38 |

*Table 14 Respondents by age group*

Figure 58 and Table 14 shows that the majority of the respondents are in the age range of 22 to 25 years, which corresponds to the 37.70 % followed by the age range of 18 to 21 years, which corresponds to the 28.10 %. This data is consistent with the last intercensal census period held in 2015 by *Instituto Nacional de Estadística, Geografía e Informática* (INEGI) that means National Institute of Statistics, Geography and Computing of Mexico, taking into account the (Figure 59) and projecting it to 2020 females in the age range of 18 to 25 will corresponds to the 4.6 % of the Mexican female population, the highest percentage group amongst all, and the highest group from the legal age range, (which in Mexico is 18 years old), followed by females in the age range of 26 to 29 with 4.5% and females in the age range of 30 to 34 with 4.0% (inegi.org.mx, 2015).

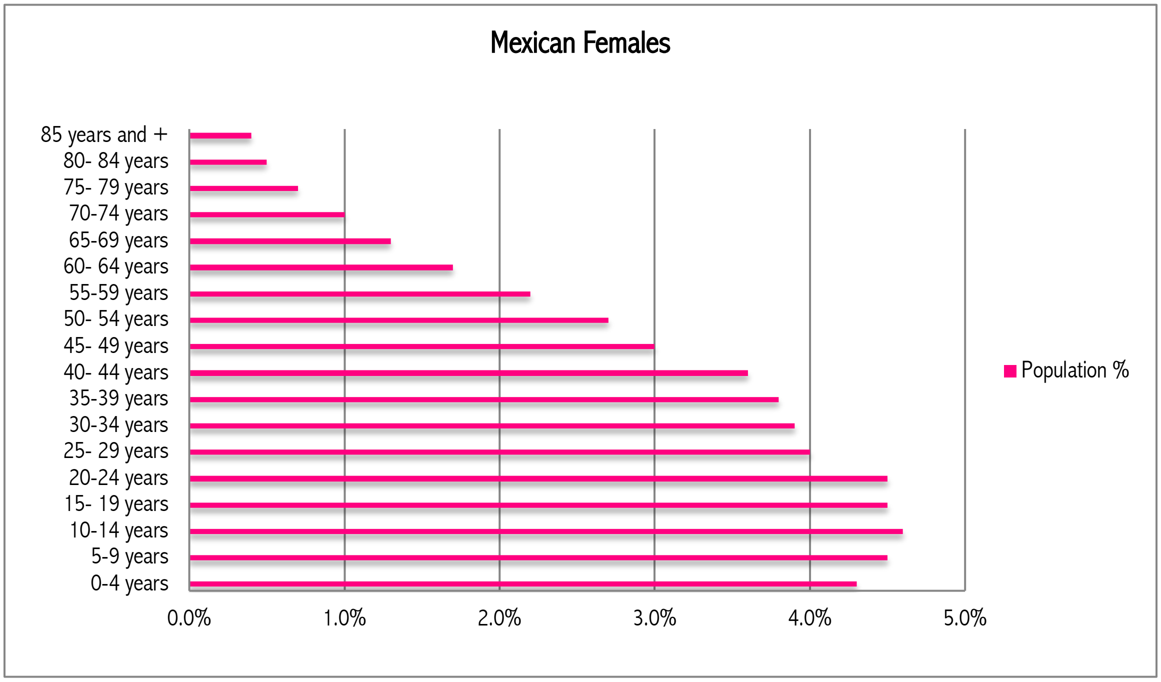



*Figure 59. Mexican Females adapted from inegi.org.mx (2015)*

This age range group 18 to 33 years old was considered in this study not only due to the high percentage, which approximately is of 4.22% of this age demographic within the total of the Mexican population, but also because this demographic group has more access to social media and consequently this suggested that a higher engagement could be provided in order to conduct the online questionnaire. According to (INEGI, Secretaría de Comunicaciones y Transportes, Instituto Federal de Telecomunicaciones, 2019) Mexico has 74.3 millions of Internet users, from which 51.5 % corresponds to females. Furthermore, the most active Internet users in Mexico correspond to the age range of 25 to 34 years (INEGI, Secretaría de Comunicaciones y Transportes, Instituto Federal de Telecomunicaciones, 2019). According to Forbes México (2019) almost 50 % of Mexico´s population corresponds to the Millennials generation.

According to the Pew Research Center (2014), the Millennials were born between 1981 and 1996. This means that in 2020, this generation are between 24 and 39 years old. Furthermore, Michael Dimock (2019), who is the president of the Pew Research Centre, points out that in 2018, the organisation has determined that the people born between 1981 and 1996 correspond to the Millennials generation, in order to clarify the generation period for further analytical work. Moreover, the Pew Research Centre, points out that the people who were born between 1997 and 2012 corresponds to the Generation Z. See Figure 60.

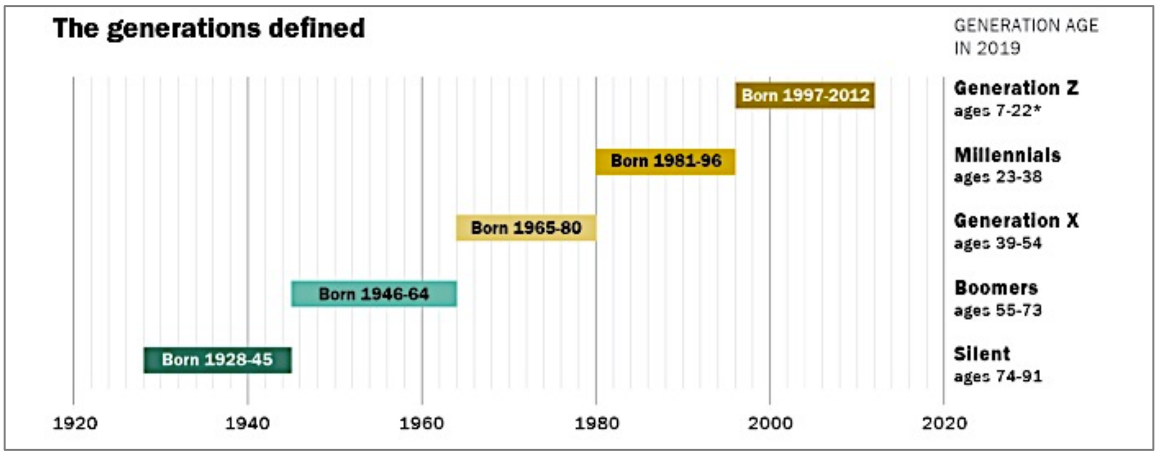



*Figure 60. The Generations Defined (Pew Research Center, 2019)*

Interestingly, this study is directed to two-generation groups, the Millennials and the Generation Z. Since from 18 to 23 is considered Generation Z, and from 24 to 33 is considered millennial.

- Residence

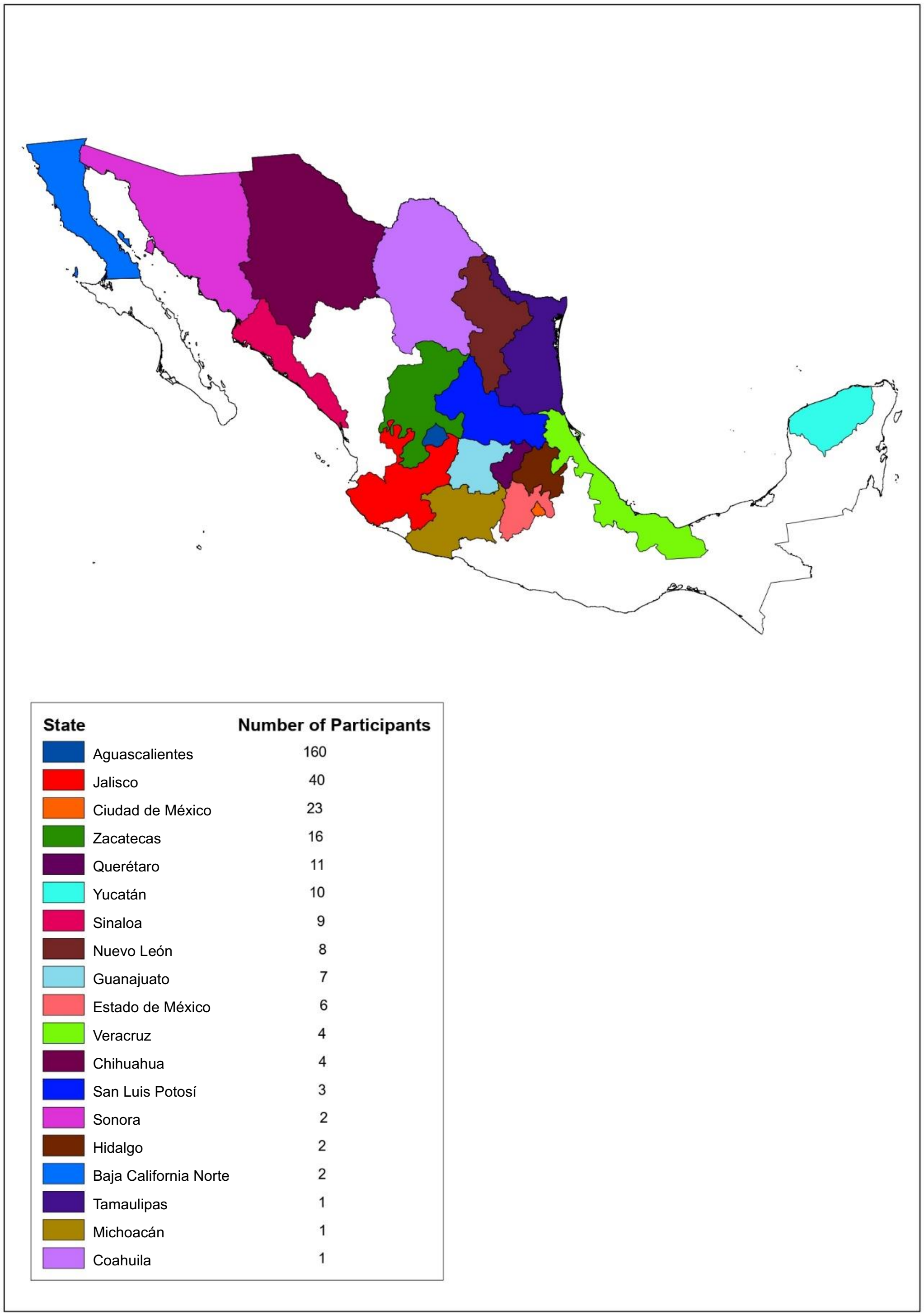



*Figure 61. Respondents by state*

In this study, participants from 19 states out of 32 were reached. Aguascalientes, Jalisco and Distrito Federal were the states with the most participants. See Figure 61. According to the *Encuesta Nacional De Ingresos Y Gastos De Los Hogares* (ENIGH) that means National Household Income and Expenditure Survey conducted by INEGI (2018a) the top 10 of the states of Mexico with major income per capita are:

1. Ciudad de México
2. Nuevo León
3. Baja California Sur
4. Querétaro
5. Jalisco
6. Sonora
7. Aguascalientes
8. Baja California Norte
9. Quintana Roo
10. Coahuila

According to INEGI (2018b) Ciudad de México is the federal entity with an income per capita of 26,361 Mexican pesos per month, which places it in the 1st position, Jalisco occupies the 5th position with an income per capita of 20,180 Mexican pesos per month, and Aguascalientes has an income per capita of 19,782 Mexican pesos per month, which places this federal entity in the 7th position. From these 10 top states, 51.6% of the participants were from Aguascalientes, followed by 12.90% from Jalisco and 7.41% from Ciudad de México.

On the expenditure side, according to the three reports of Household Income and Expenditure of Aguascalientes, Jalisco and Ciudad de México conducted by INEGI (2018bcd), Aguascalientes, is the federal entity from these three states that designates the highest percentage (4.9%) of its expenditure to clothing and footwear, followed by Jalisco, which designates 4.6% and Ciudad de México, which designates 4.3%. This means that although Aguascalientes occupies the 7th position with respect to income per capita of Mexico, it is the state that designates the highest percentage of its expenditure to clothing and footwear compared to the other federal areas within Mexico.

- Relationship status

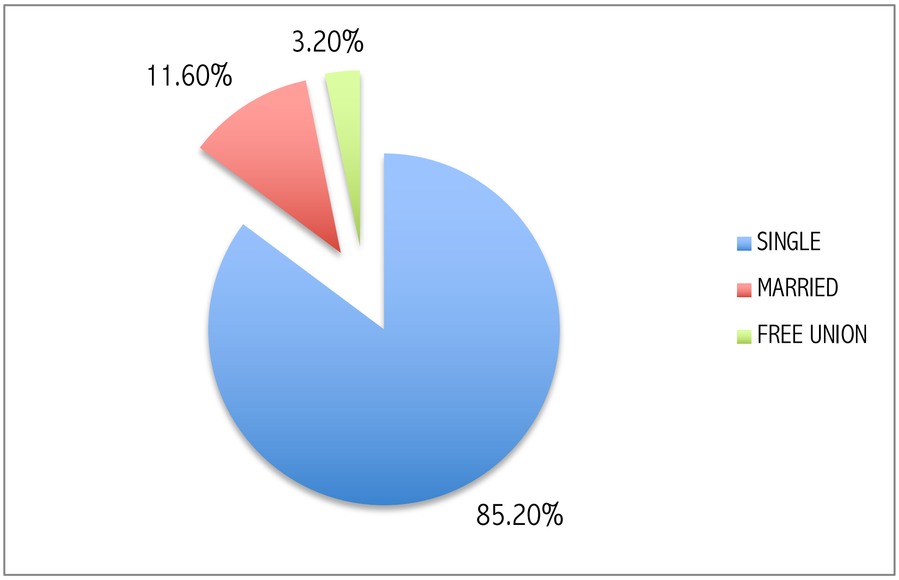



*Figure 62. Respondents by relationship status*

| Relationship status | Number of Participants |
|---|---|
| Single | 264 |
| Married | 36 |
| Free union | 10 |

*Table 15 Respondents by relationship status*

Turning now to the marital status, the percentages are lower compared with the statistics of the *Instituto Nacional de Estadística, Geografía e Informática* (INEGI), since in the study 85.20% of the participants are single, while 11.60 % married and 3.20 % is in free union. Figure 62 and Table 15. Whereas, according to inegi.org.mx (2019a) 54% of the Mexicans from 12 years and more are married or in free union, whilst 34% are single. The average age for Mexican females to get married is 29.4 years (INEGI, 2019). However, the data of this study is focused only in Mexican females in the age range of 18 to 33 years. Furthermore 52 % of the participants were from Aguascalientes. The marital status in this city, according to INEGI (2016), indicates that 37.4% of the population is single, 42.8% married and 9.9 % in free union. Moreover, according to inegi.org.mx (2019a), the marriage rate in Mexico has decreased by 29.13% from 2000 to 2018. Therefore, this data supports the fact that in recent times the marital status has decreased within the age range studied (18 to 33 years).

- Children- Dependents

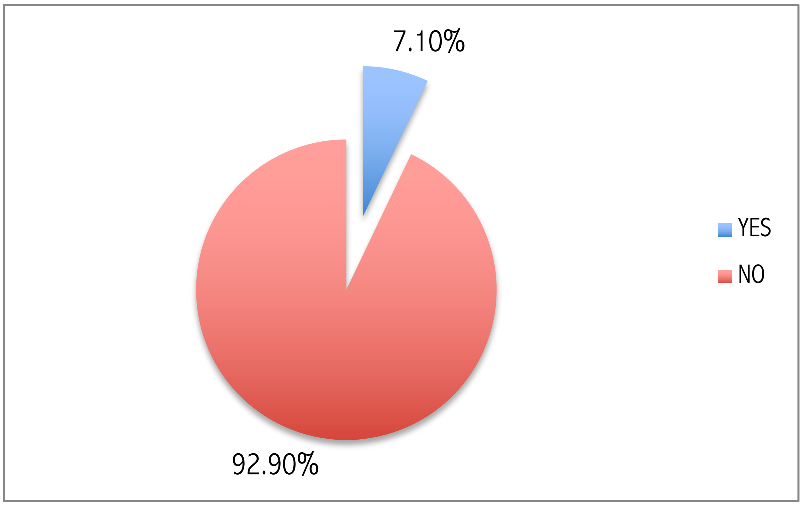



*Figure 63. Respondents by dependant status*

| Children | Number of Participants |
|---|---|
| Yes | 22 |
| No | 288 |

*Table 16. Respondents by dependant status*

- Living Arrangements

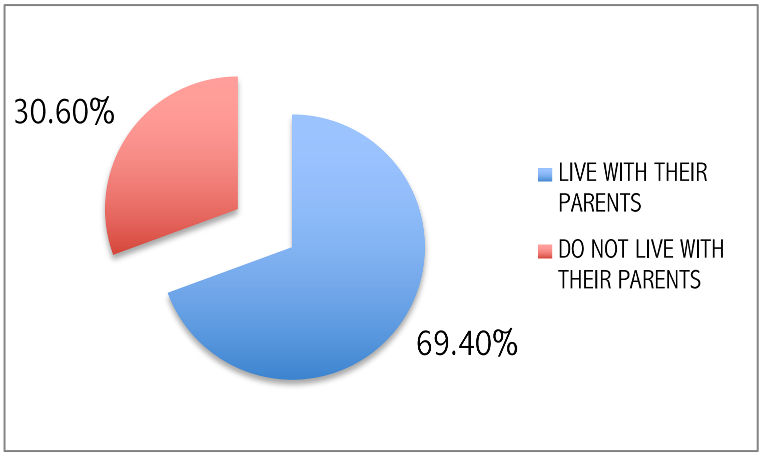



*Figure 64. Respondents by living arrangements status*

| Living arrangements | Number of Participants |
|---|---|
| Live with their parents | 215 |
| Do not live with their parents | 95 |

*Table 17. Respondents by living arrangement status*

In this study, 92.90% of the respondents do not have children and 69.40% of the participants live with their parents, (See Figure 63 - Table 16 and Figure 64 - Table 17). Moreover, 65.80% of the total sample corresponds to the age range of 18 to 25 years. The results of this study, have a strong correlation with the publication of Forbes México (2019) which mentions that almost 50% of the Mexican Millennials are students, 63% live with their parents and 52% are not only single but also do not have children. In this study, the living arrangements, culture and age range of the participants tends to have a relation with the occupation.

- Occupation

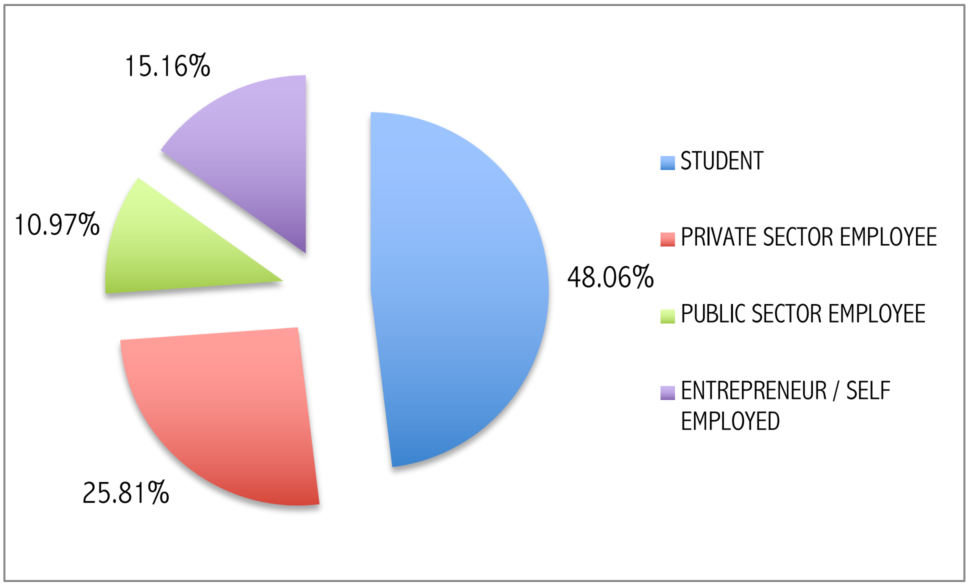



*Figure 65. Respondents by occupation status*

| Occupation | Number of Participants |
|---|---|
| Student | 149 |
| Private sector employee | 80 |
| Public sector employee | 34 |
| Entrepreneur/ self employed | 47 |

*Table 18. Respondents by occupation status*

The majority of the participants 48.06 % are students, followed by a 25.81 %, which corresponds to private sector employees. See Figure 65 and Table 18. The results of this study have a strong correlation with the publication of Forbes México (2019), which mentions that almost 50% of the Mexican Millennials are students. Moreover 36% of the respondents (112 participants) correspond to the age range of 18-25 years, do not have children, live with their parents and are students.

- Socioeconomic Level

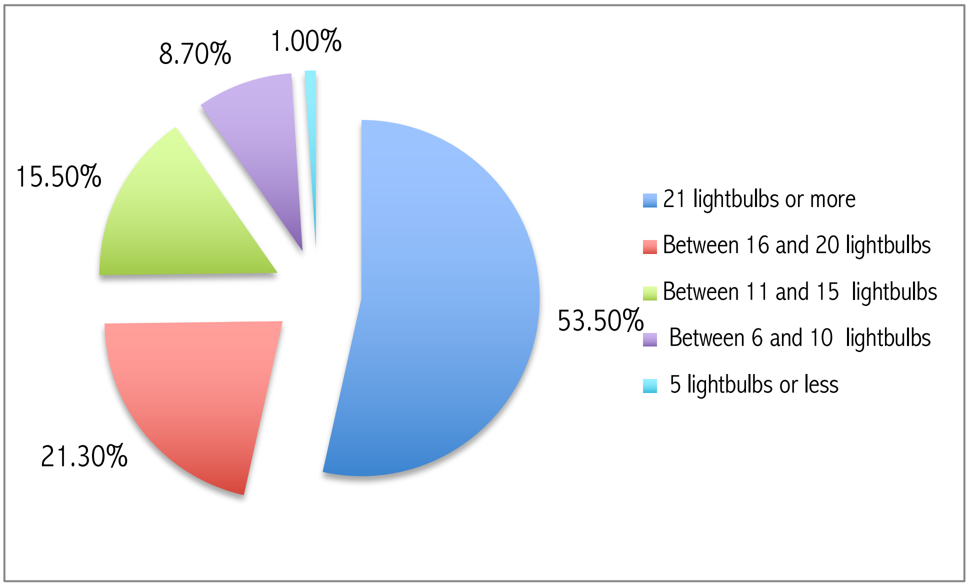



*Figure 66. Respondents by social class status*

| SOCIOECONOMIC LEVEL | Number of Participants |
|---|---|
| 21 lightbulbs or more | 166 |
| Between 16 and 20 lightbulbs | 66 |
| Between 11 and 15 lightbulbs | 48 |
| Between 6 and 10 lightbulbs | 27 |
| 5 lightbulbs or less | 3 |

*Table 19. Respondents by social class status*

Moving to the socio-economic status section. The socioeconomic level of a person is associated with the quantity of lightbulbs they have at their house (AMAI, 2005, cited by Deschamps, Carnie and Mao 2016). The authors point out, that 16 lightbulbs or more means that they correspond to the A/B socioeconomic level, between 11 and 15 lightbulbs means that they correspond to the C+ socioeconomic level, between 6 and 10 lightbulbs means that they correspond to the D+ and C socioeconomic level, whereas 5 lightbulbs or less corresponds to the D and E socioeconomic level.

According to the Nse.amai.org (2018) the A/B socioeconomic level has the following predominant characteristics: The head of the family has an academic degree, the house has internet, and it is the level that designates more money to the education of their children.

The C+ socioeconomic level has the following predominant characteristics: They designate most of their income 60% to fulfil their basic needs, such as food, transport and communication. The house has internet, and they have at least one car (Nse.amai.org, 2018).

The D+ and C socioeconomic level has the following predominant characteristics: 49.5 % has Internet at their house; they designate most of their income to food 38.5 % and only a small percentage (7%) is designated to the education of their children (Nse.amai.org, 2018).

The D and E socioeconomic level has the following predominant characteristics: They do not have Internet at their house; they designate most of their income 49% to food (Nse.amai.org, 2018).

According to the study by Deschamps, Carnie and Mao (2016), the higher the socioeconomic level the higher the interest towards positive behaviour patterns with regards to most sustainable textile products consumption.

The results of the survey indicate that the majority of the participants, 74.80% corresponds to the A/B socioeconomic level, 15.50% corresponds to the C+ socioeconomic level, 8.70% corresponds to the D+ and C socioeconomic level, and 1.00% corresponds to the D and E socioeconomic level. See Figure 66 and Table 19. The socioeconomic level A/B is the highest one, meaning that it is the one that has more economic solvency amongst all the socioeconomic levels.

- Demographic profile of the respondent

According to the results obtained from the survey the demographic profile of the respondent is the following: 54.19 % of the total sample is a Mexican female between 18- 25 years old, do not have children and lives with their parents. It should be noted that the total sample is 310 respondents. See Figure 67.

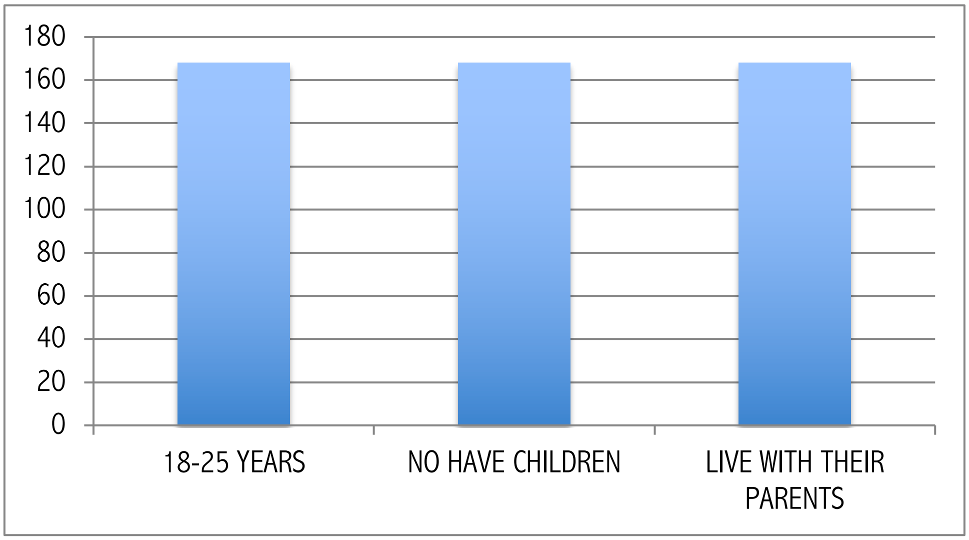



*Figure 67. Typical profile of the respondent*

The next section of the survey is concerned with the environment interest and the purchase behaviour of the respondents.

### 6.2. Environment care interest- Clothing purchase – Sale channel

The purpose of this section is to investigate if the target demographic group audience is interested in the caring for the environment, and see if their answers are coherent with their purchase decisions.

- "Do you consider what influencers wear, in order to buy similar clothing?"

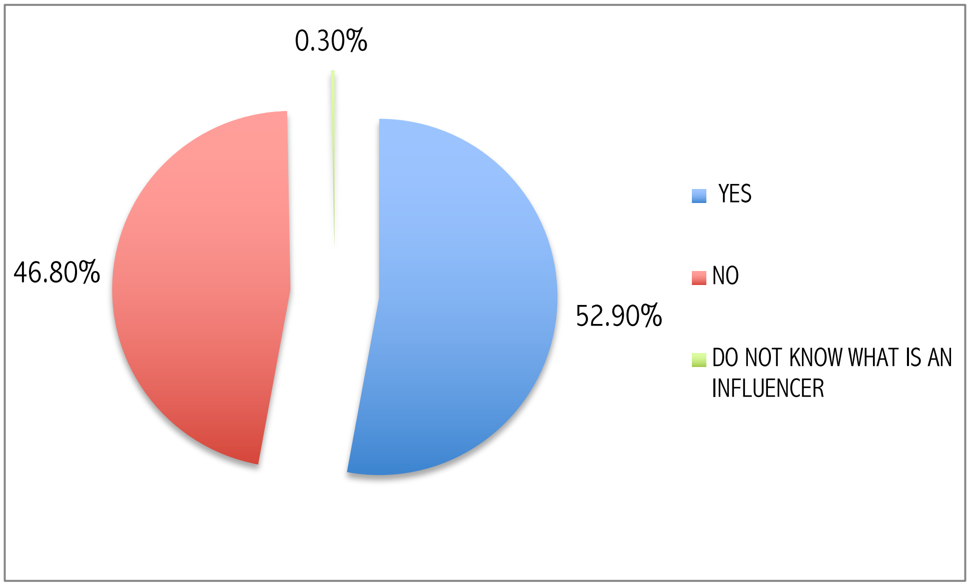



*Figure 68. Influencers*

| Consider influencers to buy similar clothing | Number of Participants |
|---|---|
| Yes | 164 |
| No | 145 |
| Do not know what is an influencer | 1 |

*Table 20. Influencers*

It can be seen from (Figure 68 and Table 20) that 99.7% of the respondents are familiar with the term influencer. “Instagram influencer marketing is the process of marketing products, brands, or services through popular individuals on Instagram who can influence their follower’s purchase decisions” (Barker, 2016, §2).

According to the report of Borden (2019), about the power of influencers, he points out that social media has given power to a new marketing industry "the social media influencer". The author defines the social media influencer as a marketing technique in which brands collaborate with people who have a significant number of followers on their social media platforms, in order to influence the purchase decisions of consumers, through social media content.

Nowadays social media influencers have great power on the purchase decisions of consumers, since social media is a channel that 74% of people use before making a purchase (Borden, 2019). This is the reason why companies are approaching influencers in order to work together (Borden, 2019). The author also mentions that the content creation of social media influencers is a powerful way to attract and recommend a specific brand product to possible consumers, since social media influencers guide the purchase decision of almost 50% of the consumers. Moreover, according to Borden (2019) the marketing technique of social media influencer is expected to gain $10 billion during this year.

- Channel for buying clothing

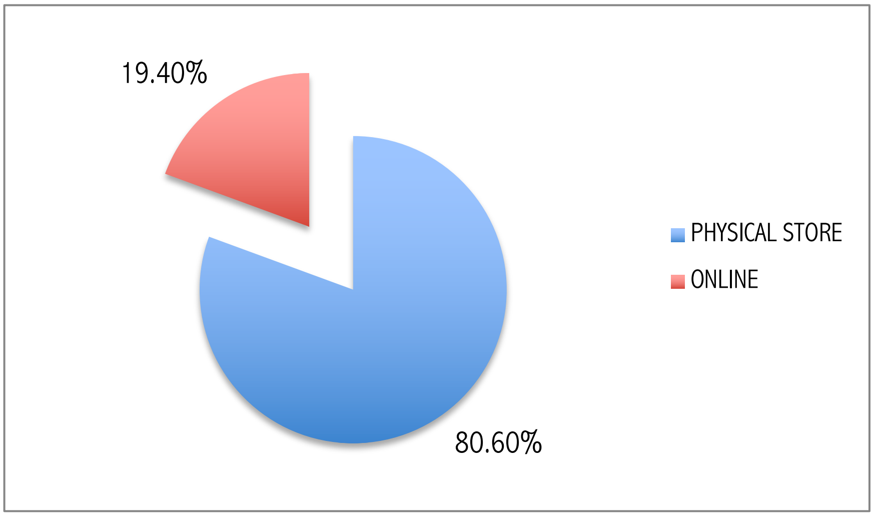



*Figure 69. Buying channel for clothing*

| Prefer to buy clothing | Number of Participants |
|---|---|
| Physical store | 250 |
| Online | 60 |

*Table 21. Buying channel for clothing*

According to the survey, influencers guide the purchase decisions of 52.90% of the respondents. However, 80.60% of the respondents prefer to buy their clothes in a physical store, while only 19.40% prefer to do their clothing shopping via online. (Figure 69 and Table 21). This result suggest that the participants would prefer to visit a physical store because they could try the clothing on and confirm if it fits them as they would like. This suggests a direct connection to the importance that participants give to good fit, since 40.97% of the participants has selected it as the most important factor when buying clothes. In contrast to online shopping, a physical store experience brings this option to the buyer. However, this preference towards physical store may change in the near future since according to El Economista (2019), e-commerce is a growing buying channel for Mexican females, especially for the age bracket of 18-24 years which have a purchase rate of 10.8%, the highest one compared with women from Argentina and Brazil. According to Enrico (2020) COVID-19 pandemic has disrupted the consumption patterns of the population worldwide, increasing the preference towards online shopping. According to the analysis carried out by the International Data Corporation (IDC, 2020) e-commerce is expected to increase up to 60% by the end of 2020 in Mexico, due to COVID-19.

- Average expenditure per garment

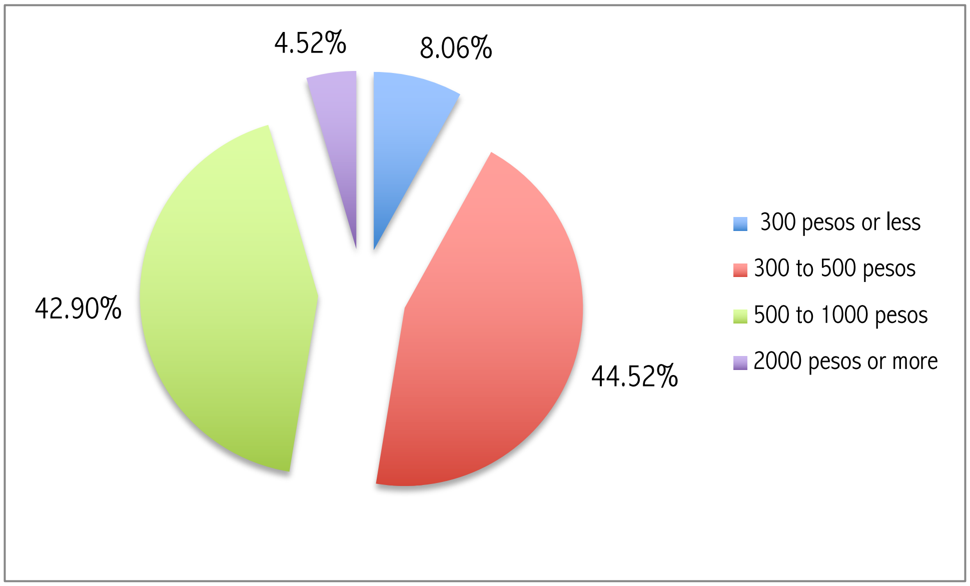



*Figure 70. Average expenditure per garment*

| Average expenditure per garment | Number of Participants |
|---|---|
| 300 pesos or less | 25 |
| 300 to 500 pesos | 138 |
| 500 to 1000 pesos | 133 |
| 2000 pesos or more | 14 |

*Table 22. Average expenditure per garment*

Moving to the expenditure on clothing of the respondents, 44.52 % of the respondents spend an average of 300 to 500 pesos on a garment followed by the 42.90% of the respondents who spends an average of 500 to 1000 pesos on a garment. (Figure 70 – Table 22) One Mexican peso is equal to approximately £0.04 (currency exchange rate corresponds to the 5th of April of 2019), meaning that the majority of the respondents 87.4% spend around £12 to £40 per garment.

- Natural fibres preference when buying clothes

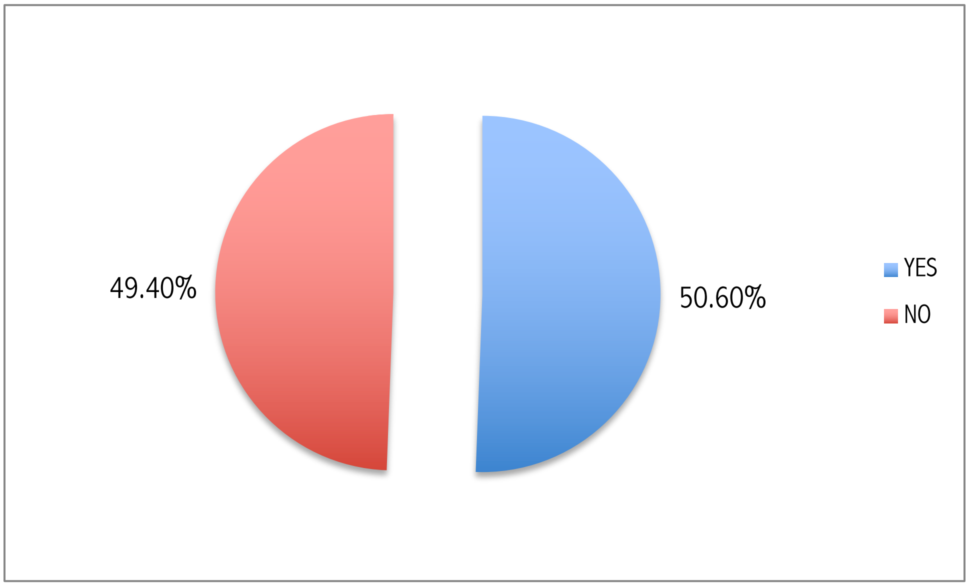



*Figure 71. Natural fibres preference*

| Natural fibres preference when buying clothes | Number of Participants |
|---|---|
| Yes | 157 |
| No | 153 |

*Table 23. Natural fibres preference*

With regards to the natural fibres preference of the respondents while buying clothing, 50.60% look for natural fibres such as cotton, linen, wool and silk, while 49.40% do not have a preference on natural fibres when buying clothing. Figure 71 and table 23.

- Most important factor when buying new clothes

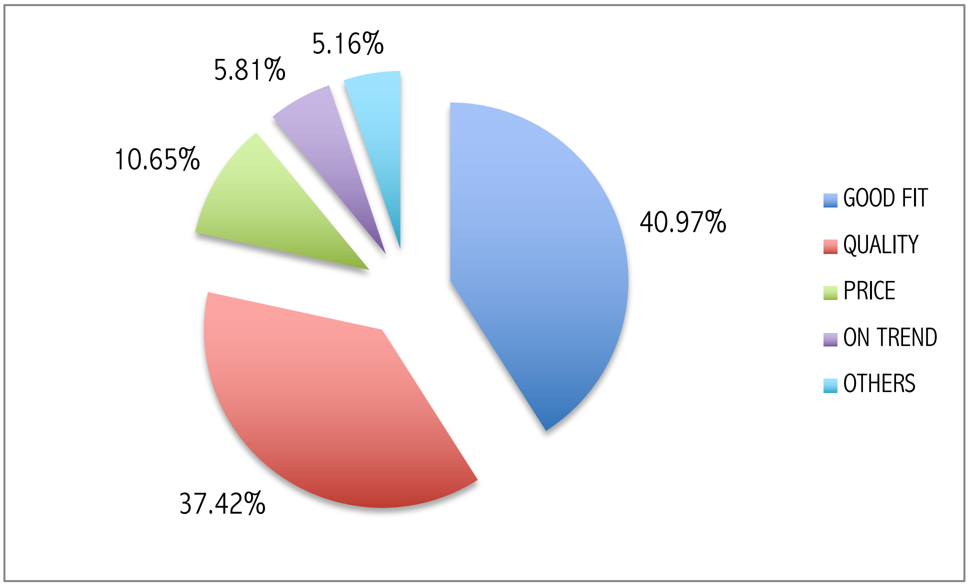



*Figure 72. Most important factor considered when buying new clothes*

| Most important factor when buying new clothes | Number of Participants |
|---|---|
| Good fit | 127 |
| Quality | 116 |
| Price | 33 |
| On trend | 18 |
| Others | 16 |

*Table 24. Most important factor considered when buying new clothes*

The three main factors considered by the respondents when buying new clothes were good fit, quality and price. Figure 72 - Table 24. 40.97% of the respondents chose good fit, followed by quality with a 37.42 % and price with a 10.65%. Therefore, this suggests that good fit and quality have a strong power in the purchase decision making of the demographic of this study.

▪ Clothing purchase frequency

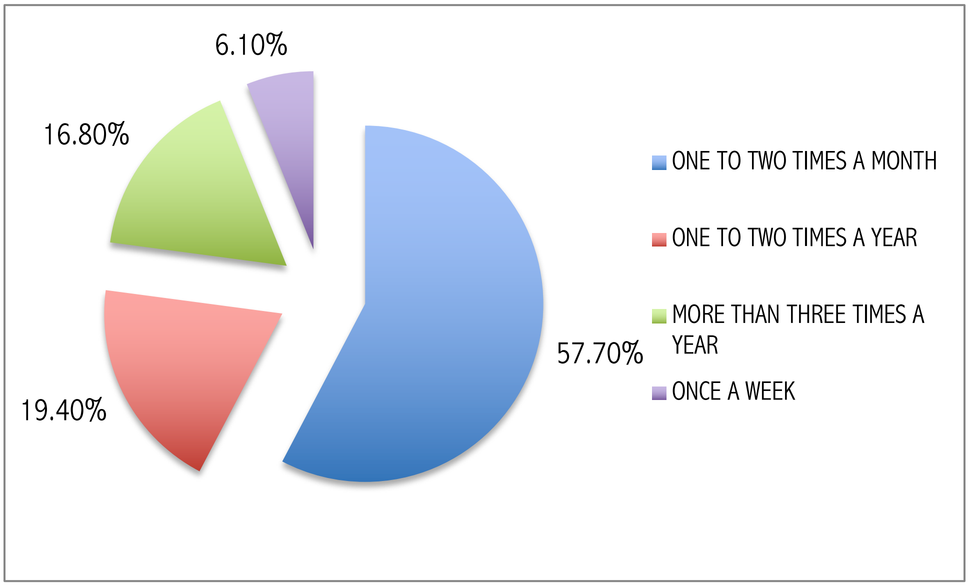



*Figure 73. Clothing purchase frequency*

| Clothing purchase frequency | Number of Participants |
|---|---|
| One to two times a month | 179 |
| One to two times a year | 60 |
| More than three times a year | 52 |
| Once a week | 19 |

*Table 25. Clothing purchase frequency*

Talking about the clothing purchase frequency of the respondents, the majority 57.70 % buy clothing one to two times per month followed by one to two times a year with 19.40%. Figure 73 - Table 25. This indicates that most of the participants (179) have a high clothing consumption rate. This high frequency could be related to fast fashion consumption. This aspect will also be considered when developing a suitable social marketing strategy, which will be discussed in Chapter 7. Since this data highlights the need to create awareness amongst the demographic of this study with regards to the effects that a high clothing consumption rate has on the environment.

- Consider the environmental consequences when purchasing clothing

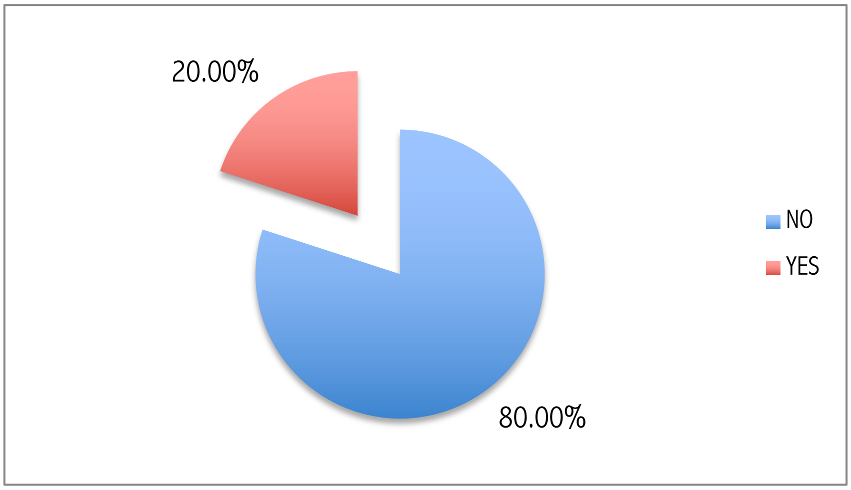



*Figure 74. Consciousness of environmental impact*

| Consider the environmental consequences when purchasing clothing | Number of Participants |
|---|---|
| No | 248 |
| Yes | 62 |

*Table 26. Consciousness of environmental impact*

- How much influence have the companies that are pro-environmental in the consumers purchase decision

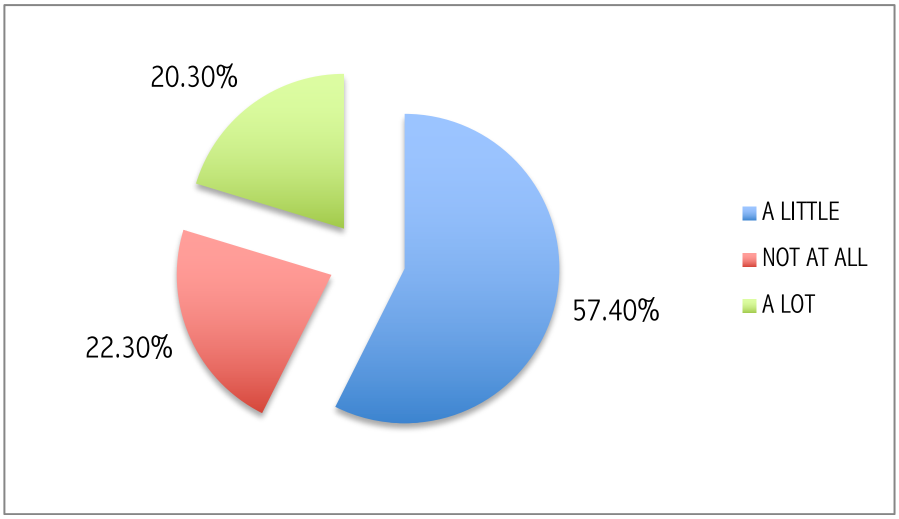



*Figure 75. Influence of environmental impact in consumers purchase decision*

| Influence in consumers purchase decision | Number of Participants |
|---|---|
| A little | 178 |
| Not at all | 69 |
| A lot | 63 |

*Table 27. Influence of environmental impact in the consumers purchase decision*

If we now turn to the environmental impact part of the survey, 80.00% of the respondents do not consider the environmental consequences when purchasing clothing and the companies who are pro-environment do not have a great impact on their purchase decisions, since for 57.4% of the respondents this factor influences their decisions only a little and to 22.30% of the respondents this factor does not influence them at all. (Figure 74 - Table 26 and Figure 75 - Table 27). Therefore, it could be extrapolated from the data gathered that environment is not important for the respondents. This aspect will also be considered when developing a suitable social marketing strategy, which will be discussed in Chapter 7. This data highlights the need to educate the demographic of this study with regards to the negative effects that metallic chemical additives have on the environment. Therefore, education would become a central aspect in order to develop a social marketing strategy that could raise environmental awareness and consequently achieve a successful social marketing intervention model for the demographic of this study.

- Consciousness of the environmental damage that the dyeing activities of clothing companies create, especially water pollution

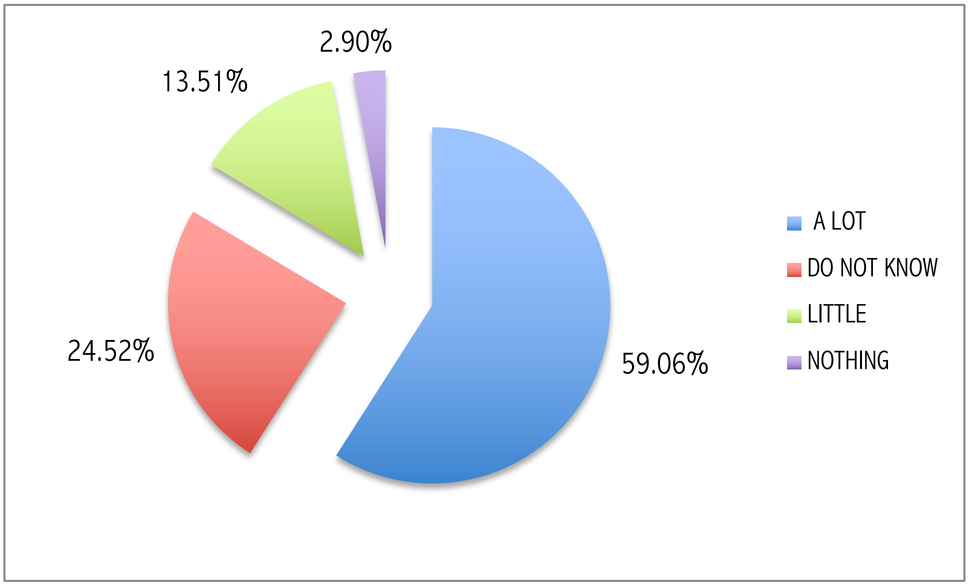


*Figure 76. Consciousness of the environmental damage that the dyeing activities of clothing companies create, especially water pollution*

| Conscious | Number of Participants |
|---|---|
| A lot | 183 |
| Do not know | 76 |
| Little | 42 |
| Nothing | 9 |

*Table 28. Consciousness of the environmental damage that the dyeing activities of clothing companies create, especially water pollution*

One unanticipated finding was that 59.06% of the respondents are conscious of the environmental damage that the dyeing activities of clothing companies create, especially on water pollution (Figure 76 - Table 28). This finding was unexpected, and suggests that more specific questions related to the environment have a direct impact on the answers from the respondents. Moreover, at the same time this could suggest that the information that was presented to the participants before answering the questionnaire may have influenced their response in this specific question. Since, it was highlighted that the research aimed to provide a sustainable colouring alternative. Therefore, this could create an anticipated negative expectation with regards to the impact that clothing companies have on water pollution due to their dyeing activities.

- Environment care interest

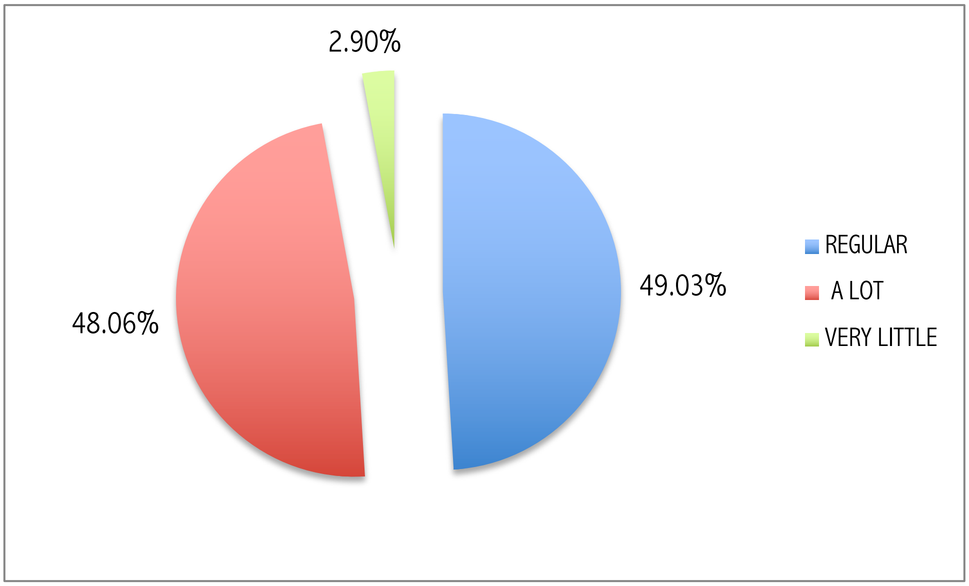



*Figure 77. Environment care interest*

| Environment care interest | Number of Participants |
|---|---|
| Regular | 152 |
| A lot | 149 |
| Very little | 9 |

*Table 29. Environment care interest*

However, when they were asked about their environment care interest, the majority (49.03%) are aware and 48.06% have a regular interest, whilst only 2.90 % reported they have very little interest. Figure 77 - Table 29.

The responses have changed dramatically from the 1st question (When buying clothes, do you think of the consequences that your purchase will have on the environment?) in which 80.00% of the respondents indicated that they do not consider the environmental consequences when purchasing clothing, and 2nd question (When making a purchase, how much influence on your decision on whether or not the company cares for the environment?) in which 57.4% of the respondents indicated that pro-environmental companies only influence their purchase decisions a little. In contrast to the following two specific questions:

- How much do you consider the dyeing activities of clothing companies contribute to environmental damage, water pollution in particular?

- How much interest do you have in the care of the environment?

In which 59.06% of the respondents indicated that they are conscious of the environmental damage that the dyeing activities of clothing companies create, especially on water pollution and 48.06% of the participants indicated that they do have a high interest towards environment care. Therefore, it could be extrapolated from this finding that the demographic do care about the environment, however educating the demographic about specific themes related to dyeing would become a central aspect of the social marketing development.

Before proceeding to examine the next section of the questionnaire, it is important to highlight the important insights of the participant's consumption behaviour that this section provided. According to a study in which 8,500 Mexican households were questioned about their consumption behaviour of clothing and footwear, Kantarworldpanel.com (2018) reported that 72% of families had bought clothing during 2017. In addition, the report's findings determined that a higher percentage of their budget was spent on clothing than on footwear. Moreover, on average a Mexican family shops for clothing 7 times per year. However, the families with a higher socioeconomic level, shop 11 times per year, and prefer to do it in physical stores spending 3 times more on clothing than an average family. The Mexican families with a socioeconomic level A/B designate a higher percentage of their expenditure (41%) on shirts, t-shirts and jackets, followed by 37% on jeans and trousers (Kantarworldpanel.com, 2018).

Although the Mexican families with a higher socioeconomic level prefer to buy their clothing in physical stores as mentioned before, according to El Economista (2019), e-commerce is a growing buying channel for Mexican females, especially to the ones between the age range of 18 to 24 years. This age group is the one that is more active online amongst all (El Economista, 2019).

Mexican females are more active in e-commerce when compared with females from Argentina and Brazil (El Economista, 2019). Clothing, footwear and accessories represent almost 80% of the online purchased items by Mexican females (El Economista, 2019). Furthermore, El Economista (2019), points out that females have not only changed their buying behaviour switching to other ways of shopping such as e-commerce; moreover, they have found added value beyond the product, which offers greater convenience to the Mexican females such as an immediate delivery. It can be extrapolated that the whole user experience in which added value is offered nowadays is an important factor that clothing companies could consider to attract Mexican females from the age range of 18 to 24 years.

## 6.3. Colour- Dyes- Food waste – Data collection

This part of the survey is concerned about the importance of colour for the participants, primarily if they are familiar with natural dyes and to validate not only if the target demographic group will be willing to accept the idea of having a piece of clothing dyed with food waste, but also if they are interested in being part of the garment colour design process. Secondly, if this creation experience is related with an emotional attachment this can lead the user towards more sustainable consumption attitudes and actions.

Colour

- Importance of colour when buying clothing

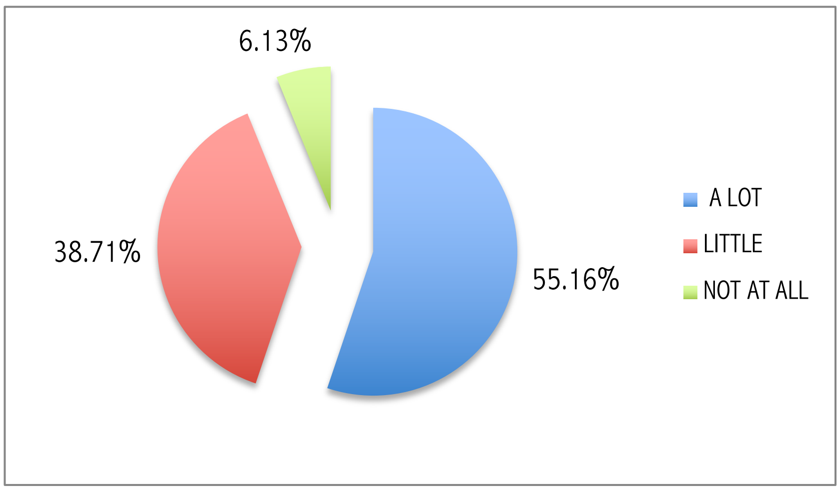



*Figure 78. Importance of colour when buying new clothes*

| Importance of colour when buying clothing | Number of Participants |
|---|---|
| A lot | 171 |
| Little | 120 |
| Not at all | 19 |

*Table 30. Importance of colour when buying new clothes*

As shown in Figure 78 and Table 30, the majority of the respondents, 55.16% have said that colour is very important when buying clothing, followed by 38.71% of the respondents who have reported that colour has only little importance when buying clothing, a minority of the respondents 6.13% indicated that, colour does not have importance at all when buying clothing. This suggests that for the participants colour plays a crucial role in clothing purchases. Therefore, if colour can be customised, this could consequently lead to a higher engagement between this demographic group and their clothing.

- Knowledge between natural and synthetic dyes

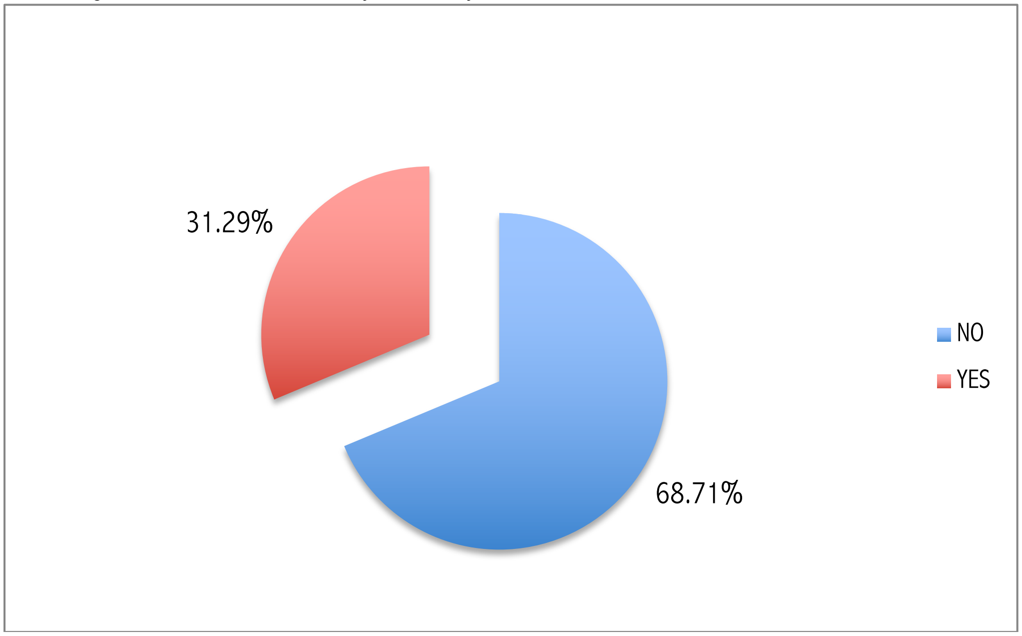



*Figure 79. Knowledge between natural and synthetic dyes*

| Knows the difference between natural and synthetic dyes | Number of Participants |
| --- | --- |
| No | 213 |
| Yes | 97 |

*Table 31. Knowledge between natural and synthetic dyes*

Turning now to the knowledge of the participants with regards to the difference between natural and synthetic dyes, the majority of the respondents, 68.71% have indicated that they do not know the difference between both, while 31.29% have reported that they do know the difference between natural and synthetic dyes. Figure 79 - Table 31. Therefore, this suggests that providing information about the differences between natural and synthetic dyes is crucial when aiming to make a shift in purchasing decision making processes of this specific demographic. The idea of educating these consumers about the negative environmental impact of metallic chemical additives in the textile dyeing activity will be discussed later in the social marketing section (See Chapter 7).

- Purchase of naturally dyed clothing

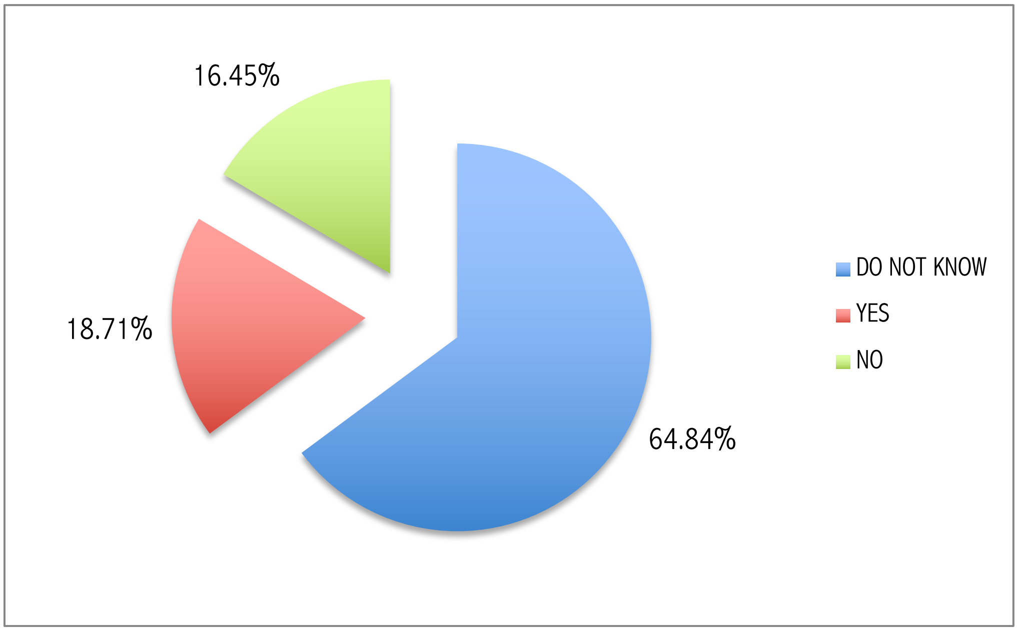



*Figure 80. Purchase of naturally dyed clothing*

| Has purchase naturally dyed clothing | Number of Participants |
|---|---|
| Do not know | 201 |
| Yes | 58 |
| No | 51 |

*Table 32. Purchase of naturally dyed clothing*

When the participants were asked if they have bought natural dyed clothing, the majority of the respondents, 64.84% have said that they do not know. See Figure 80 and Table 32. This is consistent with the earlier graphic that indicated that 68.71% of the participants does not know the difference between natural and synthetic dyes. 18.71% have indicated that they have bought natural dyed clothing and 16.45% have said that they have not bought natural dyed clothing. Figure 80 - Table 32. Therefore, this suggests coupled with the responses obtained previously that it is crucial to educate the demographic of this study with regards to the difference between natural and synthetic dyes in order to make a shift in their purchasing decision making process. This will be discussed later in the social marketing section (See Chapter 7).

- Why the 51 participants have not bought naturally dyed clothing?

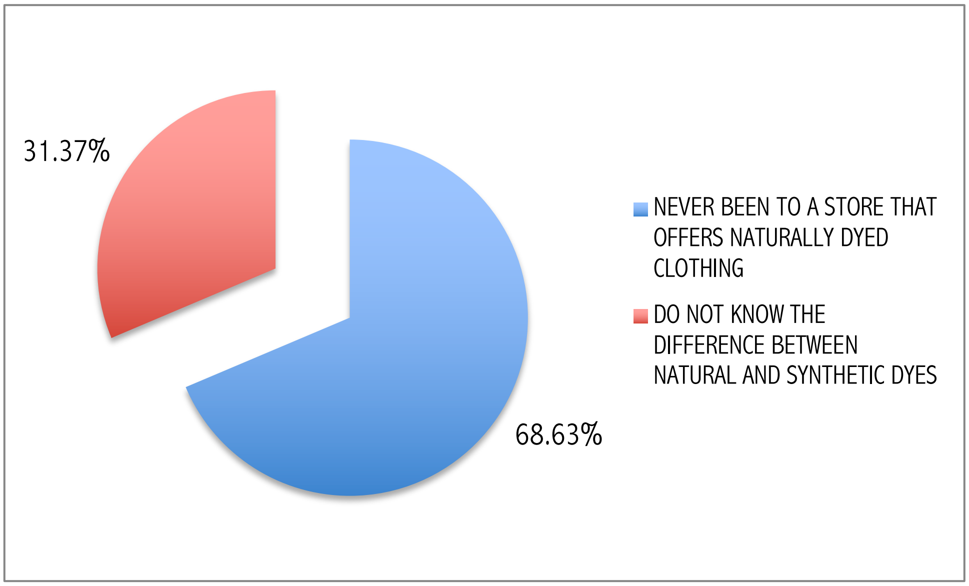



*Figure 81. Why they have not bought naturally dyed clothing ?*

| Why the 51 participants have not bought naturally dyed clothing? | Number of Participants |
|---|---|
| Never been to a store that offers naturally dyed clothing | 35 |
| Do not know the difference between natural and synthetic dyes | 16 |

*Table 33. Why they have not bought naturally dyed clothing?*

For the 16.5% that have said they have not bought natural dyed clothing, which corresponds to 51 participants, an additional question was addressed to them in order to understand the reasons why they have not purchased naturally dyed clothing. The majority of the respondents 68.63% indicated that they have never been to a store that offers naturally dyed clothing, while 31.37% have reported that the main reason why they have not bought naturally dyed clothing was mainly attributed to the lack of knowledge between natural and synthetic dyes. Figure 81 - Table 33.

- Colour palette preference between natural and synthetic *allium cepa* dyes

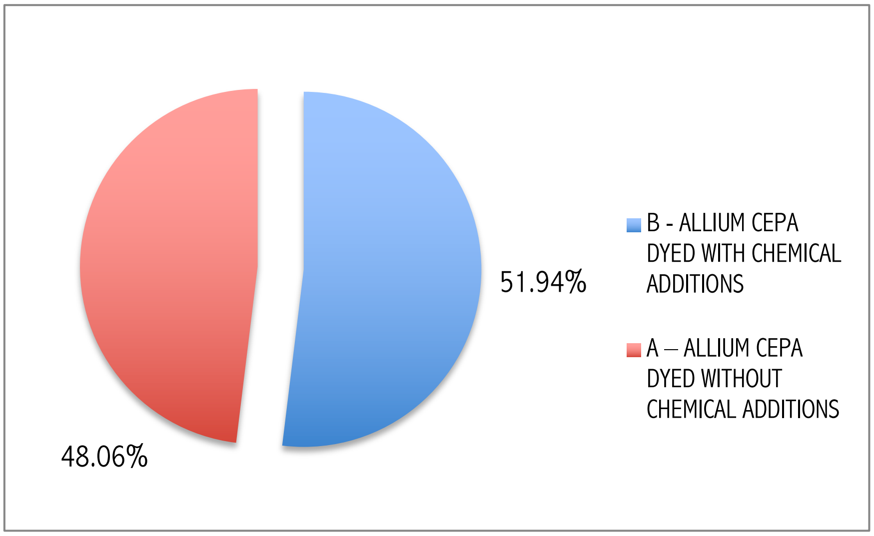



*Figure 82. Colour palette preference*

| Colour palette preference | Number of Participants |
| --- | --- |
| B - *Allium cepa* dyed with chemical additions | 161 |
| A – *Allium cepa* dyed without chemical additions | 149 |

*Table 34. Colour palette preference*

Turning now to the experimental evidence with regards to the colour palette preference between the colour palette A obtained from the experimental section from *Allium cepa* was used as a natural dyestuff along with salt in order to improve the colour strength and the colour palette B was obtained from experimental work following method of Vankar, Shanker and Wijayapala (2009) in which *Allium cepa* was used as a natural dyestuff along with chemical additives (stannous chloride, stannic chloride, copper sulphate and ferrous sulphate) in order to improve the colour strength.

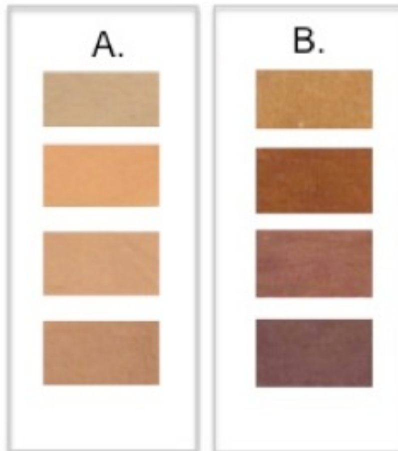



*Figure 83. Colour palettes A & B*

The same format (digital picture) as shown in Figure 83 was used to show participants the colour palette, however the light conditions were not standardised throughout the time the participants answered the survey.

51.94% of the participants indicated their preference towards colour palette B, while 48.06% indicated their preference towards the colour palette A. Comparing these two results, it can be seen that there was no significant difference between the two responses. Figure 82 and Table 34.

However, the respondents who indicated their preference towards palette B were asked, if they will still prefer to buy brighter colours, knowing that in order to increase their colour metallic chemicals are added, having consequently a negative effect on the environment and water pollution in particular.

- Colour B palette preference - *Allium cepa* dyed with chemical additions

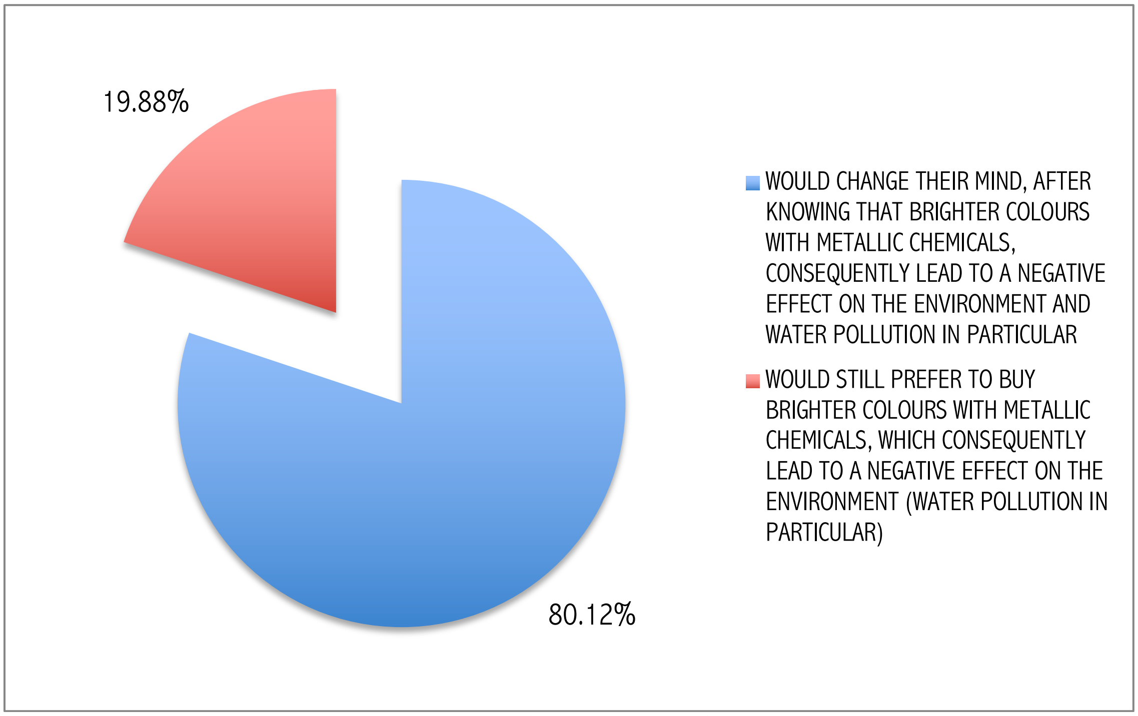



*Figure 84. Colour B palette preference*

| From the 161 participants who preferred palette b | Number of Participants |
|---|---|
| Would change their mind, after knowing that brighter colours with metallic chemicals, consequently lead to a negative effect on the environment and water pollution in particular | 129 |
| Would still prefer to buy brighter colours with metallic chemicals, which consequently lead to a negative effect on the environment (water pollution in particular) | 32 |

*Table 35. Colour B palette preference*

It can be seen in Figure 84 and Table 35, that the majority, 80.12% changed their mind after being made aware of the negative environmental impacts, while only 19.88% have indicated that they will still prefer to buy brighter colours being aware of the negative impacts of their decision. It can be extrapolated from these data results that there is a shift in thinking amongst the participants when informed of the negative impact factor on the environment when chemical dyes are used. Therefore, this suggests that providing information about environmental impact is important when aiming to make a shift to a more informed purchasing decision making process of this specific demographic. This idea of educating these consumers about the environmental impact will be discussed later in the social marketing section (See Chapter 7).

- Acceptance of natural dyes performance without chemical additives

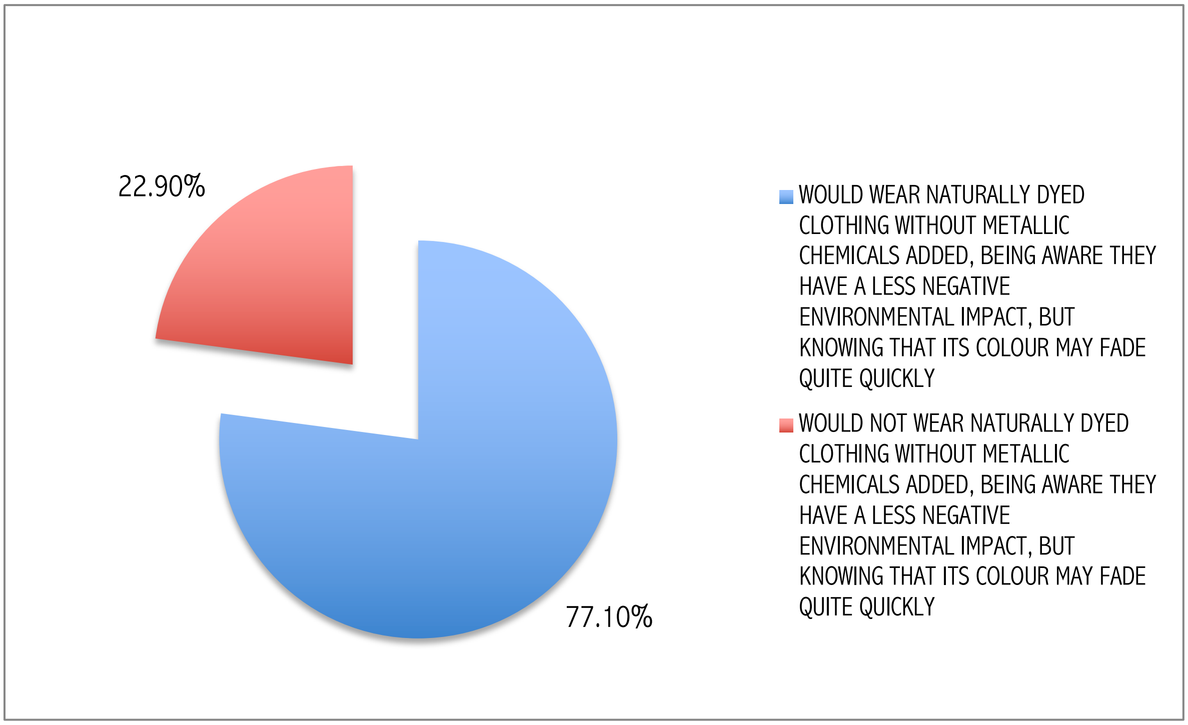



*Figure 85. Acceptance of natural dyes performance without chemical additives*

| Acceptance of natural dyes performance without chemical additives | Number of Participants |
|---|---|
| Would wear naturally dyed clothing without metallic chemicals added, being aware they have a less negative environmental impact, but knowing that its colour may fade quite quickly | 239 |
| Would not wear naturally dyed clothing without metallic chemicals added, being aware they have a less negative environmental impact, but knowing that its colour may fade quite quickly | 71 |

*Table 36. Acceptance of natural dyes performance without chemical additives*

When the survey participants were asked about the acceptance of natural dyes performance without chemical additives, 77.10% indicated that they would wear naturally dyed clothing without metallic chemical additives added, being aware they have a less negative environmental impact, but knowing that its colour may fade quickly, while only 22.90% have reported that they would not wear naturally dyed clothing without metallic chemicals added, being aware they have a less negative environmental impact, but knowing that its colour may fade quickly. See Figure 85 and Table 36. Therefore, this validates the hypothesis of the study which is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives, such as lack of colour strength, standardisation and durability when compared to synthetic dyes.

- Importance of colour standardisation

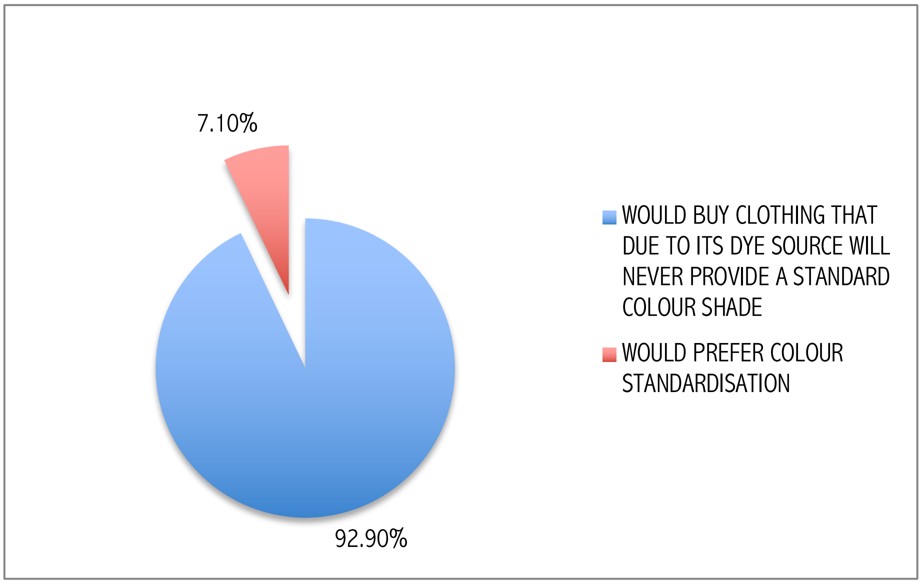



*Figure 86. Importance of colour standardisation*

| Colour standardisation | Number of Participants |
|---|---|
| WOULD BUY CLOTHING THAT DUE TO ITS DYE SOURCE WILL NEVER PROVIDE A STANDARD COLOUR SHADE | 288 |
| WOULD PREFER COLOUR STANDARISATION | 22 |

*Table 37. Importance of colour standardisation*

Moving now to the importance of colour standardisation, the majority of the respondents 92.90% have said that they would buy clothing that due to its dye source will never provide a standard colour shade, while only 7.10% have reported that they would not buy clothing that due to its dye source will never provide a standard colour shade. Figure 86 and Table 37. This data regarding the openness of the participants to accept non-standard colour shades is important since the approach of the study is to guide consumers to embrace the natural dyes performance and not see inconsistency as a limitation.

- Colour variation acceptance

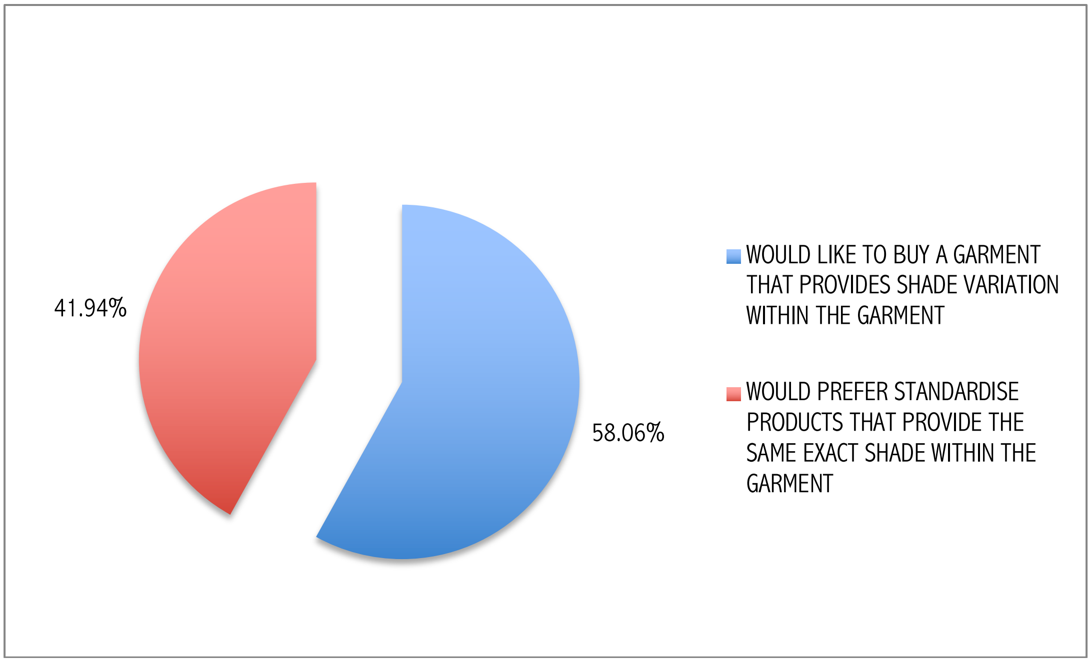



*Figure 87. Colour variation acceptance*

| Colour variation acceptance | Number of Participants |
|---|---|
| Would like to buy a garment that provides shade variation within the garment | 180 |
| Would prefer standardise products that provide the same exact shade within a garment | 130 |

*Table 38. Colour variation acceptance*

Interestingly, when they were asked about the colour variation acceptance, 58.06% have indicated that they would be likely to buy a garment that provides shade variations within the garment, while 41.94% have indicated that they prefer standardised products that provide the same exact shade within the garment. Figure 87 and Table 38. This outcome was not expected, since in the previous page (200), the majority of the participants (92.90%) have indicated that they would buy clothing that due to its dye source will never provide a standard colour shade. This result suggests that the majority of the participants (58.06%) would accept colour variation only if it provides a uniform colour within the garment. This could be further explored, after testing the social marketing intervention model and may need a technological solution in the form of improved natural dye processes.

Food waste

- Food waste acceptance

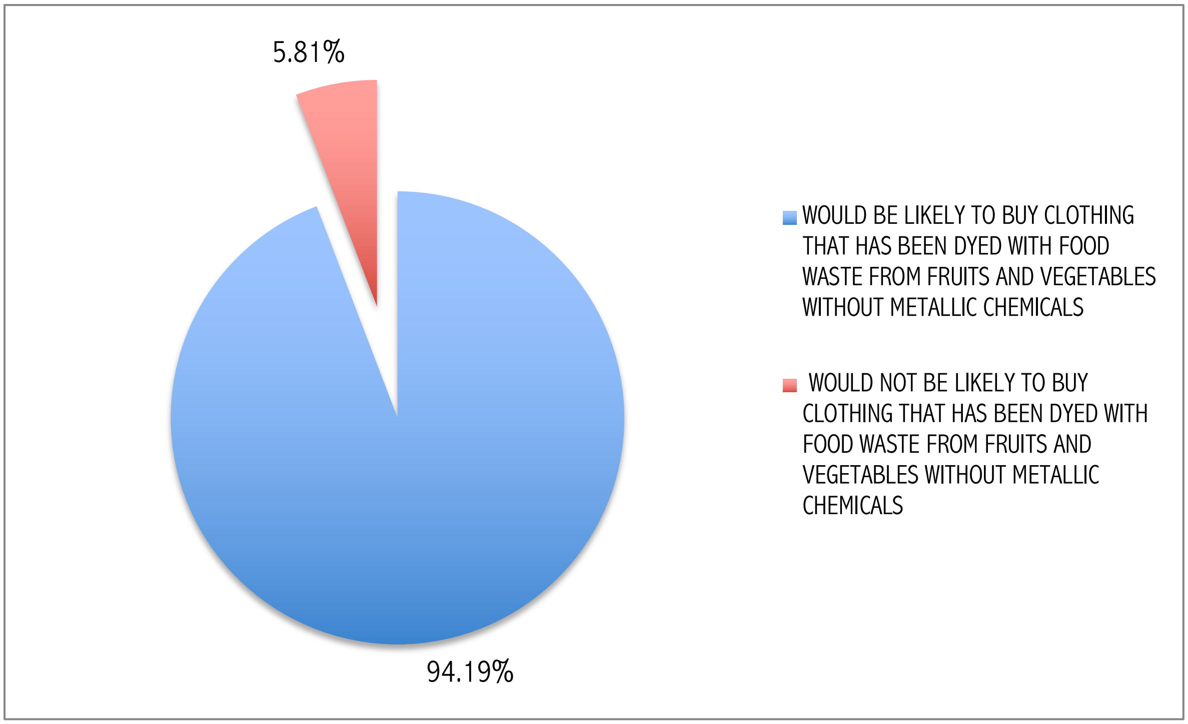



*Figure 88. Food waste acceptance*

| Food waste acceptance | Number of Participants |
|---|---|
| Would be likely to buy clothing that has been dyed with food waste from fruits and vegetables without metallic chemicals | 292 |
| Would not be likely to buy clothing that has been dyed with food waste from fruits and vegetables without metallic chemicals | 18 |

*Table 39. Food waste acceptance*

Turning now to the main question of the survey with regards to food waste acceptance, almost all of the respondents, 94.19% have indicated that they would be likely to buy clothing that has been dyed with food waste from fruits and vegetables without metallic chemicals, while the minority, 5.81% have indicated that they would not be likely to buy clothing that has been dyed with food waste from fruits and vegetables without metallic chemicals. Figure 88 and Table 39. This data is highly important in order to validate the respondent's acceptance towards the use of food waste as a natural resource for textile dyeing. This aspect will also be considered further when developing a suitable social marketing strategy, which will be discussed in Chapter 7.

For the 94.19% of the respondents, which have indicated that they would be likely to buy clothing that has been dyed with food waste, an additional question was asked, in order to understand their reasoning for accepting food waste as a source of natural dyes.

- Relevance for the food waste resource acceptance as a natural dyed resource

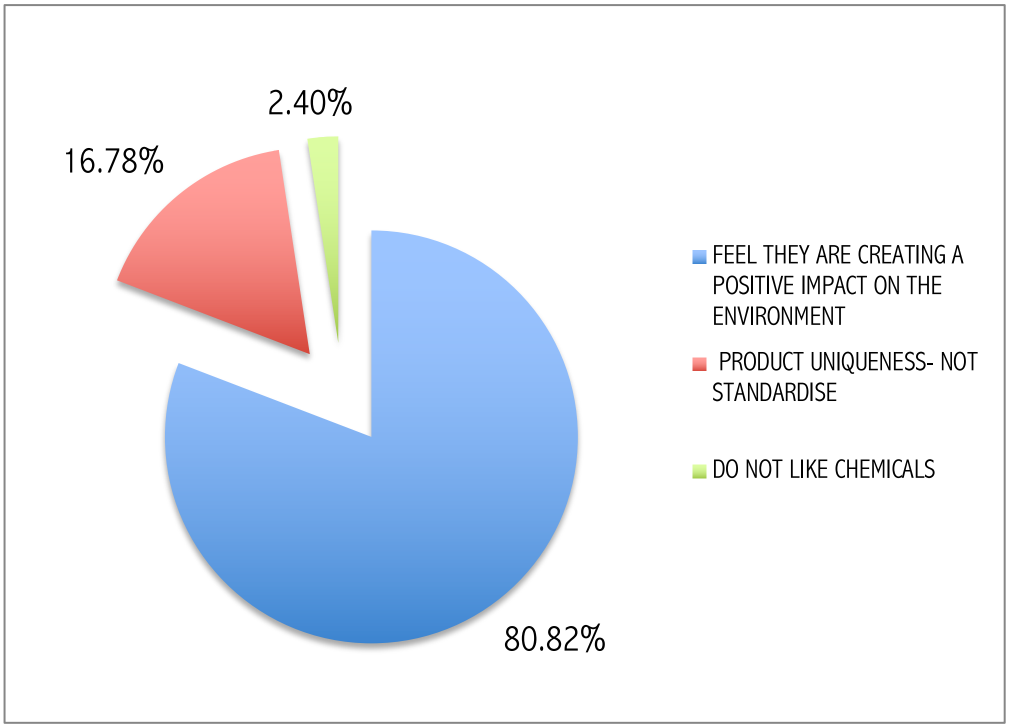



*Figure 89. Relevance for the food waste resource acceptance as a natural dyed resource*

| Relevance factor for the food waste resource acceptance of the 292 participants who accepted food waste as a natural dyeing resource | Number of Participants |
|---|---|
| Feel they are creating a positive impact on the environment | 236 |
| Product uniqueness- not standardise | 49 |
| Do not like chemicals | 7 |

*Table 40. Relevance for the food waste resource acceptance as a natural dyed resource*

Figure 89 - Table 40 shows that, the majority of the respondents 80.82% indicated that it was because of the feeling of creating a positive impact on the environment, while interestingly 16.78% have indicated that it was because they are interested in a product that can be unique and not a standardised product where lots of people have exactly the same product, this indicates that this 16.78% which are 49 participants respond positively to products uniqueness or non-standardisation. Only 2.40% have indicated that it was because they do not like chemicals.

However it is important to highlight as discussed previously in pages (187 - 188) how the participants attitude changed towards the environment as more specific questions were asked, since according to the first question about the environment 80% of the participants indicated that they do not consider the environmental consequences when purchasing clothing (Figure 73- Table 24). As a result it would be interesting to further explore attitudes to the importance of the environment as part of further studies.

Turning now, to the 5.81 % of the respondents which have indicated that they would not be likely to buy clothing that has been dyed with food waste. See Figure 88. An additional question was asked, in order to gain an insight as to why they would not embrace food waste a natural dye source.

- Relevance for the participants who do not like the idea of using food waste as a natural dyed resource

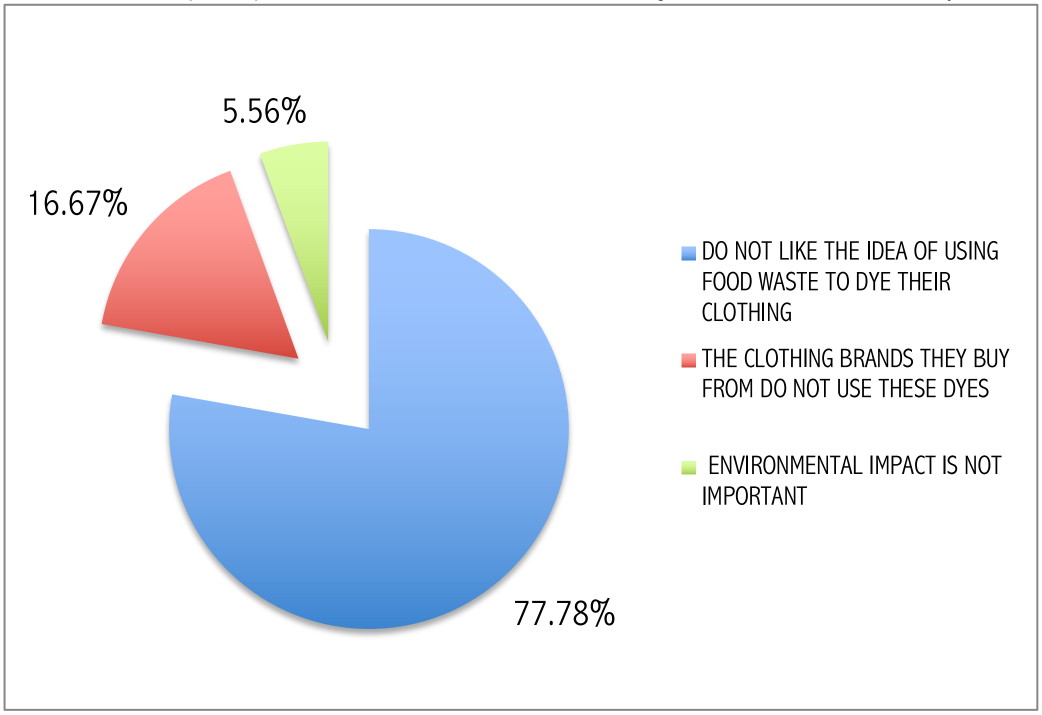



*Figure 90. Relevance for the participants who do not like the idea of using food waste as a natural dyed resource*

| Relevance factor for the 18 participants who do not accepted food waste as a natural dyeing resource | Number of Participants |
|---|---|
| Do not like the idea of using food waste to dye their clothing | 14 |
| The clothing brands they buy from do not use these dyes | 3 |
| Environmental impact is not important | 1 |

*Table 41. Relevance for the participants who do not like the idea of using food waste as a natural dyed resource*

The majority of the respondents 77.78% indicated that it was because they do not like the idea of using food waste to dye their clothing, followed by the 16.67 % who reported that it was because the clothing brands they usually buy from do not use these dyes, and the minority 5.56% indicated that its negative response was because the environmental impact is not important for them. Figure 90 and Table 41. As a result, it would be interesting to further explore if the attitudes of participants towards food waste acceptance changes if other terms are used instead of 'waste' as part of further studies.

- For the 14 participants who do not like the idea of using food waste as a natural dyed resource

For the fourteen participants who indicated that the reason why they would not be likely to buy clothing that has been dyed with food waste was because they do not like the idea of using food waste to dye their clothing an additional question was asked in order to know if they would change their mind if they become part of the design process of the dyed garment.

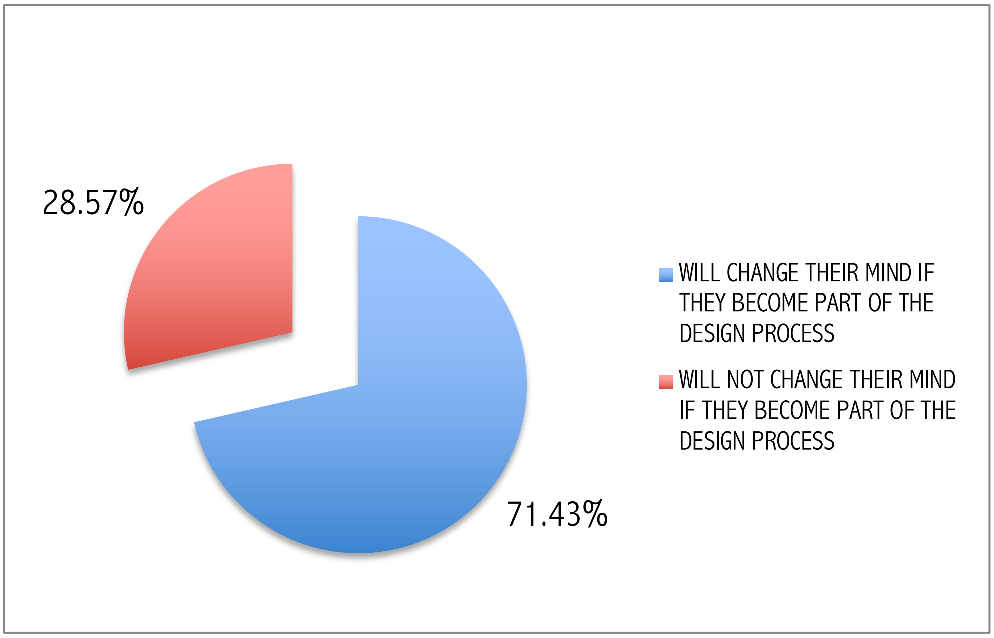



*Figure 91. Change their mind if they become part of the design process of the dyed garment*

| For the 14 participants who do not like the idea of using food waste as a natural dyed resource | Number of Participants |
|---|---|
| Will change their mind if they become part of the design process | 10 |
| Will not change their mind if they become part of the design process | 4 |

*Table 42. Change their mind if they become part of the design process of the dyed garment*

Surprisingly, the majority 71.43% of the respondents indicated that they would accept the idea of food waste, if they become part of the design process, while only 28.57 % do not report any change even if they become part of the design process. Figure 91 and Table 42.

An additional question was asked to the participants (If you do not like the idea of using food waste to dye your clothing, will you change your mind if you become part of the colour design process?). The same proportion of respondents 71.43% indicated that they would accept the idea of food waste if they become part of the colour design process, while the same 28.57 % do not report any change even if they become part of the colour design process. Taken together, these results indicate that there is a possible mind-set change if co-design is applied when aiming for the acceptance of food waste as a natural resource for textile dyeing. This mind-set change through the application of co-design is fundamental for developing the social marketing intervention model. Since this intangible feature would contribute towards the construction of the social marketing intervention model, which will be discussed in Chapter 7. Moreover, the application of co-design becomes fundamental for the social objective of this study, which is the acceptance of natural dyes with no metallic chemical additives.

- Customisation and do it yourself (DIY) influence on purchase decision – if a clothing store of naturally dyed garments offers you the possibility of sending recipes for you to re-dye your clothes at home, once the previous natural colour fades

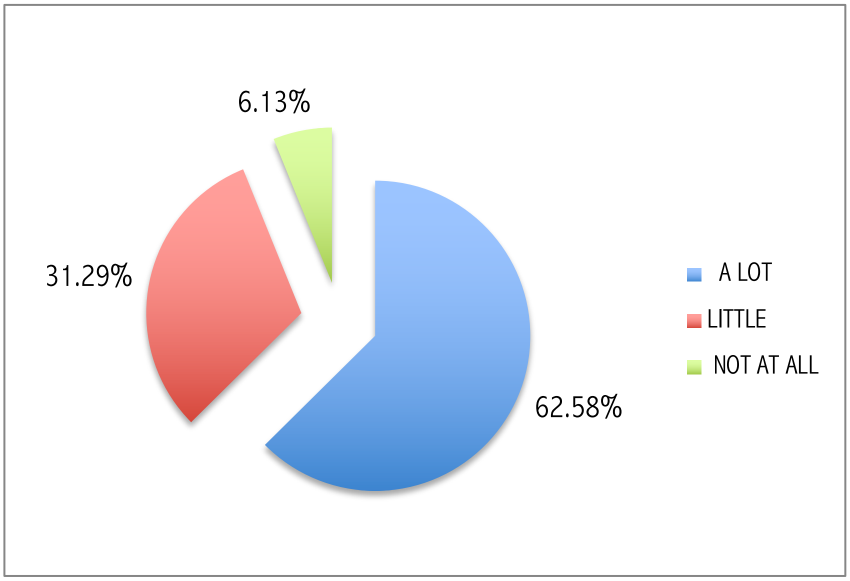



*Figure 92. Customisation and DIY importance*

| Customisation and DIY importance | Number of Participants |
|---|---|
| A lot | 194 |
| Little | 97 |
| Not at all | 19 |

*Table 43. Customisation and DIY importance*

Moving to the final section which was customisation, when the following question was asked to the respondents: If a clothing store stocking naturally dyed garments offers you the possibility of sending recipes for you to re-dye your clothes at home, once the previous natural colour fades using food waste and no added chemicals would that influence your purchase decision? The majority of the respondents, 62.58% indicated that this would positively influence their purchase decision, followed by the 31.29% of the respondents who indicated that this factor would influence just a little, while only 6.13 % reported that this would not create any influence on their purchase decision. Figure 92 and Table 43. To summarise this section, the results indicate that, co-design and customisation are important tools that should be considered in order to provide a positive acceptance towards the use of food waste as a natural resource for textile dyeing. Moreover, this indicates an added value to the consumer, which could impact on an active use of the garment. The next section therefore, moves on to validate the use of emotional attachment as a design strategy towards sustainable consumption through a long-life garment with active use.

## 6.4. Emotions – Clothing

This section, evaluates if the use of emotional attachment in conjunction with co-design is a design strategy that could lead towards sustainable consumption through a long-term garment ownership with active use.

- Favourite clothing

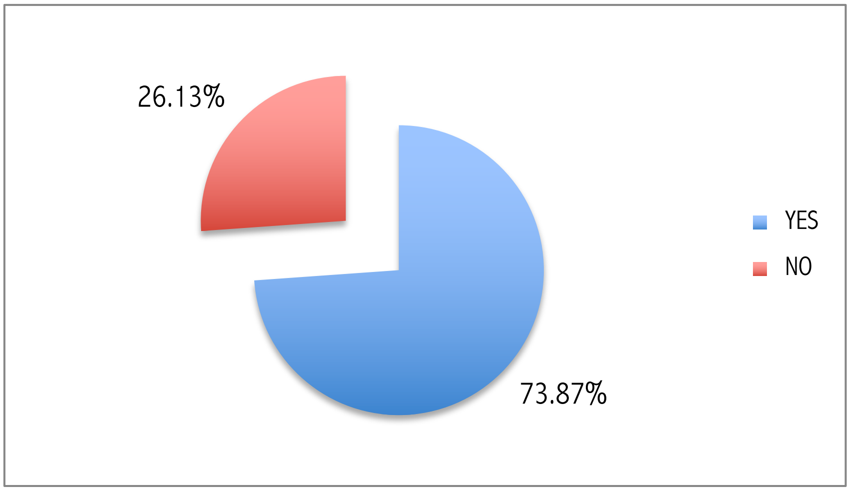



*Figure 93. Favourite clothing*

| Favourite clothing | Number of Participants |
| --- | --- |
| Yes | 229 |
| No | 81 |

*Table 44. Favourite clothing*

73.87% of the respondents indicated that they do have a favourite garment, while the minority 26.13 % indicated that they do not have a favourite garment. Figure 93 and Table 44. For the 73.87% of the respondents (229 participants) who have indicated that they have a favourite garment, the two following additional questions were asked:

1. For how long have you owned it?
2. Do you actively use it?

▪ 1. For how long have you owned it?

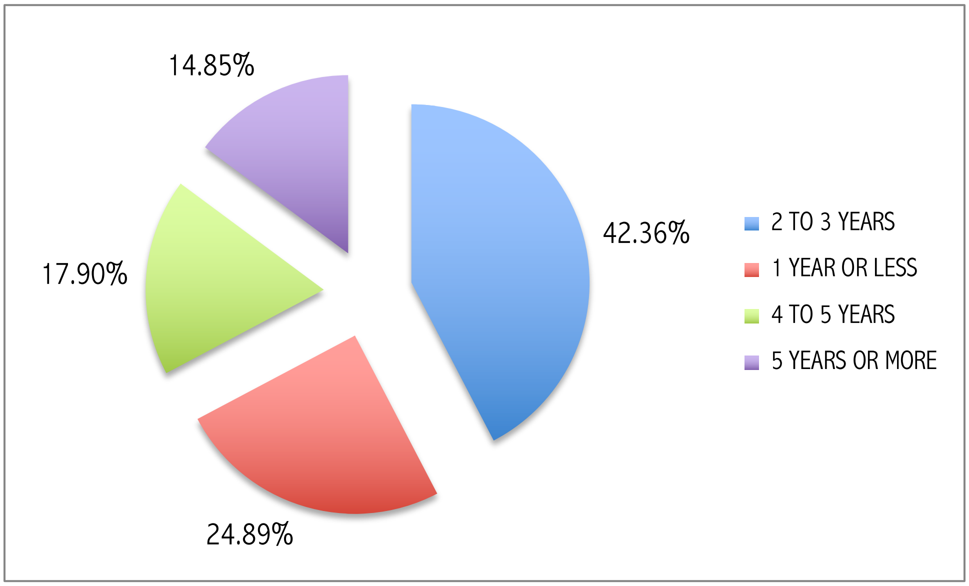



*Figure 94. Time owned*

| Time owned - Favourite garment | Number of Participants |
|---|---|
| 2 to 3 years | 97 |
| 1 year or less | 57 |
| 4 to 5 years | 41 |
| 5 years or more | 34 |

*Table 45. Time owned*

The majority 42.36% reported that they owned it between 2 to 3 years, 24.89% of the participants indicated that they have owned the favourite garment for 1 year or less, followed by the 17.90% who reported that they have owned it for 4 to 5 years, while only 14.85% indicated that they have a favourite garment for 5 years or more. Figure 94 and Table 45. Taken together these results indicate that the majority of the participants (42.36%) have owned their favourite garment between 2 and 3 years.

- 2. Do you actively use it?

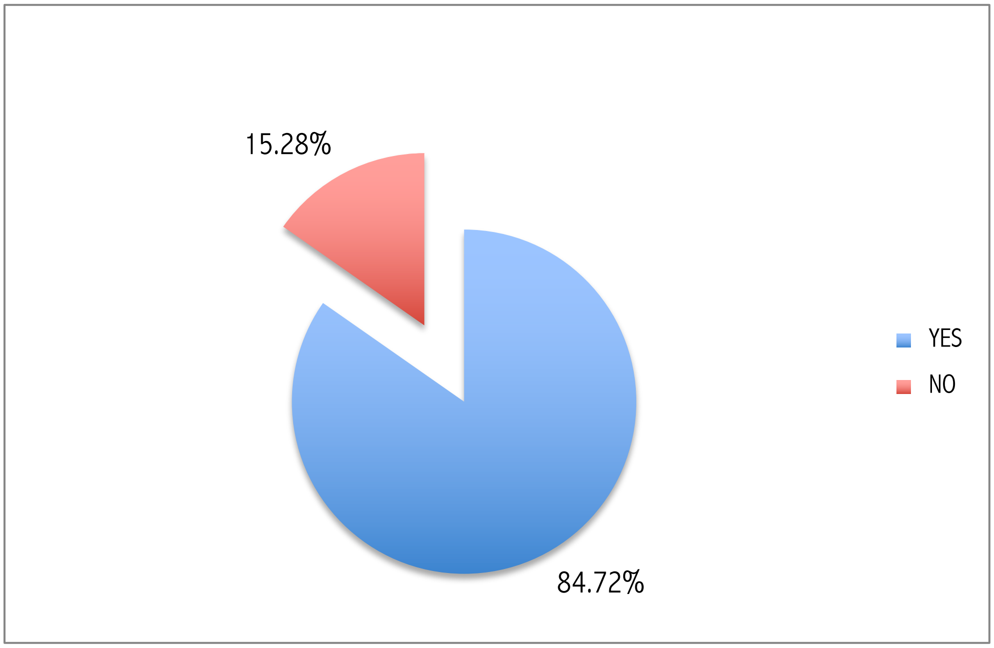



*Figure 95. Active use*

| Active use - Favourite clothing | Number of Participants |
|---|---|
| Yes | 194 |
| No | 35 |

*Table 46. Active use*

When the participants were asked if they actively use their favourite garment, the majority 84.72% indicated that yes, while only 15.28% indicated not. Figure 95 and Table 46.

- Joy in clothing

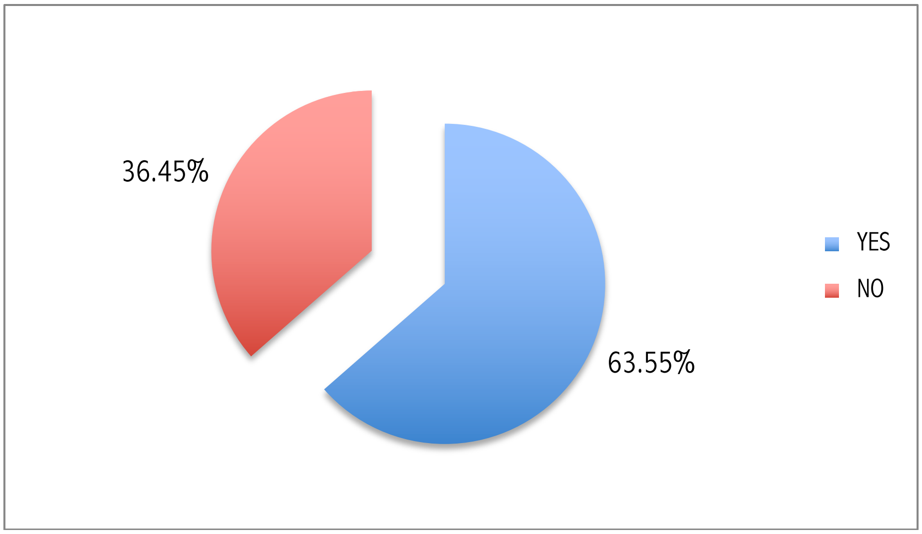



*Figure 96. Joy in clothing*

| Joy in clothing | Number of Participants |
|---|---|
| Yes | 197 |
| No | 113 |

*Table 47. Joy in clothing*

- Luck in clothing

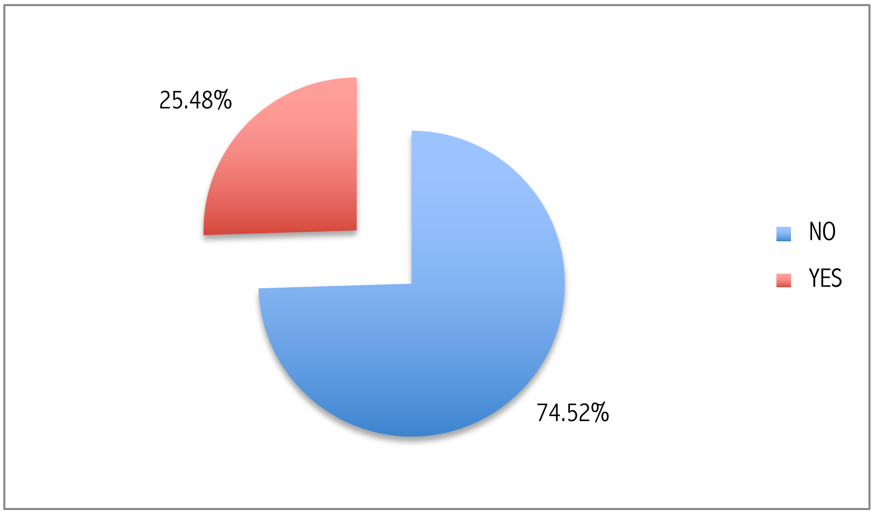



*Figure 97. Luck in clothing*

| Luck in clothing | Number of Participants |
|---|---|
| No | 231 |
| Yes | 79 |

*Table 48. Luck in clothing*

When the participants were asked if they believe that clothing could bring joy, the majority 63.55% indicated that yes it could, while 36.45% indicated no. Figure 96 and Table 47. Conversely when they were asked if they believe clothing could bring luck, the majority 74.52% indicated no, while 25.48% indicated that they do have a piece of clothing that brings them luck. Figure 97 and Table 48.

- Clothing – Power to change your mood

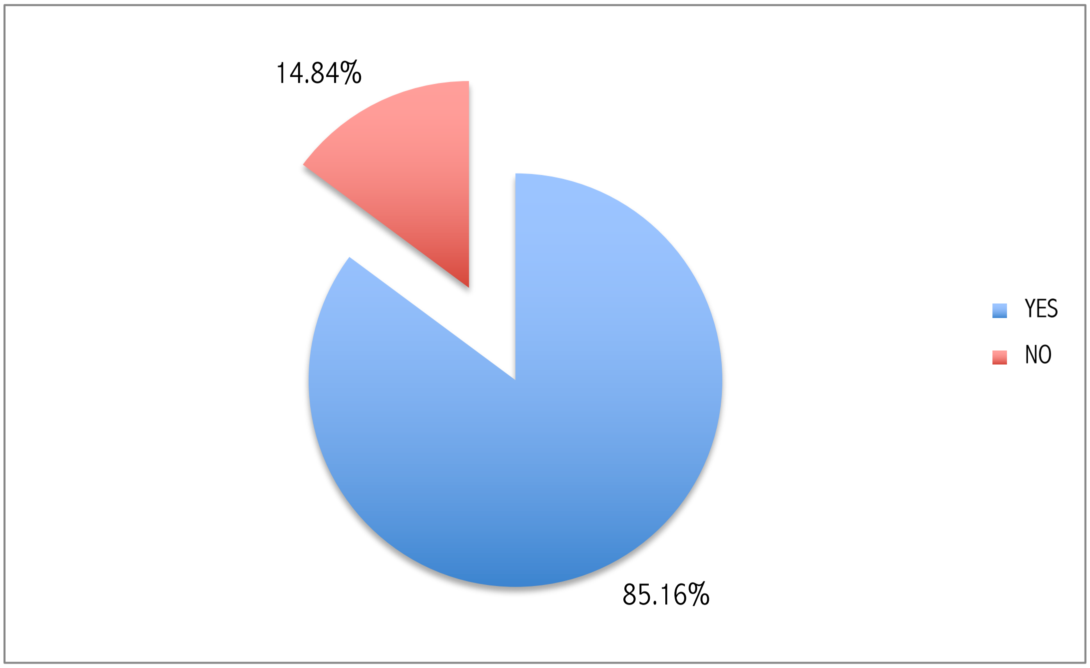



*Figure 98. Clothing- Power to change your mood*

| Clothing - Power to change mood | Number of Participants |
|---|---|
| Yes | 264 |
| No | 46 |

*Table 49. Clothing- Power to change your mood*

However, when they were asked if they believe that clothing has the power to change their mood, the majority 85.16% indicated yes, while only 14.84% indicated no. Figure 98 and Table 49. From these results the following conclusions can be drawn; for the target demographic group clothing could bring them joy, and clothing has the power to change their mood. This information could be used as a positive indicator that if they become part of the design process or the colour design process, emotional aspects could be developed as a strategy towards a more active sustainable consumption. Since according to Lobos and Babbitt (2013, p.20) "As sustainability tries to address many of these issues, the notion of integrating emotional attachment into design offers a viable solution for the problem".

- Clothing customisation

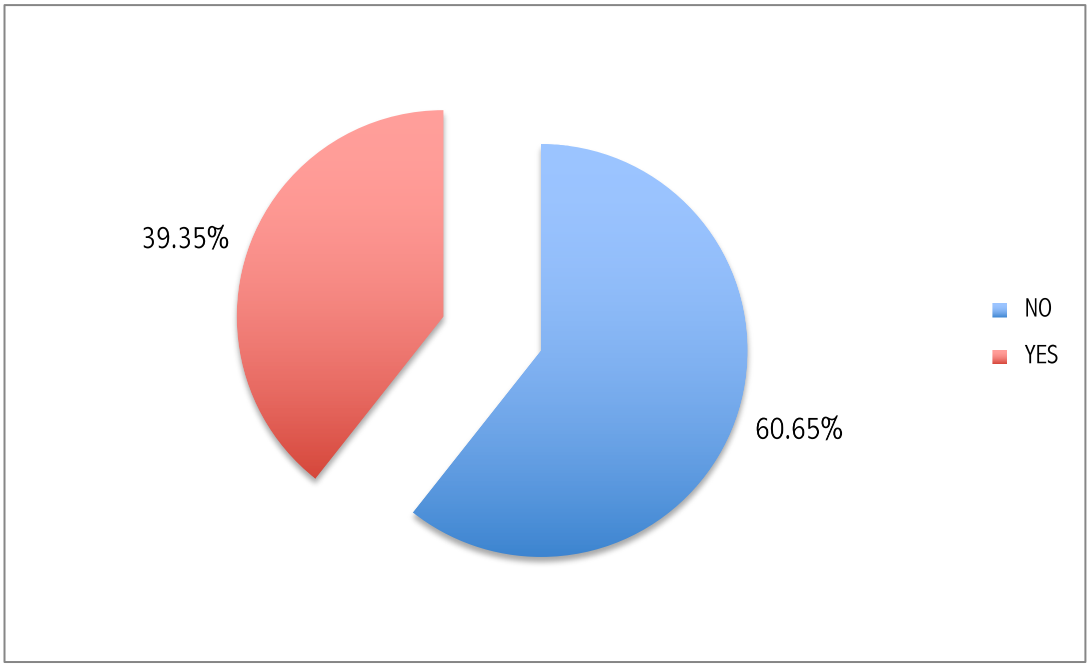



*Figure 99. Clothing customisation*

| Clothing – Customisation | Number of Participants |
|---|---|
| No | 122 |
| Yes | 188 |

*Table 50. Clothing customisation*

Moving to the customisation aspect, when the participants were asked if they have customised a garment, the majority 60.65 % indicated that yes, while 39.35% indicated that no. Figure 99 and Table 50. For the 60.65% participants who indicated that they have customised a garment, an additional open question was asked:

- How you have customised clothing?

- For the 122 participants – How had you customised clothing?

Reading the 122 open answers of the participants, they were classified in 8 categories: Fittings, letters, cuts, details, painting, dyeing, designing and alternative use. (See Figure 100 and Table 51). These categories were determined by following the models developed for content analysis of open questions by Gillham (2007). The author proposes after reading an open answer to highlight "…the statements that make a key point, that really say something" (Gillham, 2007, p. 66). The key statements will contribute towards the generation of categories (Gillham, 2007).

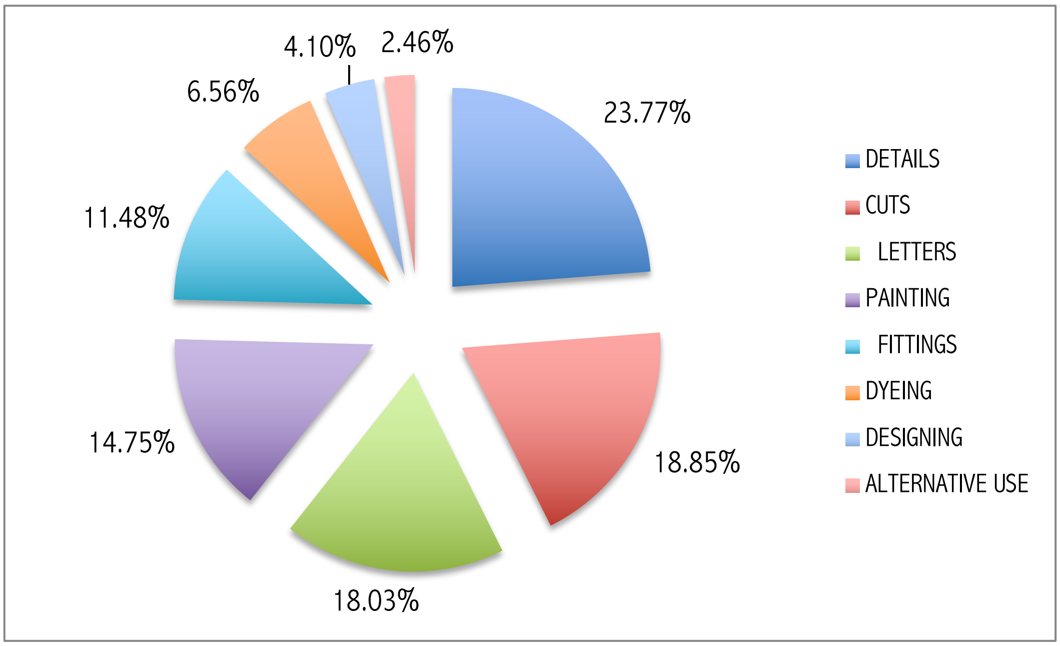



*Figure 100. Clothing customisation- How?*

| Customised clothing – how? | Number of Participants |
|---|---|
| Details | 29 |
| Cuts | 23 |
| Letters | 22 |
| Painting | 18 |
| Fittings | 14 |
| Dyeing | 8 |
| Designing | 5 |
| Alternative use | 3 |

*Table 51. Clothing customisation - How?*

Fittings category

14 participants indicated that they customised their clothes through adjustments in the garment. 3 of these 14 specified that they do the adjustments because the size did not fit them well. 1 of those 3 participants specified that she is 156 cm tall and the garments she usually buys are pretty big for her, therefore she adjusts the garment and with the leftover fabric she makes new garments. Other participants indicated that most of their clothes are from second hand shops; therefore they adjust or modify the garments to their preference.

Letters category

22 participants indicated that they customised their garments through the use of letters. 10 participants specified that they put the initials of their name on the garment, 9 indicated that they put their complete name on it. 2 specified that they put phrases on their garment, and one said that she customised their clothes by choosing a word along with their friends in order to complete a phrase together.

Cuts category

23 participants indicated that they customised their garments through the use of cuts on their garments. 2 participants specified that they cut t-shirts, 4 specified that they cut jeans. 1 of those 4 said that once, she cut and frayed the hem of one pair of jeans she did not use it anymore, in order to use it again since she really liked the colour of them but she did not like the cut, she added that with this cut-customisation most of her friends asked if these jeans were new.

Details category

29 participants indicated that they customised their garments by adding details on their garments. 10 specified that they add patches to their garments, 8 specified that they add embroidery on their garments, 2 specified they add studs to their garments. The remaining 9 only said they add accessories without specifications. However, one of these 9 said that she adds to her garments accessories that are emotionally meaningful for her.

Paintings category

18 participants indicated that they customised their garments through paintings. 1 mentioned she is an artist, so she customised her garments with her paints. 4 mentioned that they send their denim jackets to a local artist to personalise them though paintings, another participant said she makes embossed printings on her garments. 2 participants specified the materials they use to paint on their garments, one said that she uses acrylic paints and other said that she uses melted crayons.

Dyeing category

8 participants indicated that they customised their garments by dyeing them. 1 specified that she do this activity in her house.

Design category

5 participants indicated that they customised their garments through design. These participants specified that they do their own garments.

Alternative use category

3 participants indicated that they customised their garments by changing the common use of their garments, for example using a shirt as a skirt.

- Clothing - Colour change or dyed experience

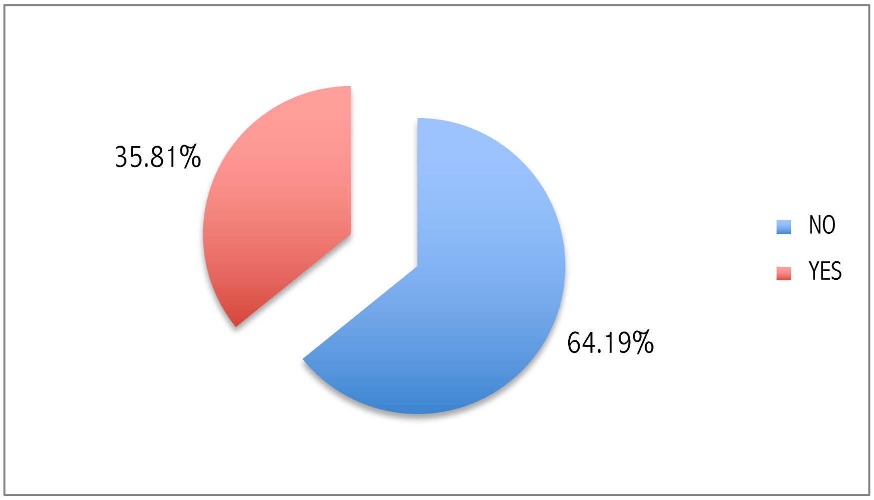



*Figure 101. Clothing - colour change or dyed experience*

| Clothing - Colour change / dyed experience | Number of Participants |
|---|---|
| No | 199 |
| Yes | 111 |

*Table 52. Clothing- colour change or dyed experience*

- Clothing- Renovate – Redyed experience – To use it again

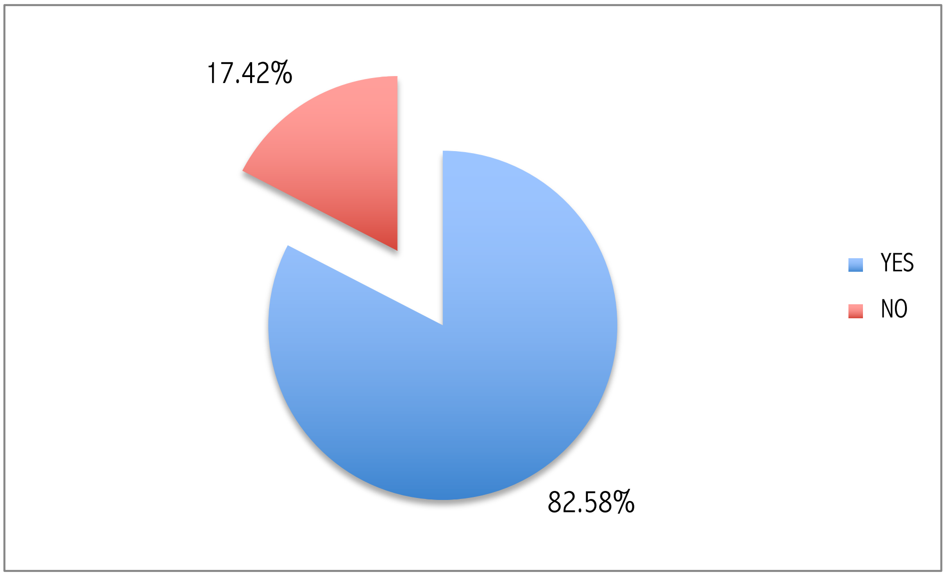



*Figure 102. Clothing - renovate- redyed experience- to use it again*

| Clothing- Renovate – Redyed experience – To use it again | Number of Participants |
|---|---|
| Yes | 256 |
| No | 54 |

*Table 53. Clothing- renovate- redyed experience - to use it again*

Moving to the next section, when the participants were asked if they have changed the colour of a garment or if they have dyed a garment, the majority 64.19% indicated that they haven't, while only 35.81% indicated they have. Figure 101 and Table 52. Interestingly, when they were asked if they would renovate or re-dye a garment they no longer use in order to use it again, the majority 82.58% indicated that yes they would. Figure 102 and Table 53. This data brings important information regarding the respondents consideration to give their garments a longer-life through renovating or re-dyeing, since this study aims to get consumers used to the natural process of colour fading, in which they could become co-designers by re-dyeing their garments at home with food waste once colour fades. This validates Dorst (2015) perspective about reframing, in which he points out that this strategy gives the opportunity to not only analyse more deeply a problem but also considering different ways of problem solving through an open thinking approach. In this case, the approach of this study was to re-frame the design problem regarding the market acceptance of natural dyes without metallic chemical additives, challenging what has previously been considered to be suitable for the market with regards to natural dyed textiles such as colour strength and colour fastness.

- Favourite clothing – Constant colour change

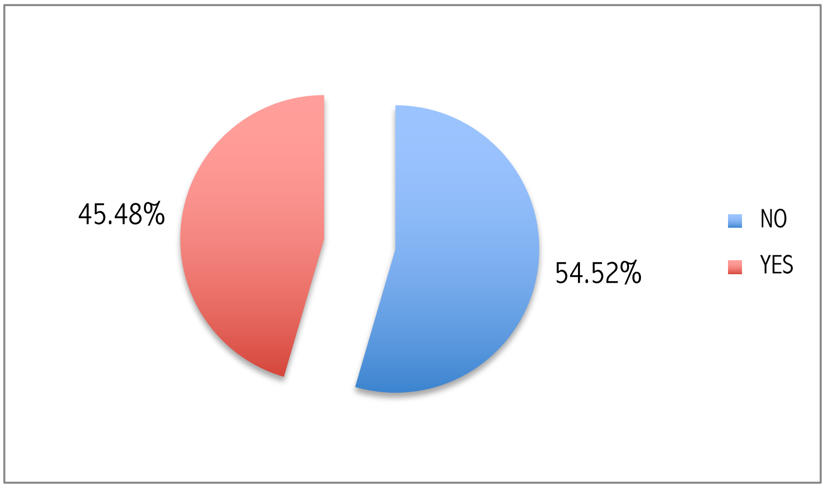



*Figure 103. Favourite clothing- constant colour changes*

| Favourite clothing – Constant colour change | Number of Participants |
|---|---|
| No | 169 |
| Yes | 141 |

*Table 54. Favourite clothing - constant colour change*

- Favourite clothing – Constant colour change – Aware not negative effects on the environment

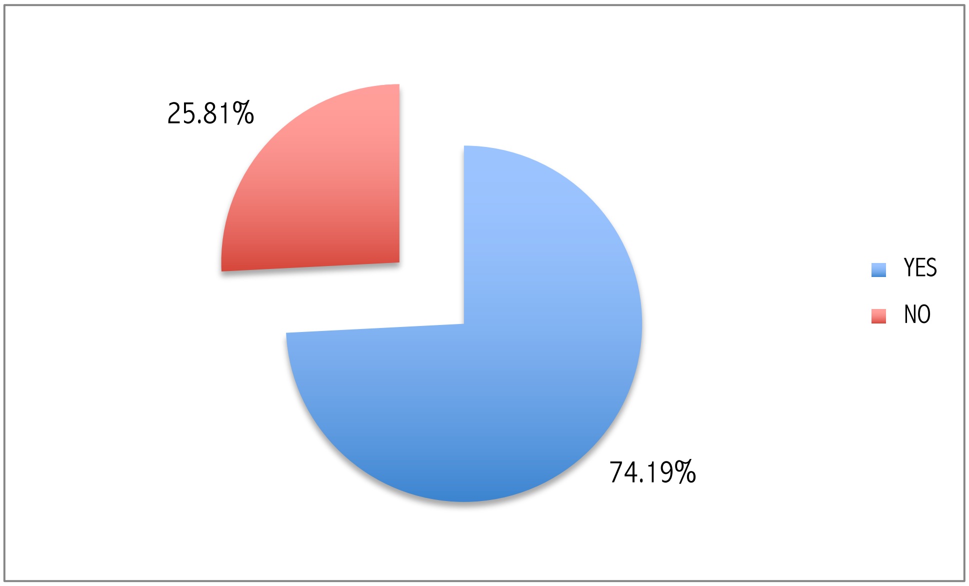



*Figure 104. favourite clothing- constant colour change - aware not negative effects on the environment*

| Favourite clothing – Constant colour change | Number of Participants |
|---|---|
| Yes | 230 |
| No | 80 |

*Table 55. Favourite clothing - constant colour change - aware not negative effects on the environment*

When the participants were asked if they could have the opportunity of constantly changing the colour of their favourite clothing, the opinions were divided, since 54.52% indicated that no, while 45.48% indicated that yes. Figure 103 and Table 54. It can be extrapolated that colour is an important part of making an article of clothing a favourite. The difference between the two responses was of 9.02%. Surprisingly when they were asked if they could change the colour of their favourite clothing, being aware no negative effects are imparted onto the environment, the majority 74.19% indicated that they would constantly change the colour of their favourite piece, while only 25.81% indicated that no they would not. Figure 104 and Table 55.

▪ Clothing – Co-design – Wearing experience change

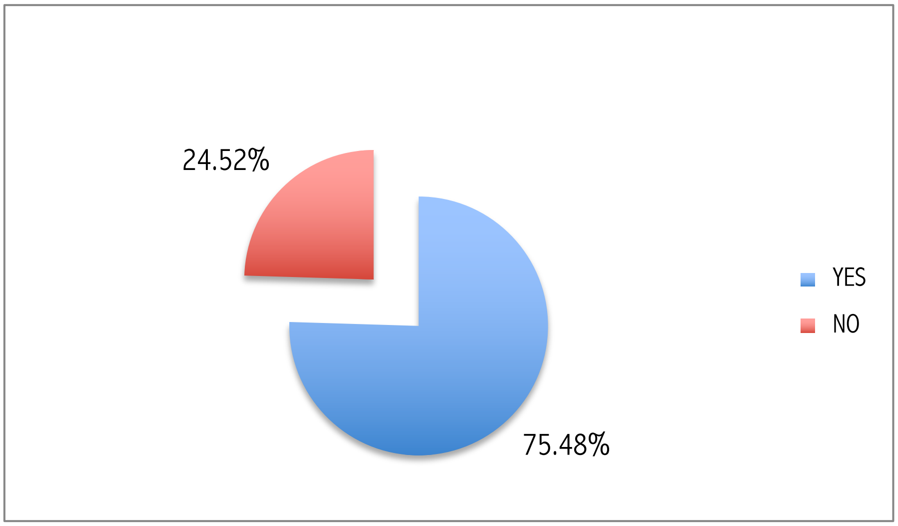



*Figure 105. Clothing - Co-design- wearing experience change*

| | Co-design – Change wearing experience | Number of Participants |
|---|---|---|
| | Yes | 234 |
| | No | 76 |

*Table 56. Clothing- Co-design- wearing experience change*

Moving to the last part of the survey, related to co-design, when the participants were asked if being part of the design process of a garment would change their wearing experience, 75.48% indicated that yes they would, while only 24.52% indicated that no. Figure 105 and Table 56.

An additional open question was asked to the 75.48%, (234 participants) in order to know why their wearing experience would change. The following categories were identified: customisation, uniqueness, emotional bond, and environmental impact. Figure 106 and Table 57.

- How being part of the design process of a garment would change their wearing experience?

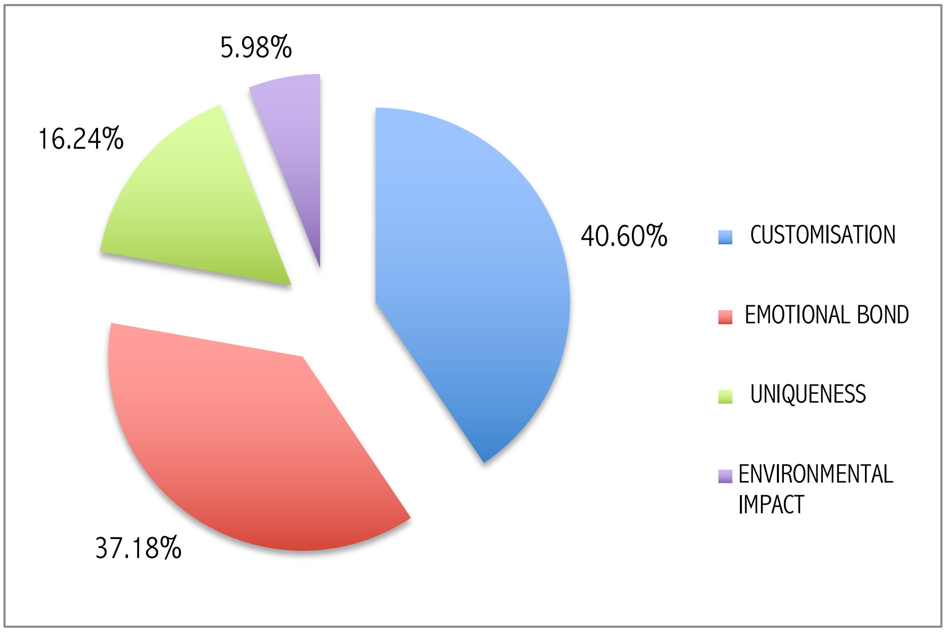



*Figure 106. How being part of the design process of a garment would change their wearing experience?*

| Factor of wearing experience change | Number of Participants |
|---|---|
| Customisation | 95 |
| Uniqueness | 38 |
| Emotional bond | 87 |
| Environmental impact | 14 |
| TOTAL | 234 |

*Table 57. How being part of the design process of a garment would change their wearing experience?*

Customisation category

95 participants indicated that being part of the colour design of their garment would change their wearing experience since they would personalise the garment.

From these 95 participants, 14 said that their garment would be personalised. One of those 14 added it would also be timeless. 6 participants said that their experience would change because they would be involved in the customisation of their garment. 8 participants said that their garment would become more personal. 1 participant said, “My experience would change because the colour design would be something created by me, therefore it would be a personal experience, which would make the garment more comfortable when wearing it”. Another participant said, “ My experience would change due to the customisation, and this would influence me wearing it more often, when compared to a non-customised garment”.

From these 95 participants, 49 said that their experience would change because they would adapt the colour design garment to their personal taste and needs.  41 Participants said that the garment would be 100% to their taste; one participant said, “ I would choose a colour that I really like and therefore I would actively use the garment”. 8 participants added that choosing the colour design of the garment would be a new experience that will suit their personal needs. One of these participants said “ No one better than me would know what I am looking for in a garment, therefore it would be a personally satisfactory experience”. Another respondent said, “ The experience of choosing the colour would be great because most of the times I have to settle with the existing colours that the market offers”. A third respondent said “ This would be a good experience for me, because sometimes I look for a specific colour and since it is not an on-trend colour it is not possible to find it. For example this year I like to find a garment with a *bougainvillea* colour, but in all the stores the colours that I found are pastel and ochre colours”.

17 participants said that their experience would change because by being involved in the colour design of their garment they would project their personality. Four participants said that it would help them to project part of their essence to others. Three participants said that the garment would have their personal touch. Another participant said “This personal experience would be innovative since I have not yet seen this option in the market.

Uniqueness category

38 participants said that their experience would change because by being involved in the colour design of their garment they would feel the garment is unique, different, new and authentic.

From these 38 participants, 24 said that they would feel the garment is unique due to the personal colour design. One of these 24 said " I would feel my garment is unique because I would be involved in the design, moreover I would be able to change it and reinvent it." Two participants said that they would feel that the garment is unique due to their personal involvement in creating it. One said " The big brands usually do not have unique colours, and I think that the colour of a garment has a great impact on us, this impact could be positive or negative. "

6 participants indicated that they would feel different due to the personal colour design. One of these 6 added that it would be a different wearing experience. 2 participants said that they would feel the garment is authentic due to the personal colour design. 4 participants said that they would feel the garment is new due to the personal colour design. One participant added that this creating experience would be innovative and other participant added that she would like to try new creating experiences. Two participants said that they would be able to have a more versatile garment due to the personal colour design experience. One of these two added that she could create new colour combinations.

Emotional bond category

87 participants indicated that being part of the colour design of their garment would make them feel part of the garment.

From these 87 participants, 42 indicated that being involved in the colour design of their garment would make them feel part of the garment. 24 participants indicated this would create an emotional bond, since they would be involved in the colour design of their garment. Three participants described it as a dynamic experience that would make them feel good with themselves. Five participants said that they would feel proud of being involved in the design process of their garment.

27 indicated that their personal involvement with the colour design, would be transferred to the garment and this would be an added value. One of these seven said that, “The garment could represent a special moment or important feeling”. Another said that the added value would be due to transferring her personal energy to her garment during the creation process. Another participant said that it would be very satisfying to see the result of a personal creation. A participant of these seven said, “ I think that my personal involvement would be reflected when wearing the garment and this would have a big sentimental value”.

7 indicated that being part of the colour design of the garment would bring them joy. One participant said that it would be fun. Another said that the creation experience would be exciting.

3 said that colours have the power to change their mood; therefore, they will choose their favourite colour, which brings them security when wearing it.

4 indicated that being part of the colour design of their garment would make them feel as if they were using a new garment and they would feel more satisfaction knowing that they could be part of their garment’s production.

<u>Environmental impact category</u>

14 participants indicated that being part of the colour design of their garment would change their wearing experience with regards to a positive environmental impact.

From these 14 participants, two said that they would feel more connected with the origin of the garment and at the same time in harmony with the environment. Another two participants indicated that due to the positive environmental impact they would use the garment more actively. The remaining ten only said that their wearing experience would change due to a positive environmental change.

## 6.5. Summary

According to the results obtained from the survey, the typical profile of the respondent is the following: 54.19% of the total sample is a Mexican female between 18- 25 years old, who does not have children and lives with their parents. It should be noted that the total sample is 310 respondents. See Figure 67 - page 176.

The survey utilised to collect and analyse data validates that Mexican females from 18 to 33 years old is a demographic group open to accept natural dyed textiles from food waste with limited colour strength and colourfastness without metallic chemical additives. Since, 94.19% of the respondents have indicated that they would be likely to buy clothing that has been dyed with food waste from fruits and vegetables without metallic chemicals. Moreover, they are open to embrace the natural dyes performance in which no metallic chemical additives are added, since the majority of the respondents 92.90% have said that they would buy clothing that due to its dye source will never provide a standard colour shade. For the 14 participants who indicated that the reason why they would not be likely to buy clothing that has been dyed with food waste because they do not like the idea of using food waste to dye their clothing, the majority of the respondents (10) said that they would change their mind if they become part of the design process and colour design process of the dyed garment. This validates the concept that co-design is an intangible resource that could guide consumers towards the acceptance of food waste as a natural resource for textile dyeing. Steen (2013, p.28) stresses that …"promoting reflexivity: by helping co-design participants to be more aware of their thoughts and feelings, and of their own roles and interests". This suggests that, If the demographic of the study, becomes aware of the negative effects, in this case, of the metallic chemical additives in the environment before being involved in a co-design experience of natural dyeing, they could understand the relevance of taking action. Moreover, the majority of the respondents 82.58% have indicated that they would renovate or re-dye a garment they no longer use in order to use it again. Therefore, this data brings important information regarding the respondents' consideration to give their garments a longer-life through renovating or re-dyeing. This supports one of this study's aims which is to get consumers used to the natural process of colour fading, in which they could become co-designers by re-dyeing their garments at home with food waste once the initial colour fades.

This study shows that Mexican females from 18 to 33 years old typically buy clothes one to two times per month, and spend around 300 to 1000 Mexican pesos on a garment. Good fit, quality and price are the most important factors when buying new clothes. Although this demographic group prefers to buy their garments in physical stores, e-commerce is a growing buying channel for this demographic group. This is the reason why, influencers could be utilised as a marketing technique that could provide a suitable strategy in gaining market acceptance with this demographic, embracing natural dyes made from food waste. Since, 99.7% of the respondents are familiar with this marketing technique (influencers) and it has an impact upon the clothing purchase decisions of 52.90% of the respondents.

If we now turn to the environmental impact, the majority of the respondents (80%) do not consider the environmental consequences when purchasing clothing and the companies who are pro-environment do not have a great impact on the purchase decisions of the majority of the respondents (57.4%). Interestingly, 59.06% of participants are conscious of the environmental damage that the dyeing activities of clothing companies create, especially with regards to water pollution.

For this target demographic, colour is important when buying clothing. However, the majority of the respondents (68.71%) do not know the difference between natural and synthetic dyes. As a result, the majority of the participants (64.84%) do not know if they have bought natural dyed clothing because they do not know the difference between the dye types or retailers do not make this information easily available. Moreover, in some cases, this target demographic has not bought natural dyed clothing because they have never been to a store that offers naturally dyed clothing.

Turning now to the experimental evidence with regards to the colour palette preference between the colour palette obtained without metallic chemical additives on cotton and the colour palette with metallic chemical additives on cotton in order to improve the colour strength, no significant difference between the two responses was obtained. However, the majority of the respondents who indicated their preference towards the colour palette with chemical additives did changed their decision after being made aware of the negative environmental impacts. Moreover, the majority have indicated that they would wear naturally dyed clothing without metallic chemical additives added, if aware that these natural dyes have a less negative environmental impact, but knowing that its colour may fade quickly. This, validates the hypothesis of the study, which is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives, such as lack of colour strength, standardisation and durability when compared to synthetic dyes. However, there was inconsistency between the following: 92.90% of the respondents have indicated that they are willing to buy clothing that due to its dye source will never provide a standard colour shade between garments. 58.06% of the respondents indicated that they would accept colour variation only if it provides a uniform colour within the garment. Therefore, this suggests further exploration in future studies, in order to determine if a technological solution may be needed in order to improve the natural dye process.

The majority of the respondents (62.58%) are interested in the customisation of their garments. Taken together, these results indicate that co-design and customisation are important tools that should be considered in order to influence a positive acceptance towards the use of food waste as a natural resource for textile dyeing. This indicates an added value to the consumer, which could impact on an active use of the garment. This demographic group has confirmed that being part of the design process of a garment would change their wearing experience. Customisation and emotional bond were the most popular answers. Taken together these responses indicate that co-design is a design strategy that could lead towards emotional attachment and consequently towards a long-life garment with active use

This demographic group has a favourite garment, which typically has been owned between one to three years and is actively used. Moreover, they think that clothing can bring them joy and has the power to change their mood. This information could indicate that the participation of the demographic in the design and colour process of a garment is a positive strategy for the study. In order to create an emotional attachment between user-clothing, which could consequently lead towards a more sustainable and active consumption of clothing.

This demographic group like to personalise their clothes, adding details, cuts or letters to their garments were the most popular answers. However, when the participants were asked if they have changed the colour of a garment or if they have dyed a garment, the majority indicated that they have not. Interestingly when they were asked if they would renovate or re-dye a garment they no longer use in order to use it again, the majority 82.58% indicated that yes they would. When the participants were asked if they could have the opportunity of constantly changing the colour of their favourite clothing, the majority indicated no. In contrast when they were asked if they could change the colour of their favourite clothing, being aware no negative effects are imparted onto the environment, the majority indicated that they would constantly change the colour of their favourite piece.

Overall, this chapter strengthens the idea that if consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes. However, the findings from this chapter suggest an education role for the social marketing intervention model in which the demographic of this study could be made aware of:

- The negative effects that a high clothing consumption rate has on the environment.
- The negative environmental impact that metallic chemical additives in the textile dyeing activity can have on the environment.
- The difference between natural and synthetic dyes in order to make a shift in their purchasing decision making process

Moreover, this chapter highlights the importance of co-design for the construction of the social marketing intervention model, which will be discussed in the next chapter (Chapter 7).

# Chapter 7. Social Marketing Intervention – Influencing the acceptance of natural dyes from domestic food waste resources without metallic chemical additives

In this chapter the concept of social marketing from different practitioners' points of view is explored in order to obtain a clear understanding of this discipline. This exploration was crucial to guide the thinking process, which has led subsequently to the creation of a model within this study. Multidisciplinary disciplines are involved in order to contribute towards the social goal of this study, which is the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives. This study aims to educate and thus influence the behaviour of Mexican females from 18 to 33 years old through a social marketing intervention model. Furthermore, it has been identified that the use of the marketing mix 4P´s (product, price, place and promotion) is fundamental in a social marketing intervention in order to use them as mental constructs in the development of a social marketing intervention model. Recently, researchers have shown an increased interest in the development of models that could facilitate behaviour change interventions; thus the two main models, the behaviour change wheel (BCW) framework and the COM-SM model are discussed and evaluated in this chapter. Although, social marketing models so far have been used mainly in the public health domain, it has been identified that social marketing can be used in any discipline that aims to contribute to a societal wellbeing. However, for the purpose of this study a new social marketing intervention model has been developed to educate and thus influence the behaviour of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives overcoming the limitations identified in the BCW framework and the COM-SM model.

## 7.1. What is Social marketing?

The concept of social marketing has evolved over the past fifty years due to the contribution of many scholars and practitioners. In 1971, Kotler and Zaltman proposed the first definition, in their attempt to help non-business institutions to accomplish their social goals more effectively. Kotler and Zaltman (1971, p.5) define it as follows: “Social marketing is the design, implementation, and control of programs calculated to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication, distribution, and marketing research”. Kotler and Zaltman (1971) point out, that the application of marketing techniques in social marketing is crucial for transforming social action efforts into the creation of communicative programs effectively designed to obtain a social acceptance response. However, the definition proposed by Kotler and Zaltman (1971) may limit the social marketing goals, merely to the acceptance of ideas. Moreover, it was not until 1990 when the existence of the Internet became an important factor that not only introduced new competitiveness to the existent market but new businesses such as Yahoo (Arthur, 2014). Therefore, it is important to consider new marketing channels such as Instagram which according to Clement (2020) is one of the most used social networks globally.

Andreasen (1994) argues in his paper “Social Marketing: Its definition and domain”, that the definition proposed by Koltler and Zaltman in 1971, tends to confuse social marketers by encouraging them to believe that social marketing is about changing attitudes and ideas, rather than influencing behaviour. However, Andreasen (1994, p.110) also creates confusion with regards to the crux of social marketing, since he first claims that “The "bottom line" of social marketing is behavio[u]r change” and in other section within the same paper, he highlights as a key element of the social marketing definition, the following statement: “Social Marketing Programs Influence Behavio[u]r— They Do Not Always Change It” (Andreasen, 1994, p.111). With regards to this latter, Andreasen (1994) says, that sometimes behaviour discouragement is needed in social marketing programs to achieve social good, such as discouraging children from consuming drugs through a campaign. Despite the confusion, Andreasen (1994, p. 110) defines social marketing as “the adaptation of commercial marketing technologies to programs designed to influence the voluntary behaviour of target audiences to improve their personal welfare and that of the society of which they are a part”. In comparison with Kotler and Zaltman (1991) the author, incorporates in the definition “voluntary behaviour” and stresses that the aim of social marketing is the improvement of human welfare. Andreasen (1994) also points out, that an emphasis on behaviour, leads to a customer focus, which is essential to a social marketing plan, since it provides to social marketers a better understanding of the target audience. Moreover, Andreasen (1994) says that, this customer focus enables social marketers to test more effectively strategies/tactics on their target audience, which could consequently influence effectively a desired behaviour.

However, for the social marketing intervention developed in this study, the definition proposed in 2013 by the boards of The Australian Association of Social Marketing (AASM) in conjunction with The International Social Marketing Association (iSMA) and The European Social Marketing Association (ESMA) has more impact and fits more with the multidisciplinary approach of the study. They define it as follows: "Social Marketing seeks to develop and integrate marketing concepts with other approaches to influence behaviour that benefit individuals and communities for the greater social good. Social Marketing practice is guided by ethical principles. It seeks to integrate research, best practice, theory, audience and partnership insight, to inform the delivery of competition sensitive and segmented social change programmes that are effective, efficient, equitable and sustainable" (iSMA, ESMA and AASM, 2013, p.1). Therefore, this definition suggests that social marketing in conjunction with other disciplines could contribute towards the influence of behaviours that could benefit the societal common good.

In addition, the boards of the iSMA, ESMA, and AASM (2013, p.2) conversely to Andersen (1994) and Kotler and Zaltman (1971) considered that the social marketing definition should be under an "on-going refinement" due to its dynamic nature. Moreover, as Aasm.org.au (2016) points out, the definition proposed by iSMA, ESMA and AASM (2013) aims to create a universal narrative with the ability to support the application of social marketing in social programs as a key asset towards societal improvement. The importance of acknowledging the dynamic nature of social marketing and the importance of incorporating different disciplinary approaches was key for this definition being more appropriate from the two others that can be classified as representing a static situation or context. Since, in the context of this research it is clear that other disciplines can contribute towards the creation of a social marketing intervention model that aims to educate and thus influence the behaviour of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

However, the following aspects for the development of a social marketing program, such as: the application of "market research" proposed by Kotler and Zaltman (1971), the application of "commercial marketing techniques", the importance of selecting a "target audience" and the aim of "influencing voluntary behaviour" proposed by Andreasen (1994) will be considered for the development of the social marketing intervention model for this study.

## 7.2. The Marketing Mix in Social Marketing (4P´s)

It has conclusively been shown that in social marketing, the application of marketing techniques is needed in order to be able to transform a social ideal into an actionable social program (Kotler and Zaltman, 1971, Andreasen 1994, AASM, 2016). Therefore, it is important to define marketing and describe its techniques. According to Kotler and Zaltman (1971, p.4) "Marketing does not occur unless there are two or more parties, each with something to exchange, and both able to carry out communications and distribution". Kotler and Zaltman (1971) highlight the exchange process, as the marketing core. Moreover, Kotler and Zaltman (1971) suggest a consumer emphasis, since they argue, that marketing should first discover what the target audience wants in order to satisfy them through the creation of goods/services that could meet those wants.

According to Kotler and Zaltman (1971), product, promotion, place and price are the four variables (4P's) that build the marketing mix, and are defined as follows:

- Product: In traditional marketing, this variable aims to meet the needs and wants of the target audience through tangible buyable products and services. In social marketing, the product becomes the social idea that benefits the target audience for a greater social good. The social idea should be developed in a way that the target audience become interested in purchasing it. The core product, as mentioned earlier is the social idea that benefits the target audience for a greater social good, however in some cases multiple tangible products and services can be created in order to contribute towards meeting the social objective.

- Promotion: "It is the communication - persuasion strategy and tactics that will make the product familiar, acceptable, and even desirable to the audience" (Kotler and Zaltman, 1971, p.7). Kotler and Zaltman (1971) used the American Cancer society to exemplify how promotion was used to raise money for their social core product: cancer research. This society used other approaches in order to motivate donations from their target audience. For example, they created special events in which glamour and excitement were used in order to attract the attention of the target audience and consequently their donations. This suggests that, different approaches with regards to promotion could be considered in order to accomplish effectively social goals. For example, in the tobacco industry… "pictorial health warnings are effective in reducing smoking intentions, particularly when they activate negative emotions and are paired with plain or standardised packaging" (O'Connor, 2019, p.1). Therefore, this suggests that promotion is not only about the selection of effective communication channels but also the identification of attraction tools that could support the desired action from the target audience. Moreover, these promotion examples suggest that, the attraction tools used, depend on the nature of the social goal.

- Place: This variable in social marketing refers to adequate channels in which the target audience can translate its motivation of realising a social goal into action. Kotler and Zaltman (1971) point out an example about a social marketing campaign that failed to provide channels in which the target audience could express their interest towards the social goal, which was awareness of environmental pollution. Therefore, the target audience became frustrated at not knowing where or how they can express or take action to contribute towards their interest in the environmental pollution issue. This highlights not only the importance of making the target audience aware of the available channels in which they can translate their motivation into action, but also in the importance of constructing channels in which the target audience can easily identify the desired action they need to perform in order to avoid frustration and enhance engagement.

- Price: In traditional marketing, this variable means the monetary costs that would be involve in acquiring a product. However, in social marketing this variable refers to all the losses that would be involved not only during the purchase but also through the post-purchase experience of a social product. Kotler and Zaltman (1971), highlight an example of giving up smoking in which the cost is not actually monetary but psychological. This suggests that price in the social marketing arena is focused on all the losses throughout the whole product experience. Therefore, the target audience should be able to perceive the benefits relative to the losses in order to motivate them to buy, or invest in a social product. In some cases, it would require finding a balance between the 4P´s (product, price, place and promotion) in order to increase the rewards (benefits) for buying it. “The main point is that social marketing requires careful thought be given to the manner in which manageable, desirable, gratifying, and convenient solutions to a perceived need or problem are presented to its potential buyers” (Kotler and Zaltman, 1971, p.10). This suggests, that the target audience action required to meet a social goal should be perceived as valuable to that audience.

## 7.3. Is it possible to reinvent the marketing mix (4P´s) in dynamic markets?

According to Lauterborn (1990) the marketing mix (4P´s) model needed to be reinvented because the consumers and indeed market conditions by 1990 were very different from those in 1970. In the same vein, Prahalad and Ramaswamy (2004) point out that, in the twenty first century the economy is complex due to a dynamic market in which fragmentation is high and standardisation is an obstacle towards differentiation, therefore businesses need to reinvent regularly in order to adapt to emerging markets. This suggests that as time passes, not only do the market conditions change but also so do consumer needs. Therefore, it is almost certain that the marketing mix will be constantly evolving to dynamic markets.

In the study conducted by Festa *et al.* (2016) the 4P´s model (product, price, promotion and price) was used as a basis to generate a marketing mix model for the dynamic marketing of wine based on 4E´s (expertise, evaluation, education and experience) in order to enhance consumer appreciation of wine and consequently increase wine sales. This example suggests that depending on the field it is possible to contextualise the (4P´s) marketing mix.

Festa *et al.* (2016) identified that if consumers have a deeper understanding of wine this "knowledge" can transform their wine consumption behaviour into a more aware consumption that appreciates wine culture. In the 4E´s model " 'knowledge' [performs] the role of glue, facilitator, and amplifier" (Festa *et al.*, 2016, p.1551). This suggests that knowledge is a barrier to consumers' appreciation of wine. Therefore, consumers' should have a prior understanding of wine in order for the 4E´s model to work. (See Figure 107).

Festa *et al.* (2016) explain the 4E´s model (expertise, evaluation, education and experience) as follows:

1. Expertise (Product): The product will be the consumer expertise, which will be acquired through a deeper knowledge of wine.

2. Evaluation (Price): In this case price will be the consumer evaluation of wine not only in monetary terms but also in other areas such as taste. This evaluation can also refer to a consumer judgement based on a better comprehension of wine's intangible values.

3. Education (Promotion): In this case promotion will be the further education of consumers in wine, this education refers to a better perception of wine due to a consumers' appreciation of wine. Since, …"wine consumer acculturation about essential concepts of tasting can be a source of great commercial potentiality for wine" (Festa *et al.*, p.1551).

4. Experience (Place): In this case place will be the consumer enriching experience of purchasing wine due to more aware consumer that appreciates wine culture.

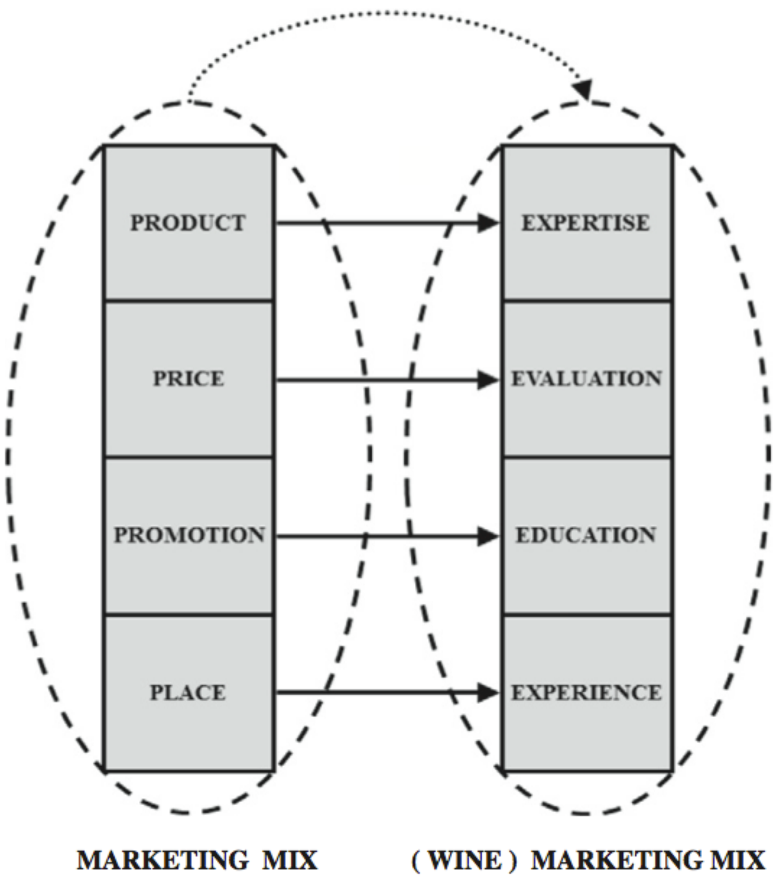



*Figure 107. A reconsideration of the (wine) marketing mix (Festa et al., 2016, p.1551).*

The 4E´s proposes a new way in which the consumer experience of drinking wine can be enhanced based on … "the knowledge that the customer can carry, apply, and develop" (Festa *et al.*, 2016, p.1550). This suggests that an increased understanding of wine culture leads to a better consumer experience of drinking wine due to an appreciation of wine's intangible values.

Moreover, …"from a social-marketing viewpoint spreading (wine) culture to inspire behavio[u]rs that are good, because customers are increasingly aware" (Festa *et al.*, 2016, p.1552). Therefore, the 4P´s model could be used for the generation of new marketing mix model that enables the promotion of intangible values, such as behaviours in the social marketing field.

In this research project, similarly to the study conducted by Festa *et al.* (2016, p.1551) it was identified that …" 'knowledge' [performs] the role of glue, facilitator, and amplifier". Since according to the findings of Chapter 6, the demographic cohort (Mexican females from 18 to 33 years old) need to be aware of:

- The negative effects that a high clothing consumption rate has on the environment.
- The negative environmental impact that metallic chemical additives in the textile dyeing activity can have on the environment.
- The difference between natural and synthetic dyes in order to make a shift in their purchasing decision making process

This (knowledge) awareness could lead not only to the acceptance of natural dyes from domestic food waste resources without metallic chemical additives but also in the longer term it may contribute towards more sustainable clothing consumption by individuals. Since according to the results from the online questionnaire (Chapter 6) if the demographic cohort becomes aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives such as lack of colour strength, standardisation and durability when compared to synthetic dyes.

## 7.4. The Behaviour change wheel – A facilitator of social marketing interventions

Michie, van Stralen and West (2011) propose the behaviour change wheel (BCW) as a systematic framework that facilitates the design of a social marketing intervention (See Figure 108). The BCW model consists of three layers. The first layer (green), corresponds to… "the three components that generate behaviour" (Michie, van Stralen and West, 2011, p.4). The second layer (red), corresponds to the nine types of interventions, which Michie, van Stralen and West (2011, p.1) define as… "coordinated sets of activities designed to change specified behaviour patterns". The third layer (grey), corresponds to the seven types of policies…"(actions on the part of responsible authorities that enable or support interven-tions)" (Michie, van Stralen and West, 2011, p.6).

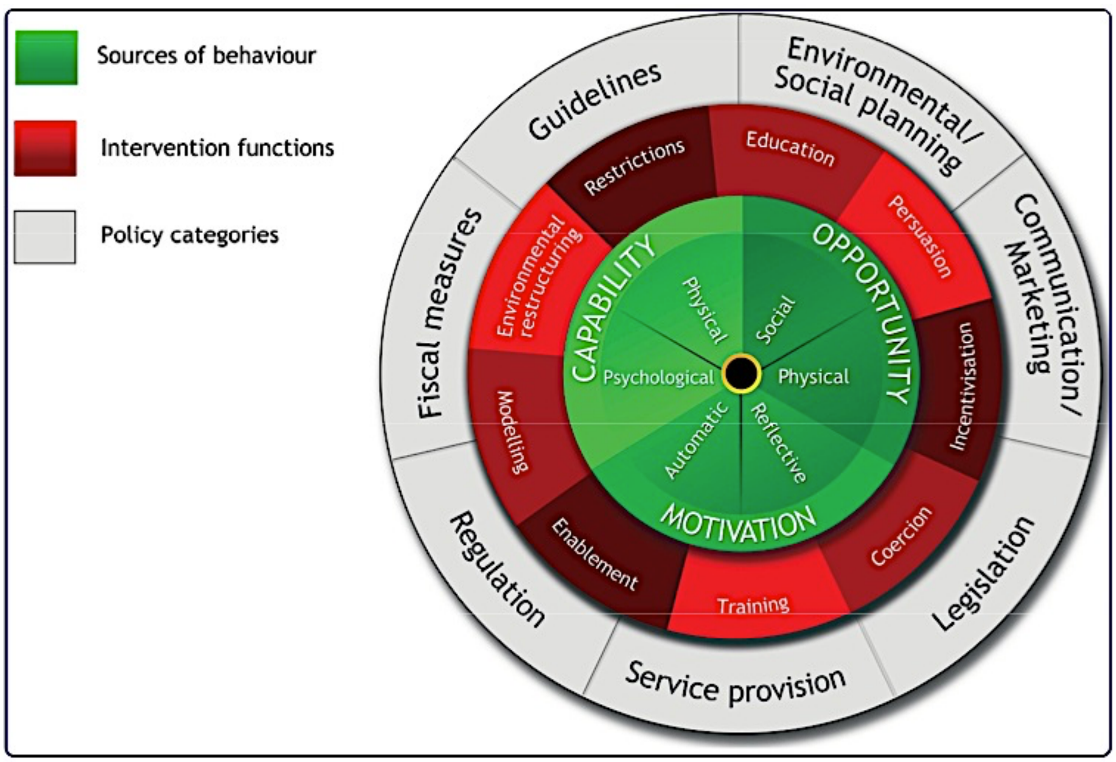



*Figure 108. The behaviour change wheel (Michie, van Stralen and West (2011, p. 7)*

Michie, van Stralen and West (2011) refer to the first layer as the "COM-B" System (capability, motivation and opportunity) and they describe the three components as follows:

- Capability: This refers to the individual´s ability (psychological, physical) to participate in a behaviour intervention. For example, having the knowledge and the skills needed to enable a behaviour change.

- Opportunity: This refers to the social and physical factors that facilitate the individual´s ability to succeed in a behaviour intervention. "The 'opportu-nity' component of the behavioural model is the context, so that behaviour can only be understood in relation to context" (Michie, van Stralen and West, 2011, p. 8-9). Similarly, Kotler and Zaltman (1971) point out, that in a social marketing intervention the target audience should be able to have an adequate channel (place) in which they can translate the motivation of meeting a social goal into action. Therefore, this suggests that, opportunity is the environment (place) that will enable a behavioural change, becoming a crucial asset for the effectiveness of a social marketing intervention.

- Motivation: This refers to the individual´s prompt to engage in a behavioural intervention. This motivation can be automatic or reflective. For automatic, they refer to emotional and impulsive responses and for reflective they refer to a response that involves an analytical thinking for decision-making.

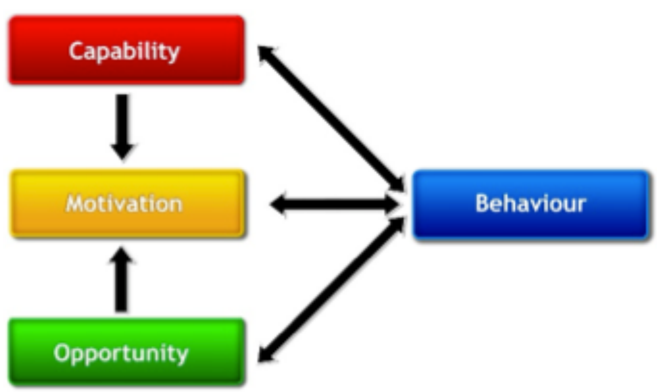



*Figure 109. The COM-B System- a framework for understanding behaviour (Michie, van Stralen and West (2011, p. 4)*

According to Michie, van Stralen and West (2011, p.4) “opportunity can influence motivation as can capability; enacting a behaviour can alter capability, motivation, and opportunity. This dynamic interaction is illustrated by the arrows (Figure 109) and suggests that capability and opportunity can influence motivation; however, a social marketing intervention, might be able to create a change in the three components: capability, motivation and opportunity. Therefore, this suggests that capability, motivation and opportunity are needed in order to generate a change in a behaviour pattern.

Michie, van Stralen and West (2011) point out that prior to selecting one or more intervention (activities) of the second layer of the BCW it is needed to identify the behaviour pattern that needs to be changed. This is done, by carrying out a context analysis of a specific target audience that will determine which component or components of the “COM-B” system need to be created or reinforced in order to achieve a behavioural change. “Because the target behaviour is part of a ‘system,’ a single intervention may have consequences for other parts of the system - these might work against sustainable change or in favour of it” (Michie, van Stralen and West, 2011, p.9). This suggests that the BWC framework can be used for designing a social marketing intervention to influence the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives. Although, the BCW framework has been used so far to support the conduction of public health interventions (Michie, van Stralen and West, 2011) it is in the same vein of transition design, which aims to create a social change via systematic design interventions (Tonkinwise, 2015).

Michie, van Stralen and West (2011, p.7) describe the nine interventions (activities) as follows:

- Education: “Increasing knowledge or understanding”. For example, providing information about the importance of wearing a seat-belt in order to promote the importance of and increase the amount of safe driving.

- Persuasion: “Using communication to induce positive or negative feelings or stimulate action”. This is exemplified in the work undertaken by Bimbo, a Mexican company of bakery products that encourages the physical activity of Mexican children from public and private schools through annual football tournaments named “Futbolito Bimbo” (Grupo Bimbo, 2019).

- Incentivisation: “Creating expectation or reward”. An example of this incentivisation activity is carried out by H&M, a clothing retailer in which individuals are rewarded with a 15% discount voucher (that can be used for purchases in H&M stores) for every bag of unwanted clothing they drop at the store to induce clothing recycling (H&M, n.d.).

- Coercion: "Creating expectation of punishment or cost". This is evident in the case of Morrisons, a United Kingdom (UK) supermarket chain that increased the cost of plastic bags to 30p to reduce plastic pollution by encouraging their reuse (Morrisons, 2020b).

- Training: "Imparting skills". For example, training students prior to their use of a laboratory facility in order to increase safe practices.

- Restriction: This refers to making use of rules in order to minimise the opportunity of individuals engaging in a behaviour that can affect their personal wellbeing. This restriction intervention can be illustrated in the action taken by, Morrisons, a supermarket chain in the UK in which prior to selling alcohol, ensures that consumers are over 18 years old in order to restrict alcohol consumption only to adults with their "Challenge 25" policy (Morrisons, 2020a).

- Environmental restructuring: "Changing the physical or social context". An example of this intervention is the action taken by PureGym, a gym chain in the UK that due to COVID-19 has changed the physical environment of their gyms in order to provide a safer training environment to their customers. PureGym has installed hand sanitasing stations, so consumers can sanitise their hands often, and has re-arranged the location of equipment/training stations in order to keep a safe distance between customers (PureGym, 2020).

- Modelling: "Providing an example for people to aspire to or imitate". This is exemplified in the work undertaken by the World Health Organisation (WHO) which due to COVID-19, provides infographics showing the appropriate way to use a fabric mask safely (World Health Organisation, n.d.).

- Enablement: “Increasing means/reducing barriers to increase capability or opportunity”. An example of this enablement activity is children day-care facilities offering childcare to support working mothers.

The third layer of the BCW model corresponds to the seven policies that could support the intervention or interventions, Michie, van Stralen and West (2011, p.7) describe them as follows:

- Communication/ marketing: “Using print, electronic, telephonic or broadcast media”. An example of this, is the social media global campaign “#Here for you” that Instagram (social media application) launched in order to raise awareness about the importance of mental health (Mckelvey, 2017).

- Guidelines: “Creating documents that recommend or mandate practice. This includes all changes to service provision”. This is exemplified in the work undertaken by the National Institutes of Health (NIH) which provides up to date electronic guidelines of COVID-19 treatment recommendations to health care providers and patients (NIH.GOV, 2020).

- Fiscal: “Using the tax system to reduce or increase the financial cost”. For example, the following countries: Armenia, Azerbaijan, Belarus, Botswana Colombia, Gabon, Ghana, Indonesia, Moldova, Mongolia, Montenegro, Nigeria, Philippines, Sierra Leone, Tonga, and Ukraine have increased the tax on tobacco in order to reduce its consumption and improve public health (worldbank.org, 2018).

- Regulation: “Establishing rules or principles of behaviour or practice”. An example of this, is the action taken by the country of Netherlands, in which spirits and beverages that contain more than 0.5% of alcohol must be sold only to individuals who are eighteen years or older (Government.nl, n.d.).

- Legislation: “Making or changing laws”. For example, according to the article 170 of Mexican Legislation, working pregnant women have the right of having a work break six weeks before and six weeks after giving birth (El Congreso de los Estados Unidos Mexicanos, 1970).

- Environmental/ social planning: “Designing and/or controlling the physical or social environment”. This is exemplified in the work undertaken by Age UK London´s environmental policy, which aims to protect the environment during their charity work, through actions such as: recycling and reusing materials and energy conservation through a minimal consumption of water, energy and electricity supplies, amongst others (Ageuk.org.uk, n.d.).

- Service provision: “Delivering a service”. According to Tamayo (2017) The Mexican Social Security Institute (Instituto Mexicano del Seguro Social - IMSS) has approved a resolution in which companies in Mexico can have an agreement with the IMSS in order to offer children day care service in their facilities. This can be an example of a service provision that companies can offer to their employees.

## 7.5. The COM-SM model – Facilitating the selection of social marketing interventions

Tapp and Spotswood (2013) created the COM-SM model based on the "COM-B" system proposed by Michie, van Stralen and West (2011) in order to improve the guidance towards the selection of a social marketing intervention, depending on a deficit on one or more of the "COM-B" system components (capability, opportunity and motivation). According to Tapp and Spotswood (2013) identifying a behaviour pattern that is needed to change from a specific target audience and providing activities (interventions) that can support a behaviour change is fundamental when designing a social marketing intervention. Tapp and Spotswood (2013) claim that a social marketing model must provide two things in order to be successful:

1. The flexibility to provide personalised behaviour change interventions for a specific target audience.
2. The reflection of the entire possible social marketing interventions that could support a specific behaviour change.

Tapp and Spotswood (2013) point out, the example of a social marketing intervention in which the social goal was to lower the speed limit of a specific city. The authors identified the 4P´s as follow:

- The product, which in this scenario were the benefits that driving more slowly would create.
- The price, which was the psychological costs, such as the self-control of the driver to not increase their driving speed.
- The place, which was the new locations in which the driving limits, would be placed.
- The promotion, which would be focused on the awareness of the new speed limits.

This example suggests that the 4P´s model was not able to provide a design model in which: The driver could find motivation through direct benefits that their change in driving speed would bring and the lack of a channel in which the first adopters could transform their self-control regarding driving speed into an action by others (Tapp and Spotswood, 2013). Furthermore, Tapp and Spotswood (2013) argue that the 4P´s approach in complex scenarios such as social ones is not able to provide the information necessary to understand the problem and consequently provide a design intervention - solution. Therefore, they point out that the COM-SM model facilitates the thinking process of selecting the intervention needed for a specific behaviour change in a social marketing arena. This suggests that for a social marketing design intervention the 4P´s need to be supported by other models, such as the BCW framework and the COM-SM model.

Tapp and Spotswood (2013) propose “design clusters” as a feasible management tool that could help in the identification of the activities needed for a social marketing design intervention. See Figure 110. Moreover, Tapp and Spotswood (2013) point out that depending on the social goal, one or a mix of the design clusters could be selected.

| |
|---|
| PROMOTION/EDUCATION |
| NUDGE TECHNIQUES |
| REWARDS AND EXCHANGES |
| SERVICE AND SUPPORT |
| RELATIONSHIPS AND COMMUNITY |

*Figure 110. Simple clusters of social marketing activity adapted from Tapp and Spotswood (2013)*

Tapp and Spotswood (2013) describe the design clusters as follows:

- Promotion: This strategy refers to communication techniques.
- Nudge techniques: This strategy refers to the activities that give a non-conscious reward towards the target audience in exchange for a behavioural change.
- Rewards and exchanges: This strategy refers to the activities that give the target audience a reward in exchange for a behavioural change, in contrast to the nudge techniques this exchange is conscious.
- Service and Support. This strategy refers to the re-design of services in order to support a social goal.
- Relationships and community. This strategy refers to long- term multidisciplinary activities, in which different fields generate an intervention in conjunction with the target audience.

According to Tapp and Spotswood (2013) their COM-SM model aims to support the critical thinking process, during the design of the social marketing intervention, facilitating the selection of the strategy needed. Tapp and Spotswood (2013) point out the relationship between the strategy and the effort needed towards a behaviour change (See Figure 111). However, Tapp and Spotswood (2013) add, that this hierarchal effort could change depending on the behaviour change pattern in a specific context.

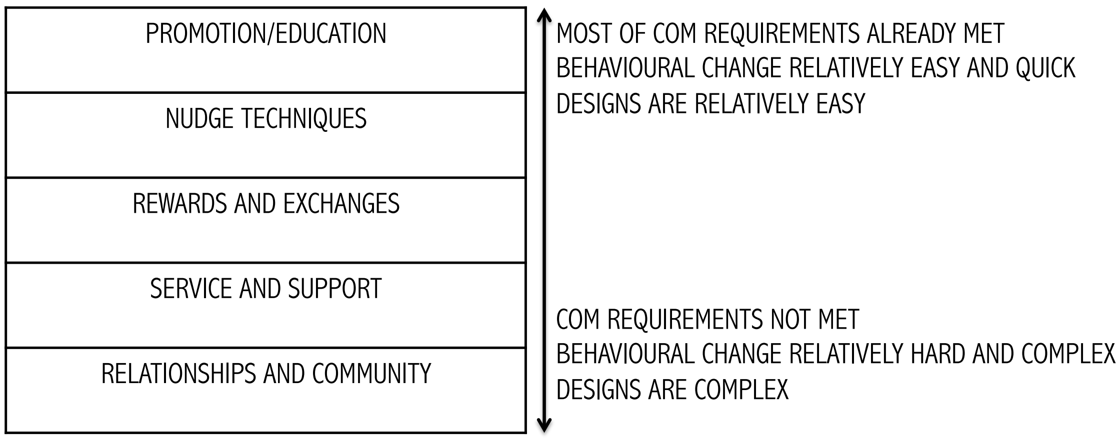



*Figure 111. A hierarchy of effort in social marketing designs based on the version of Tapp and Spotswood (2013)*

Tapp and Spotswood (2013) describe the hierarchy effort and the relationship between the COM-SM model and design clusters as follow:

- Promotion/Education: This strategy should be considered when the target audience already have the capability and opportunity for a behavioural change, but an increase in motivation is needed by increasing the awareness of the target audience about a specific topic through the promotion of the behavioural issue. According to Michie, van Stralen and West (2011) there are two types of motivation: automatic and reflective. As mentioned earlier, reflective motivation is prompted through analytical thinking (Michie, van Stralen and West, 2011). Therefore, this suggests that by increasing the awareness of the target audience about a specific topic, the target audience will be motivated through reflective analysis.

- Nudge techniques: This strategy should be considered when the target audience already have the capability to influence a behaviour change but a twist is required to the opportunity and motivation.

- Reward/exchanges: This strategy is at the middle of the effort hierarchy since the target audience requires a stronger motivation in order to change behaviour.

- Service and Support: This strategy is needed to apply when the target audience do not have either the skills or the opportunities, or indeed lack both facets needed to change a behaviour, although they have the motivation to change.

- Relationship and community: This strategy requires a long-term action, since there is a lack of: capability, opportunity and motivation.

In contrast to Michie, van Stralen and West (2011) Tapp and Spotswood (2013) propose design clusters instead of interventions and policies. However, Tapp and Spotswood (2013) provide a clear example on how to use a design cluster depending on a deficit on the "COM-B" system components. Due to this, the social marketing design intervention for the acceptance of natural dyes from domestic food waste resources without metallic chemical additives will consider both the interventions and policies of the BCW framework and the design clusters of COM-SM model.

## 7.6. The creation of a social marketing model that could facilitate the acceptance of natural dyes from domestic food waste resources without metallic chemical additives

Although Michie, van Stralen and West (2011) propose the behaviour change wheel (BCW) as a systematic framework to facilitate the design of a social marketing intervention, the framework fails to provide a guidance to link a deficit in the "COM-B" system components (capability, opportunity and motivation) towards the interventions (activities) that can support a behaviour change. This is the reason why; this model incorporates the design clusters and the guidance of the COM-SM model developed by Tapp and Spotswood (2013) to facilitate the selection of the intervention or interventions needed to influence the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. Moreover, the 4P´s developed by Kotler and Zaltman (1971) will be used in this model to strengthen the creative thinking process for a social marketing design intervention. Furthermore, the model will consider the intervention and policies proposed by Michie, van Stralen and West (2011) in order to cover all the possible alternatives to support the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. See Figure 112. The resultant novel model proposes the following steps below:

1. Identify the behaviour change needed carrying out a contextual and target audience analysis.

2. Determine the marketing mix (4P´s) of the study.

3. Determine which component or components of the "COM-B system" (capability, opportunity and motivation) proposed by Michie, van Stralen and West (2011) needs to be created or reinforced in order to achieve a behaviour change .

4. Link the deficit of the "COM-B" system component or components to a design cluster, following the guidance proposed by Tapp and Spotswood (2013).

5. Consider additional interventions and policies proposed by Michie, van Stralen and West (2011) in the BCW framework in order to cover all the possible alternatives to support the behaviour change.

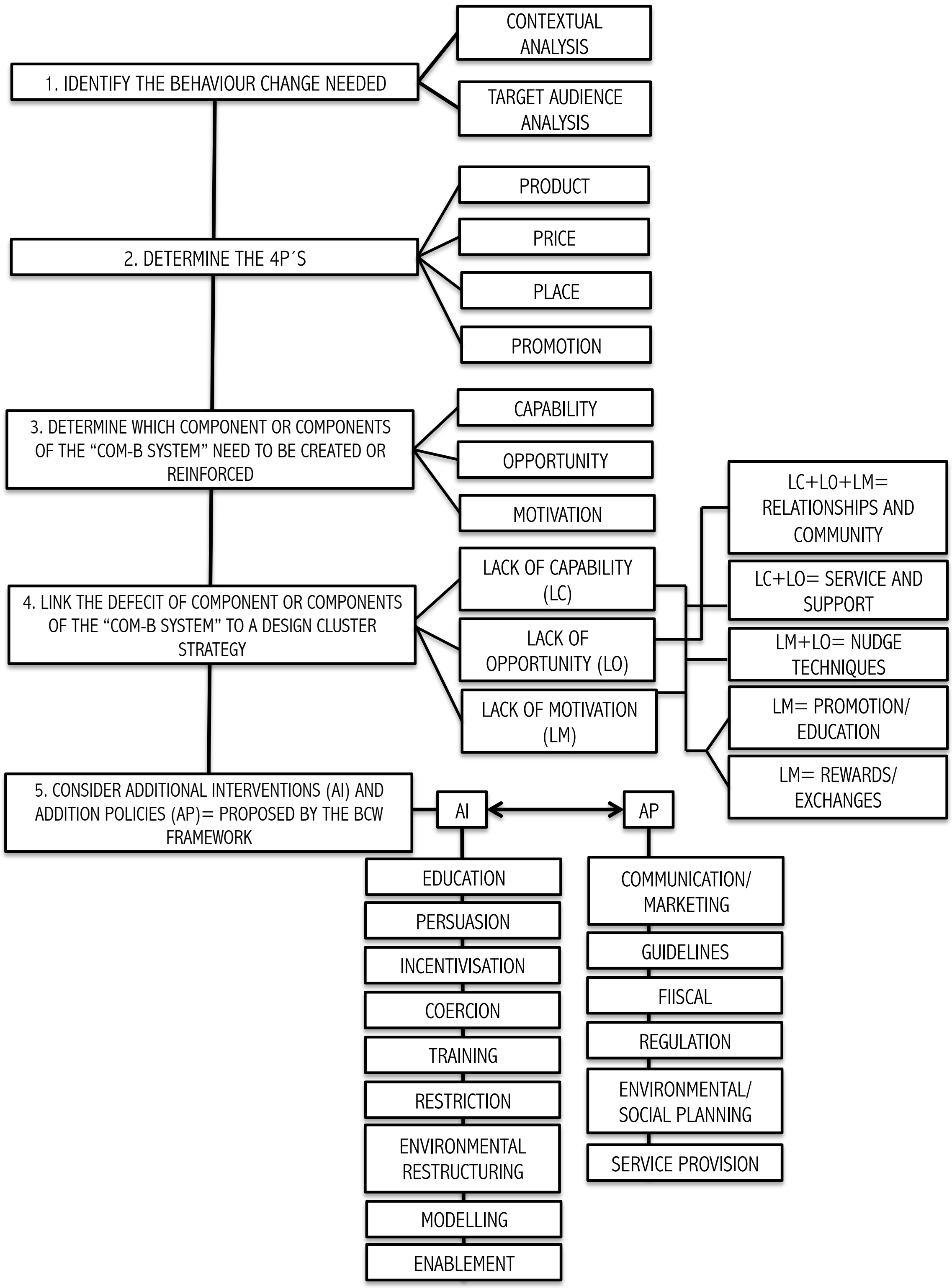



*Figure 112. SM - Model*

## 7.7. Discussion of the model in action

1. Identify the behaviour change needed by carrying out a context analysis of the target audience.

- Context Analysis: The country of Mexico.

The main problem identified within Mexico's primary economic sector, agriculture activity is that a considerable amount of food ends up in waste becoming a pollutant within Mexico´s landfills (Pérez, 2015). Moreover, Mexico´s waterways are being affected by the textile industry's wastewater discharge (Arellano Aguilar, 2018). Therefore, based on these two main issues, this study investigated the demographic response towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. However, as mentioned in Chapter 4 (Section 4.1.5 - Discussion of mordants and the negative impacts of their utilisation) not all the metallic chemical additives used in textile dyeing have the same impact on the environment. Therefore, within the context of this study the following metal salts will be considered as polluting substances (chromium, tin, copper). The focus of this study considered whether rather than using damaging metallic chemical additives that affect waterways adversely, instead consumers are open to accept natural dyed textiles with limited colour strength and colour fastness, embracing the limitations of the process.

- Target Audience Selection: Mexican females from 18 to 33 years old.

This target demographic was selected because this demographic group has more access to social media. According to (INEGI, Secretaría de Comunicaciones y Transportes, Instituto Federal de Telecomunicaciones, 2019) Mexico has 74.3 million of Internet users, from which 51.5 % corresponds to females. Furthermore, the most active Internet users in Mexico correspond to the age range of 25 to 34 years (INEGI, Secretaría de Comunicaciones y Transportes, Instituto Federal de Telecomunicaciones, 2019). The data about social media access and Internet activity was important because the analysis of this target audience was conducted through an online questionnaire. Therefore, these factors suggested that a higher engagement could be provided in order to conduct the online questionnaire.

- Behaviour change: Social acceptance. In this case the model aims to influence the social acceptance of the target audience (Mexican females from 18 to 33 years old) towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives

2. Determine the marketing mix (4P´s) of the study.

- Product: The social acceptance of natural dyes from domestic food waste resources without metallic chemical additives. According to Kotler and Zaltman (1971) in social marketing, the product becomes the social idea that benefits the target audience for a greater social good.

  Price: According to Kotler and Zaltman (1971) this variable refers to all the losses that would be involved not only during the purchase but also through the post-purchase experience of a social product. Therefore, this suggests that this variable also refers to the barriers towards the market adoption of natural dyestuffs from domestic food waste resources without metallic chemical additives. In this case the barriers identified in Chapter 4, were the lack of colour strength standardisation and durability of *Allium cepa* derived natural dyestuffs applied without metallic chemical additives when compared to synthetic dyes performance. In addition, the psychological costs could be the self-control of the target audience to accept a garment that does not provide brighter colours and uses domestic food waste as a natural dye resource. Since according to the results from the online questionnaire, which are discussed in Chapter 6. The majority of the participants 51.94% (149 participants) indicated their preference towards the brighter colour palette in which *Allium cepa* was used as a natural dyestuff along with chemical additives (stannous chloride, stannic chloride, copper sulphate and ferrous sulphate) in order to improve the natural dye colour strength. However subsequently 129 of these participants changed their mind when they were informed of the negative impacts that metallic chemicals have on the environment and water pollution in particular. In addition, the majority of the respondents 80.82% indicated that the motivation for accepting food waste as natural dyeing resource was the feeling of creating a positive impact on the environment. Therefore, this suggests that providing information about environmental impact is important when aiming for the target audience to accept natural dyes from domestic food waste resources without metallic chemical additives.

- Place: Co-design environment. According to Kotler and Zaltman (1971) this variable in social marketing refers to adequate channels in which the target audience can translate its motivation of meeting a social goal into action. According to the results from the online questionnaire, which are discussed in Chapter 6. The majority of the respondents 75.48% (234 participants) indicated that if they were able to participate in the design process of a garment (co-design) their wearing experience would change. An additional open question was asked to these 75.48% in order to know why their wearing experience would change (How being part of the design process of a garment would change their wearing experience?) 95 participants indicated that being part of the colour design of their garment would change their wearing experience since they would personalise the garment and 87 participants indicated that being part of the colour design of their garment would make them feel part of the garment. In addition, according to the results from the online questionnaire, co-design can enable the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. Only 4.51% (14 participants) indicated that they do not like the idea of using food waste to dye their clothing. However subsequently ten of these participants indicated that they would accept the idea of natural dyes from food waste resources, if they become part of the design process and part of the colour design process. Therefore, this suggests that co-design will be the channel (flexible environment) in which the target audience can translate their acceptance of natural dyes from domestic food waste resources without metallic chemical additives into action by becoming co-designers of their own natural dyed garments.

- Promotion: DIY re-dye activity, and customisation. According to Kotler and Zaltman (1971) this variable refers to the tactics that will make the product desirable to the target audience. Therefore, this suggests that promotion refers to the identification of tools that could influence the attraction of the target audience towards the product.

  According to the results from the online questionnaire, which are discussed in Chapter 6. In relation to the DIY- Re-dye activity, the majority of the respondents 82.58% indicated that they would renovate or re-dye a garment they no longer use in order to use it again. Moreover, 62.58% of the respondents indicated that if a clothing store stocking naturally dyed garments offers them the possibility of sending recipes to re-dye their clothes at home, once the previous natural colour fades using domestic food waste and without metallic chemical additives, this would positively influence their purchase decision. In addition, when the participants were asked if they could change the colour of their favourite clothing, being aware no negative effects are imparted onto the environment, the majority 74.19% indicated that they would constantly change the colour of their favourite piece. Therefore, this data supports the notion that a DIY activity in which the target audience could re-dye their garments at home is a tool that could attract towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

With regards to customisation, the majority of the respondents 62.58% are interested in the customisation of their garments. In addition, the majority of the respondents, 55.16% said that colour is very important when buying clothing. This suggests that for the participants colour plays a crucial role in clothing purchases. Therefore, if colour can be customised, this could consequently lead to a higher engagement between this demographic group and their clothing. As discussed in Chapter 5, customisation can enable users to express their personal identity into an object (Haines-Gadd *et al.*, 2018). In addition, Prahalad and Ramaswamy (2004) argue that, in the emergent economy the competitive advantage of a company relies on the consumer experience of being involved in the creation process of their product/service. Therefore, this suggests that customisation could be a supportive tool that could not only influence the attraction of the target audience towards the product, but also to enhance the co-design channel allowing the target audience to not only translate their motivation into action but also to transfer personal narratives to their natural dyed garment.

3. Determine which component or components of the "COM-B" system (capability, opportunity and motivation) proposed by Michie, van Stralen and West (2011) needs to be created or reinforced in order to achieve a behaviour change .

- Components that need to be reinforced in order to achieve the acceptance of natural dyes from domestic food waste resources without metallic chemical additives: Capability, opportunity and motivation

- Capability: According to Michie, van Stralen and West (2011) this behavioural component refers to the individual´s ability (psychological, physical) to participate in a behaviour intervention. In this research project, according to the analysis conducted in Chapter 6, it was identified that the target audience require knowledge (education) in the following topics:

- The negative effects that a high clothing consumption rate has on the environment.
- The negative environmental impact that metallic chemical additives in the textile dyeing activity can have on the environment.
- The difference between natural and synthetic dyes in order to make a shift in their purchasing decision making process.

Since, the majority of the respondents, 57.70 % buy clothing one to two times per month. This high frequency highlights the need to create awareness amongst the demographic of this study with regards to the effects that their high clothing consumption rate has on the environment. Moreover, 80.00% of the respondents do not consider the environmental consequences when purchasing clothing and the companies who are pro-environment do not have a great impact on their purchase decisions, since for the majority (57.4%) of the respondents this factor influences their decisions only a little. Furthermore, the majority of the respondents, 68.71% have indicated that they do not know the difference between natural and synthetic dyes. This suggests that providing information about the differences between natural and synthetic dyes is crucial when aiming to make a shift in purchasing decision making processes within this specific demographic. In addition, when the survey participants were asked about the acceptance of natural dyes performance without chemical additives, 77.10% indicated that they would wear naturally dyed clothing without metallic chemical additives added, being aware they have a less negative environmental impact, but knowing that its colour may fade quickly. Therefore, this validates the hypothesis of the study which is the following: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives, such as lack of colour strength, standardisation and durability when compared to synthetic dyes. Therefore, education in these specific themes becomes a central aspect in order to develop a social marketing strategy that could raise environmental awareness and consequently achieve a successful social marketing intervention model for the demographic of this study.

- Opportunity. According to Michie, van Stralen and West (2011) this behavioural component refers to the social and physical factors that facilitate the individual´s success in a behaviour intervention. Similarly, Kotler and Zaltman (1971) point out, that in a social marketing intervention the target audience should be able to have an adequate channel (place) in which they can translate their motivation of meeting a social goal into action. Therefore, this suggests that, opportunity is the environment (place) that will enable a behavioural change, becoming a crucial asset for the effectiveness of a social marketing intervention. In this case opportunity and place from the marketing mix refer to the co-design environment as previously discussed on page (255).

- Motivation. According to Michie, van Stralen and West (2011) this behavioural component refers to the individual´s automatic or reflective prompt to engage in a behavioural intervention. In this case the model will aim for a reflective motivation enabled via analytical thinking for a decision-making process around the acceptance of natural dyestuffs from domestic food waste resources without the addition of metallic chemicals through the obtention of the target audience's capability (education) in the themes previously discussed in pages (256,257). Since, according to Michie, van Stralen and West (2011) capability can influence motivation.

4. Link the deficit of the "COM-B system" component or components to a design cluster, following the guidance proposed by Tapp and Spotswood (2013).

- Design cluster: Relationship and community.

According to Tapp and Spotswood (2013) this design cluster strategy is selected for a social marketing intervention when there is a lack of: capability, opportunity and motivation. Therefore, this relationship and community strategy was selected because according to the data collection and subsequent analysis of the online questionnaire conducted with Mexican females from 18 to 33 years old which can be found in Chapter 6, it was identified that there is a lack of: capability, opportunity and motivation in order to influence the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. Moreover, according to Tapp and Spotswood (2013, p.216) the relationship and community strategy refers to …" "[l]ong term, complex in nature, and interwoven with other professions, the use of social marketing here is typically located in specific communities, and may for example be part of a co-creation philosophy in which citizens have an active role in generating solution". This suggests, that in order to conduct a relationship and community strategy, the following aspects should be considered:

- The selection of a specific context.
- The selection of a target audience.
- The exploration of strategies in multidisciplinary fields that could support a behaviour change.
- The consideration of the target audience as an active stakeholder in the intervention.
- The acknowledge that the model would require a long-term action in order to be adopted.

In this social marketing intervention model, Mexico was selected as the context and the target audience are Mexican females from 18 to 33 years. In addition, both chemistry and design fields were explored in order to understand the performance of natural dyes without metallic chemical additives and subsequently the design field was explored in order to identify the strategies that could enhance the social acceptance of the target audience towards the utilisation of natural dyes from domestic food waste resources without metallic chemical additives. Moreover, co-design was selected as the adequate channel (environment) as discussed in page (255) in which the target audience could translate their acceptance of natural dyes from domestic food waste resources without metallic chemical additives into action by becoming co-designers of their own natural dyed garments. Furthermore, this model would require a long- term action, this means that the model does not recommend one solution but rather a systematic process change in which different steps would need to be addressed in order to adopt a behaviour change of accepting the performance of the natural dyes from food waste resources without the addition of metallic chemical additives. This systematic process is in the same vein of transition design, in which complex societal problems are addressed through a deep understanding of the problem and all the stakeholders are involved within, through a holistic systematic approach process (Tonkinwise, 2015; Irwin, 2018).

5. Consider additional interventions and policies proposed by Michie, van Stralen and West (2011) in the BCW framework in order to cover all the possible alternatives to support the behaviour change.

- Intervention activity: Modelling

According to Michie, van Stralen and West (2011, p.7) this modelling activity refers to "[provide] an example for people to aspire to or imitate". According to the results from the online questionnaire, which are discussed in Chapter 6. Almost all the participants (99.7%) are familiar with the "influencer" marketing technique and it has an impact upon the clothing purchase decisions of 52.90% of the respondents. In addition, as discussed in Chapter 6, by Borden (2019), nowadays influencers have great power on the purchase decisions of consumers, since social media is a channel that 74% of people use before making a purchase; this is the reason why companies are approaching influencers in order to work together (Borden, 2019). The content creation of influencers is a powerful way to attract and recommend a specific brand's product to possible consumers, since influencers guide the purchase decision of almost 50% of the consumers (Borden, 2019). Moreover, according to Borden (2019) the marketing technique of social media influencer is expected to gain $10 billion during this year. Therefore, this suggests that Mexican influencers could enhance the acceptance of Mexican females from 18 to 33 years old towards natural dyes from domestic food waste resources without metallic chemical additives.

- Policy: Fiscal

According to Michie, van Stralen and West (2011, p.7) this policy activity refers to "[use] the tax system to reduce or increase the financial cost". In this scenario Mexico´s government could increase the price of the following metal polluting salts: chromium, tin, copper. As mentioned in Chapter 4 (Section 4.1.5- Discussion of mordants and the negative impacts of their utilisation) not all the metallic chemical additives used in textile dyeing have the same impact on the environment. Therefore, within the context of this study chromium, tin, copper will be considered as polluting substances. As mentioned in page (245) this fiscal policy has been used in sixteen countries in order to reduce their tobacco consumption by increasing its cost (worldbank.org, 2018). Therefore, this suggests that if Mexico increases the price of chromium, tin and copper, this could help to reduce their consumption in the textile dyeing activities and consequently improve Mexico´s waterways pollution.To reinforce this position, Mexico could also consider adding import duties to chromium, tin and copper providing this would not disrupt other manufacturing where these chemicals are used, that benefit the economy, but do not harm the waterways and environment.

## 7.8. Validating the model tools - DIY domestic natural dyeing workshop and questionnaires

As mentioned in section 1.3, the expected outcome of the study included the validation of the strategic tools identified for the development of the novel model such as: Co-design, customisation and DIY re-dye activity. Since these tools were theoretically explored, it was not possible to carry out the intended practical validation because of the COVID-19 pandemic. Therefore, this section includes the following subsections:

- The rationale behind this workshop and its relationship with the dyeing experiment conducted including an explanation of the choice of new and un-treated cotton.

- A pilot version of the DIY domestic natural dyeing workshop stages based on referenced action research of the introductory exercise proposed by Kadolph and Casselman (2004).

- An explanation detailing the pilot version of the workshop in two modalities: Face to face and online delivery.

- An explanation of how data will be collected from the pilot DIY domestic natural dyeing workshop.

- An explanation of how the DIY domestic natural dyeing workshop could be used in order to identify an initial behaviour change from the demographic cohort in the short-term (This includes a post-questionnaire that can be found in Appendix 4).

### 7.8.1. Rationale behind this workshop and its relationship with the dyeing experiment conducted

The DIY domestic natural dyeing workshop may have played a vital role in bringing about the validation of the novel model strategies (Co-design, customisation, DIY re-dye activity). Since the findings from the online questionnaire indicated the following:

94% of the respondents have indicated that they would be likely to buy clothing that has been dyed with food waste from fruits and vegetables without metallic chemicals. However, 14 participants indicated that the reason why they would not be likely to buy clothing that has been dyed with food waste is because they do not like the idea of using food waste to dye their clothing, the majority of these respondents (10) said that they would change their mind if they become part of the design and colouration process of the dyed garment. In addition, when the participants were asked if they have changed the colour of a garment or if they have dyed a garment, the majority 64% indicated that they haven't. Interestingly, 83% have indicated that they would renovate or re-dye a garment they no longer use in order to use it again.

In addition, when the following question was asked to the respondents: If a clothing store stocking naturally dyed garments offers you the possibility of sending recipes for you to re-dye your clothes at home, once the previous natural colour fades using food waste and no added chemicals would that influence your purchase decision? 63% of the respondents indicated that this would positively influence their purchase decision. Moreover 75% of the respondents indicated that being part of the design process of a garment would change their wearing experience. From this 75%, the majority indicated that this change will be attributed to customisation.

Therefore, these findings, while preliminary, suggest that the target demographic would be likely to participate in a DIY workshop in which they could be part of the design and colour customisation process by renovating a personal garment that is no longer used through a domestic dyeing activity using their kitchen waste as natural dyestuffs. However, this consumer focus may raise intriguing questions regarding the new and untreated cotton used to conduct the dyeing experiments for this study. However, the role of the dyeing experiments was to gain experiential knowledge with regards to the performance of natural dyes from domestic food waste exemplified by *Allium cepa* skin without metallic chemical additives in a substrate in this case cotton due to the importance for the context of this study (further details about the importance of cotton in Mexico can be found in section 1.1.3 and 4.1.6). The undertaking of the dyeing experiment enabled the identification of the limitations of natural dyes without metallic chemical additives in wearable textile applications such as lack of colour strength, standardisation and durability when compared to synthetic dyes. These limitations provided the opportunity to explore the acceptance of natural dyes from domestic food waste resources without metallic chemical additives in Mexico, challenging what has been considered as fundamental in the textile dyeing field namely colour uniformity and reproducibility. Although, the use of new and untreated cotton is linked to the workshop activity by motivating the target demographic to use a personal garment that is no longer used, to conduct a DIY domestic natural dyeing workshop, it is important to consider that this is only to validate the strategies that the novel model proposes. Since, the focus of this study is not on the choice of cotton but on educating and influencing a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives though a social marketing intervention model that this study proposes.

### 7.8.2. Planning the pilot of a DIY domestic natural dyeing workshop

This pilot workshop is based upon an action research introductory exercise proposed by Kadolph and Casselman (2004).

1. Set up a work area and prepare the materials needed:

- Choose a place to carry out the DIY workshop activity in which the surfaces are suitable for the activitiy to be carried out or where the working space can be protected with plastic sheeting or similar.

- Materials:
  - A second-hand garment, or a personal garment that is no longer used in order to give it a second life. The textile selected should be made of 100% natural fibres, which could be from vegetable or animal origin (check the garment tag). The most common are cotton, silk, wool and linen. In addition, the textile should be clean and dry before starting the dyeing activity.

  - Dyestuffs: domestic food waste from your home kitchen. Colourful options: brown/purple onion skins, hibiscus, beetroot skin, purple cabbage, red bell pepper, carrot skin, orange skin, mint, spinach, etc.
  - A clean self-sealing plastic bag
  - A cooking pot.
  - A table spoon.
  - A cup (235 ml).
  - Rubber bands (minimum two).
  - A Liquid mordant: Vinegar, fruit juice, tea (choose only one).
  - A dry mordant: Table salt, baking powder with alum, baking soda (choose only one).
  - A spray bottle.

  *Optional: A non-rebound hammer or kitchen pestle if you have one.


*Figure 113. Step 1- Set up a work area and prepare the materials*

2. Fill 1/2 of a cup with the liquid mordant selected and pour into the spray bottle then spray it over the garment (in this case vinegar was utilised).

Figure 114. Step 2 - Spray the liquid mordant over the garment

3. Apply the dyestuffs over the garment ( if you have a kitchen pestle or non-rebound hammer use it to press your dyestuffs). in this case purple onion skins, red bell pepper, beetroot and carrot skins were available.

*Figure 115. Step3 - Apply the dyestuffs over the garment*

4. Fill two tablespoons with the selected dry mordant and spread it all over the textile (in this case table salt was available).

*Figure 116. Step 4 - Spread the dry mordant over the garment*

5. Fold tightly the garment ( if a kitchen pestle or non-rebound hammer are available use it to press your dyestuffs while you fold the garment).

*Figure 117. Step 5 - Fold tightly the garment*

6. Wrap the garment as tightly as possible using rubber bands and place it in a self-sealing plastic bag, once inside remove any excess air.

*Figure 118. Step 6 - Wrap the garment using rubber bands*

*Figure 119. Step 6 part II - Place the garment in a self-sealing plastic bag*

7. Place the self-sealing plastic bag in a pot of water and bring to the boil (the plastic bag should be perfectly sealed). Let the item boil for 15 minutes, then place the lid on the pot for 10 minutes, after this turn off the heat and allow to rest in the water for a period of 1 hour.

*Figure 120. Step 7 - Place the self-sealing plastic bag in a pot of water and bring to boil*

8. Unwrap the garment, remove the dyestuffs and let it dry at ambient temperature for one week away from direct sunlight hanging on a plastic hook. After this, rinse the textile under cold tap water for 1 minute and then allowed to dry under ambient conditions.


*Figure 121. Step 8 - Unwrap the garment and remove the dyestuffs*


*Figure 122. Step 8 Part II - Let the garment dry for one week away from direct sunlight hanging on a plastic hook*

### 7.8.3. Conducting the pilot version of the workshop in two modalities: Face to face and online delivery

A flyer with the following title: " FREE-DIY domestic natural dyeing workshop for Mexican females from 18 to 33 years old" could be posted through Instagram. The Instagram flyer (selected because the Instagram App is highly popular with the target demographic) would indicate that participants could choose from two modalities: Face to face and online delivery and contain a contact email in order to enable the interested participants to send an email to the workshop facilitator and a caption with the following: Please indicate in the email which modality you would be interested to participate in. Once the participants make contact, an invitation will be sent back and depending on the modality selected the information will vary as follows:

- Face to Face modality: This invitation would contain the address, date, time and the following information: "Please bring a personal garment that is no longer used in order to give it a second life. The textile selected should be made of 100% natural fibres, which could be from vegetable or animal origin (check the garment tag). The most common are cotton, silk, wool and linen. The garment should be clean and dry. In addition, please bring domestic food waste from your home kitchen. Colourful options: brown/purple onion skins, hibiscus, beetroot skin, purple cabbage, red bell pepper, carrot skin, orange skin, mint, spinach, etc. This domestic waste will be used as dyestuffs and would be colocated on one table in order to increase the colour palette options of the participants by sharing the collected domestic food waste with all the participants. The rest of the materials needed would be provided by the workshop facilitator".

- Online delivery: This invitation would contain the zoom details and the list of materials needed in order to prepare everything in advance (See section 7.8.2).

The conduction process for both modalities would be the same. Once the meeting starts, the workshop facilitator will guide the process step by step as shown in (section 7.8.2) and will ask the participants to first see how each step should be done and then will ask for the participants to take action.In addition, at the end of the workshop the assistant would send a link through their emails and the facilitator would invite the participants to answer a questionnaire related to the workshop activity ( See Appendix 3).

### 7.8.4. Data collection of the pilot DIY domestic natural dyeing workshop

The presentation about natural dyes from food waste that was delivered to Greenhead college students and teachers in December 2019 in United Kingdom (UK) served as a pilot test in order to provide useful technique improvements to the initial design questionnaire that was later conducted to Mexican females from 18 to 33 years old in order to probing participant's responses to the acceptance of natural dyes from domestic food waste resources without metallic chemical additives along with the ideas of co-design, customisation and DIY activities.

This is the reason why; a structured questionnaire will be used (see Appendix 3) as the qualitative research instrument to collect data with regards to the participant's workshop experience in order to use the data findings as opportunities to explore how the workshop experience could be improved. Since, as mentioned in section 3.1 by Biddix (2018, p.76) "Qualitative research seeks to explore and represent reality as it exists in context and to enlighten the ways in which individuals experience that reality".

The data analysis of the questionnaire findings will be undertaken following the three main tasks suggested by Miles, Huberman, and Saldana (2015, cited by Biddix 2018) which is as follows:

1. Data condensation: This task mainly refers to the process of identifying and transforming data frequently involving a coding approach.
2. Data display: This task mainly refers to the creation process leading to an organised set of data that could help to sketch conclusions.
3. Drawing and verifying conclusions: This task mainly refers to a careful interpretation process of the data allowing conclusions to be formed that are consequently grounded in the research context but are derived via an open-minded approach.

The conclusions formed from the data analysis will be used to improve the DIY domestic natural dyeing workshop, which is used to validate the strategic tools identified for the development of the novel model such as: Co-design, customisation and DIY re-dye activity.

### 7.8.5. How the DIY domestic natural dyeing workshop could be used in order to identify an initial behaviour change in the short-term?

Although the data collection and subsequent analysis of the online questionnaire conducted with Mexican females from 18 to 33 years old which can be found in Chapter 6 identified that the target audience lack of: capability, opportunity and motivation and consequently the model would require a long- term action in order to adopt a behaviour change of accepting the performance of the natural dyes from domestic food waste resources without the addition of metallic chemical additives. The DIY domestic natural dyeing workshop could be used in order to identify an initial behaviour change in a short period term of two months by doing the following:

The questionnaire in which 310 Mexican females from 18 to 33 years old participated that can be found in Appendix 1 and 2 (Spanish and English) will be sent along with the invitation to the DIY domestic natural dyeing workshop as a pre-questionnaire activity. By doing this, the data set would be increased by reaching more participants. In addition, during the one hour waiting period of the step 7 (page 273) the workshop participants would receive information about the following themes:

- The negative effects that a high clothing consumption rate has on the environment.
- The negative environmental impact that metallic chemical additives in the textile dyeing activity can have on the environment.
- The difference between natural and synthetic dyes in order to make a shift in their purchasing decision making process.

Furthermore, a post-questionnaire would be sent to the workshop participants via email two months after the DIY domestic natural dyeing workshop. This could be used in order to identify a possible change from their initial responses after receiving education about the themes they lacked knowledge in and if the novel model strategic tools: Co-design, customisation and DIY re-dye activity have a positive influence in the social acceptance of natural dyes from domestic food waste without metallic chemical additives. Fishbein and Ajzen (2010, p. 63) point out that "on a questionnaire, people may express an intention to engage in a given behavior". This approach has been used by Reid *et al.* (2021) in which pre and post workshop questionnaires were used to collect data about the participants knowledge, attitudes and future intentions to engage in a behaviour change with regards to the theme exposed at the workshop. According to Reid *et al.* (2021) the findings from the data collected through the pre and post workshop questionnaires provided a set of strategies that could influence a behaviour change. In addition, the findings from the post-questionnaire indicated that the workshop provided a positive change with regards to the participants knowledge and attitudes (Reid *et al.*, 2021). According to Fishbein and Ajzen (2010, p.29) the following elements could facilitate the observation of behaviour: "the action performed, the target at which the action is directed, the context in which it is performed, and the time at which it is performed". Since according to Fishbein and Ajzen (2010, p.29) "behavio[u]rs are observable events". Therefore, in this study the use of pre and post questionnaires of the DIY re-dye workshop activity could faciliate the observation of an initial behaviour change in Mexcian females from 18 to 33 years old. According to Fishbein and Ajzen (2010, p.319) "performance of the behavior is preceded by activation of an intention, even if this activation occurs below conscious awareness".

This suggests that, the personal involvement of the partictipants in the workshop activity in which the strategic tools (co-design, customisation and re-dyeing activitiy) of the novel model along with education could be key in terms of activiting the conscious intention of the target audience to change their behaviour towards the social acceptance of natural dyes from domestic food waste resources without metallic chemical additives. Since, as previously mentioned in section 2.3 by Kadolph and Casselman (2004, p. 21) "[t]he ultimate satisfaction of natural dyes in a mass-market environment is personal involvement in a simple aesthetic exercise that restores individuality and cultural meaning to otherwise ordinary clothing and textiles". In addition as Ball and Tasaki (1992) points out personal involvement (customisation) allows the individual to transfer their personal identity to the product. This is the reason why the post-questionnaire which can be found in Appendix 3 includes questions regarding the personal involvement in a DIY domestic natural dyeing activity.

### 7.9. Summary

Analysis of the online questionnaire that was conducted to the demographic cohort (Mexican females from 18 to 33 years old) that can be found in Chapter 6 was crucial for the development of the social marketing intervention model within this study. In addition, the social marketing intervention model created to educate and thus influence the behaviour of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives draws on the findings from Chapter 4 and Chapter 5.

In Chapter 4, the lack of colour strength standardisation and durability *of Allium cepa* natural dyestuff when compared to synthetic dyes performance were identified in the novel model as the price (barriers) towards the product acceptance of natural dyes from domestic food waste resources without metallic chemical additives. In Chapter 5, co-design, customisation and DIY activities were identified as design routes towards the utilisation of natural dyes without metallic chemical additives. Co-design was identified in the novel model as the place (channel) in which the target audience could translate their acceptance of natural dyes from domestic food waste resources without metallic chemical additives into action by becoming co-designers of their own natural dyed garments. DIY re-dye activity, and customisation were identified as the promotion (strategic tools) in the model that could influence the attraction of the target audience.

The design cluster that was selected for the model was relationships and community due to the target audience's lack of: capability, opportunity and motivation. In addition, it was identified that the modelling intervention activity through the use of influencers and fiscal policy through the increasement in the price of chromium, tin, copper could help support the behavioural change of the demographic cohort.

To conclude, this chapter provides the development of the social marketing intervention model that this study proposes, the role of which is to educate and thus influence a behavioural change of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. In addition, the tools which form this model aim to increase the attraction of the demographic cohort to domestic participation in natural dyeing, making use of their kitchen waste as natural dyestuffs. Although, there is a definite need to trial the proposed model strategies, this chapter offers some insights about how these strategies could be validated through a DIY domestic natural dyeing workshop.

# Chapter 8. Conclusion

This chapter aims to provide a discussion on how this study's aim and objectives were reached. Moreover, it crystallises the contribution to knowledge and includes a section of potential future research work, which was created, based on possible research projects that can be undertaken as a result of the conclusions of this study.

## 8.1. Meeting the aim and objectives

This study developed a social marketing intervention model to educate and thus influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. The social marketing intervention model developed in this work identified the following design routes as building blocks within this model: Co-design, DIY re-dye activity, and customisation. Co-design, is the channel via which the target audience can translate their acceptance of natural dyes from domestic food waste resources without metallic chemical additives into action by becoming co-designers of their own natural dyed garments. DIY re-dye activity, and customisation were identified as the promotion (strategic tools) that could influence the attraction of the target audience. In addition, the model requires a long-term action in order to influence the behaviour change of the demographic cohort. This means that the model does not recommend one solution but rather a systematic process change in which the target audience will be taking part of the different steps that need to be taken in order to encourage a behaviour change. This starts from receiving education in specific themes in order to increase their awareness and get motivation through a reflective analysis in which they could translate the motivation acquired into action by becoming co-designers of their garments in which they use domestic food waste resources as natural dyestuffs without metallic chemical additives embracing the limitations of its performance.

This study validated the following hypothesis: If consumers become aware of the environmental impact that is made through the use of synthetic dyes, they eventually become more receptive to embrace the limitations of the use of natural dyes without metallic chemical additives, such as lack of colour strength, standardisation and durability when compared to synthetic dyes. According to the results from the online questionnaire, 77.10% of the participants indicated that they would wear naturally dyed clothing without metallic chemical additives added, being aware they have a less negative environmental impact, but knowing that its colour may fade quickly.

Moreover, they are open to embrace the natural dyes performance in which no metallic chemical additives are added, since the majority of the respondents 92.90% have said that they would buy clothing that due to its dye source will never provide a standard colour shade. Furthermore, when the participants were asked to choose their preference between two colour palettes, 51.94% (161 participants) indicated their preference towards the palette with brighter colours, however 129 participants from the 51.94% changed their mind after being made aware that the palette with brighter colours contained metallic chemicals that leads to a negative environmental impact, especially in water pollution. In addition, the majority of the respondents 80.82% indicated that the motivation for accepting food waste as natural dyeing resource was the feeling of creating a positive impact on the environment.

The following objectives were reached:

1. The experimental work using *Allium Cepa* (onion) skin as an example of a Mexican food waste resource to analyse its performance as natural dyestuff without metallic chemical additives on cotton indicated lack of colour strength, standardisation and durability as limitations to wearable textiles. However, the approach of this study was to re-frame the design problem regarding the market acceptance of natural dyes without metallic chemical additives, challenging what has previously been considered to be suitable to market with regards to natural dyed textiles such as colour strength and colour fastness. The limitations identified were re-framed according to the ideas and thinking proposed by Dorst (2015) and subsequently developed as a design opportunity.

2. This study provides a holistic posture in which different design routes such as: Co-design, customisation and DIY re-dye activities were explored and identified as strategic tools for the development of the social marketing intervention model that aims to educate and thus influence the behaviour of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. It is hard for natural dyes to compete with synthetic dyes in the traditional market competition areas of quality, price and colourfastness properties. As a result, this study looks outside the product and focuses on the user experience, in which the co-design approach along with customisation and DIY re-dye activities, could generate added value to the demographic cohort experience in order to embrace the limitations of natural dyes from domestic food waste resources without metallic chemical additives. It is expected that the demographic cohort of the study transfer part of themselves

(personal narratives of value) during a co-design experience, towards their natural dyed garments, since they would be taking part in the design process of their own garments. In addition, if the demographic of the study, becomes aware of the negative effects of the metallic chemical additives in the environment before being involved in a co-design experience of natural dyeing, they would be able to understand the relevance of transforming their motivation to accepting natural dyes from domestic food waste resources without metallic chemical additives into action by becoming co-designers of their own natural dyed garments. With regards to DIY re-dye activities, due to lack of colour strength, standardisation and durability of natural dyes without metallic chemical additives, the demographic cohort could be able to transform their colour garment once the initial colour dye fades, offering a more active life to the garment by allowing the users to keep transferring new meanings and positive feelings to their garment by keep surprising the demographic cohort due to the intrinsic aesthetic characteristics (variability) of natural dyes without metallic chemical additives.

3. A social marketing intervention model was created to educate and thus influence a behavioural change in Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. Details about the model development can be found in Chapter 7 and the social marketing intervention model diagram can be seen in page 252.

## 8.2. Contribution to Knowledge

The contribution to knowledge this research makes is the social marketing intervention model created. The foundations of this novel model were around two main problems within a Mexican context: The water situation and the high percentage of food that ends up as waste every year. Social marketing can be used in any discipline that aims to contribute to a societal wellbeing. However, social marketing models so far have been primarily used in the public health domain. Therefore, this social marketing intervention model is novel residing in the transition design domain. Transition design guides this project research providing a holistic posture in which different disciplines and themes were explored and integrated.

This social marketing intervention model starts with a contextual and target audience analysis in order to identify the behaviour change needed. This model incorporates the design clusters and the guidance of the COM-SM model developed by Tapp and Spotswood (2013) and the intervention and policies proposed by Michie, van Stralen and West (2011) in the BCW framework. The role of the social marketing intervention model that this study proposes is to educate and thus influence the behaviour of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives. Education is a central aspect of this novel model, since this is expected to raise environmental awareness in the demographic cohort and consequently generate a reflective motivation to participate in a channel that would allow them to translate the motivation generated into action. In this novel mode, Co-design was identified as the channel, while DIY re-dye activity, and customisation were identified as the promotion (strategic tools) that could influence the attraction of the target audience towards the social accpetance of natural dyes from domestic food waste resources without metallic chemical additives.

## 8.3. Reflections of Limitations and Future Work

The initial further work will be to carry out the pilot stage of the DIY re-dye workshop and the associated planned questionnaire (See section 7.8) via online delivery with four participants within the target demographic in order to evaluate this approach. Once trialled, the DIY re-dye workshop and the questionnaire will be undertaken with more participants within the target demographic in order to validate if the strategic tools identified for the development of the novel model such a: Co-design, customisation and DIY re-dye activity will influence the behaviour of Mexican females from 18 to 33 years old towards the acceptance of natural dyes from domestic food waste resources without metallic chemical additives.

Another initial idea for further work is to investigate natural mordants that could be easily available in Mexican homes and to increase the options of natural substrates for natural dyeing such as wool, since according to Secretaría de Agricultura y Desarrollo Rural (2020) Mexico produced 4 thousand tons of wool in 2018. Moreover, more data could be collected in order to analyse if wearing specific colours could cause a mood change on the wearer, changing their state of mind. Since according to the results from the online questionnaire, 85.16% of the participants indicated that clothing has the power to change their mood.

The findings from the online questionnaire, suggest that colour variation acceptance should be further explored. The majority of the participants (58.06%) indicated that they would accept colour variation only if it provides a uniform colour within the garment. As a result, this aspect could be further explored, after testing the social marketing intervention model and therefore consider if a technological solution in the form of improved natural dye processes can be developed in order for the demographic cohort to accept the colour variation performance of natural dyes without metallic chemical additives.

Data collection can be expanded to consider the Mexican female age range from 34 to 49 years old considering an extra 3.82% of all the Mexican female population. In addition, another country from Latin American could be considered such as Uruguay to analyse and compare similarities and differences between countries' population behaviour towards the acceptance of domestic food waste as a natural resource for textile dyeing without metallic chemical additives. Since according to Yee-Batista (2013) 70% of the wastewater from Latin America is not treated leading consequently to the pollution of rivers. Moreover, almost 50% of Uruguay´s drinking water is wasted due to old pipes, theft or fraud (Yee-Batista, 2013).

Moreover, conducting focus groups with Mexican females between the age range of 18 to 49 years old could enhance the research findings in order to analyse if the creation of a new service business could guide consumers towards a longer life of their garments through re-design and customisation. For example, ten Mexican females between the age range of 18 to 49 years old are invited to bring one garment that they no longer use but they do not want to dispose of due to an emotional attachment. In order to analyse if they will be open to changing the garment function by being part of a re-design process in these focus group sessions. Seamstresses along with image consultants would be invited to facilitate a redesign process in order inspire the participants and see if participants are receptive to the idea of giving a second life to the garments they no longer use.

While this work represents an important step in this area, there is much work to do in order to achieve the end goal of consumer behaviour change. This section has identified several examples of how the study could be extended in order to strengthen the idea of not only accepting natural dyes from domestic food waste resources without metallic chemical additives but also exploring different ways of giving clothing a longer active life.

**References**

Aasm.org.au. 2016. *What Is Social Marketing?*. [online] Available at: <https://www.aasm.org.au/what-is-social-marketing/> [Accessed 3 April 2020].

Acqnotes.com. 2021. [online] Available at: <https://acqnotes.com/acqnote/tasks/technology-readiness-level> [Accessed 1 June 2021].

Ageuk.org.uk. n.d. *Environmental Policy*. [online] Available at: <https://www.ageuk.org.uk/london/about-us/policies/environmental-policy/> [Accessed 18 October 2020].

Alihosseini, F. and Sun, G., 2011. Antibacterial colorants for textiles. In: N. Pan and G. Sun, ed., *Functional textiles for improved performance, protection and health*. Cambridge: Woodhead Publishing, pp.346-403.

Amaherbal.com. n.d.a *Industrial use*. [online] Available at: <https://www.amaherbal.com/pages_m.php?head_id=11&page_type=INDUSTRIAL%20USE> [Accessed 24 May 2021].

Amaherbal.com. n.d.b *Natural Dye Manufacturer & Supplier | GOTS Certified Dyes*. [online] Available at: <https://www.amaherbal.com/index.php> [Accessed 29 April 2021].

Andreasen, A., 1994. Social Marketing: Its Definition and Domain. *Journal of Public Policy & Marketing*, 13(1), pp.108-114.

Archroma.com. 2017. *Archroma's Earthcolors Selected In Patagonia's Newest Clean Color Collection*. [online] Available at: <https://www.archroma.com/press/releases/archromas-earthcolors-selected-in-patagonias-newest-clean-color-collection> [Accessed 7 May 2020].

Archroma.com. 2021. *EarthColors® by Archroma: Sustainable textile dyes synthesized from waste*. [online] Available at: <https://www.archroma.com/innovations/earth-colors-by-archroma> [Accessed 17 May 2021].

Ardanuy, M., Faccini, M., Amantia, D., Aubouy, L. and Borja, G., 2014. Preparation of durable insecticide cotton fabrics through sol–gel treatment with permethrin. *Surface and Coatings Technology*, 239, pp.132-137.

Arellano Aguilar, O. (2018). "Contaminados, 70% de cuerpos de agua en México: especialistas". Interview by Carolina Gómez Mena for *La Jornada*, 27 May, p.34.

Armstrong, C., Niinimäki, K. and Lang, C., 2016. Towards Design Recipes to Curb the Clothing Carbohydrate Binge. *The Design Journal*, 19(1), pp.159-181.

Arthur, C., 2014. *Digital Wars: Apple, Google, Microsoft And The Battle For The Internet*. 2nd ed. London: Kogan Page, pp.1-327.

Babu, B., Parande, A., Raghu, S. and Kumar, T., 2007. Cotton Textile Processing: Waste Generation and Effluent Treatment. *The Journal of Cotton Science*, 11, pp.141-153.

Ball, A. and Tasaki, L., 1992. The Role and Measurement of Attachment in Consumer Behavior. *Journal of Consumer Psychology*, 1(2), pp.155-172.

Barker, S., 2016. *Reaching The Masses: The Secret Guide To Instagram Influencer Marketing*. [online] Business.com. Available at: <https://www.business.com/articles/the-secret-guide-to-instagram-influencer-marketing/> [Accessed 11 April 2020].

Belk, R., 1988. Possessions and the Extended Self. *Journal of Consumer Research*, 15(2), pp.139-168.

Benítez, V., Mollá, E., Martín-Cabrejas, M., Aguilera, Y., López-Andréu, F., Cools, K., Terry, L. and Esteban, R., 2011. Characterization of Industrial Onion Wastes (Allium cepa L.): Dietary Fibre and Bioactive Compounds. *Plant Foods for Human Nutrition*, 66(1), pp.48-57.

berkeleyearth.org. n.d. *Global Temperature Report For 2019*. [online] Available at: <http://berkeleyearth.org/archive/2019-temperatures/> [Accessed 24 September 2020].

Biddix, J., 2018. *Research Methods And Applications For Student Affairs*. 1st ed. San Francisco: John Wiley & Sons, Incorporated, Newark, pp.1-323.

Biermann, C., 1996. Stock Preparation and Additives for Paper Making. In: C. Biermann, ed., *Handbook of Pulping and Papermaking*, 2nd ed. California: Academic Press, pp.205-206.

Borden, G., 2019. The Power of Influencers. *The Lane Report*, [online] 34(11), pp.42-43. Available at: <https://search.proquest.com/docview/2348211809?accountid=11526> [Accessed 5 Mar. 2020].

Burkinshaw, S. and Salihu, G., 2017. The role of auxiliaries in the immersion dyeing of textile fibres: Part 5 practical aspects of the role of inorganic electrolytes in dyeing cellulosic fibres with direct dyes. *Dyes and Pigments*, pp.1-14.

Burkinshaw, S. and Salihu, G., 2019. The role of auxiliaries in the immersion dyeing of textile fibres: Part 1 an overview. *Dyes and Pigments*, 161, pp.519-530.

Chakraborty, J., 2011. An overview of dye fastness testing. In: M. Clark, ed., *Handbook of Textile and Industrial Dyeing : Volume 1 Principles, Processes and Types of Dyes*. Cambridge: Woodhead Publishing, pp.207-224.

Chavan, R., 2011. Environmentally friendly dyes. In: M. Clark, ed.,*Handbook of textile and industrial dyeing: Volume1 Principles, Processes and Types of Dyes*. Cambridge: Woodhead Publishing, pp.515-561.

Chhabra, E., 2015. Natural dyes v synthetic: which is more sustainable?.*The Guardian*, [online] Available at: <https://www.theguardian.com/sustainable-business/sustainable-fashion-blog/2015/mar/31/natural-dyes-v-synthetic-which-is-more-sustainable> [Accessed7 May 2018].

Cifor.org. n.d. *Forests and non-timber forest products*. [online] Available at: <https://www.cifor.org/Publications/Corporate/FactSheet/ntfp.htm> [Accessed 19 June 2021].

Clark, M., 2011. Fundamental principles of dyeing. In: M. Clark, ed.,*Handbook of Textile and Industrial Dyeing : Volume 1 Principles, Processes and Types of Dyes*. Cambridge: Woodhead Publishing, pp.3-27.

Clement, J., 2020. *Global Social Networks Ranked By Number Of Users 2020*. [online] Statista.com. Available at: <https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/> [Accessed 10 November 2020].

Clima-de.com. n.d. *Clima De México. Riqueza Climática*. [online] Available at: <https://www.clima-de.com/mexico/> [Accessed 18 March 2020].

Cohen, J., 2018a. *Reunión ordinaria de trabajo de las Comisiones Unidas de Relaciones Exteriores Asia-Pacífico; de Relaciones Exteriores; y de Comercio y Fomento Industrial, para el análisis del Tratado Integral y Progresista de Asociación Transpacífico (CPTPP)*. Ciudad de México. Available at: http://comunicacion.senado.gob.mx/index.php/informacion/versiones/40616-reunion-ordinaria-de-trabajo-de-las-comisiones-unidas-de-relaciones-exteriores-asia-pacifico-de-relaciones-exteriores-y-de-comercio-y-fomento-industrial-para-el-analisis-del-tratado-integral-y-progresista-de-asociacion-transpacifico-cptpp.html.

Cohen, J., 2018b. 'México carece de normas para evitar el ingreso de prendas subvaluadas al país'. Interview by Jaime Cevallos for *Modaes Latinoamérica, 11 October.*

Comisión Nacional Del Agua, 2004. *ESTADÍSTICAS DEL AGUA EN MÉXICO 2004*. Ciudad de México, p.131.

Commission for Environmental Cooperation, 2017. *Characterization And Management Of Food Loss And Waste In North America*. Montreal, pp.1-34.

Coyne, I., 1997. Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries?. *Journal of Advanced Nursing*, 26(3), pp.623-630.

Creswell, J., 2014. *Research Design: Qualitative, Quantitative, And Mixed Methods Approaches*. 4th ed. Los Angeles: SAGE Publications, pp.1-21.

Deschamps, T., Carnie, B. and Mao, N., 2016. Public consciousness and willingness to embrace ethical consumption of textile products in Mexico. *Textiles and Clothing Sustainability*, 2(6), pp.1-16.

Dictionary.com. n.d. Definition of pollutant. [online] Available at: <https://www.dictionary.com/browse/pollutant> [Accessed 18 March 2020].

Dimock, M., 2019. *Defining Generations: Where Millennials End And Generation Z Begins*. [online] pewresearch.org. Available at: <https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins/> [Accessed 4 March 2020].

Dorst, K., 2015. Frame Creation and Design in the Expanded Field. *She Ji: The Journal of Design, Economics, and Innovation*, 1(1), pp.22-33.

Drugbank. n.d. *Quercetin*. [online] Available at: <https://go.drugbank.com/drugs/DB04216> [Accessed 9 April 2020].

Efron, S. and Ravid, R., 2013. *Action Research In Education: A Practical Guide.* 1st ed. New York: The Guilford Press, pp.1-268.

El Congreso de los Estados Unidos Mexicanos, 1970. *LEY FEDERAL DEL TRABAJO*. pp.1-236. [online] Available at: <https://www.gob.mx/cms/uploads/attachment/file/156203/1044_Ley_Federal_del_Trabajo.pdf> [Accessed 18 October 2020].

El Economista, 2019. Mujeres mexicanas, las más activas en el e-commerce. [online] Available at: <http://ttps://www.eleconomista.com.mx/finanzaspersonales/Mujeres-mexicanas-las-mas-activas-en-el-e-commerce-20190310-0081.html> [Accessed 6 March 2020].

El-Sheekh, M., Gharieb, M. and Abou-El-Souod, G., 2009. Biodegradation of dyes by some green algae and cyanobacteria. *International Biodeterioration & Biodegradation*, 63(6), pp.699-704.

Emmett, S., 2003. *Adding value to onion waste*. [online] New-ag.info. Available at: http://www.new-ag.info/03-6/focuson/focuson4.html [Accessed 7 Dec. 2018].

English, P., 2016. Imperfection: Embracing Wabi-Sabi. *Liminalities: A Journal of Performance Studies*, 12(4), pp.1-9.

Enrico, C., 2020. El efecto de COVID-19 en el ecommerce. *Forbes México*, [online] Available at: <https://www.forbes.com.mx/el-efecto-de-covid-19-en-el-ecommerce/> [Accessed 25 September 2020].

Fao.org. 2009a. *Profiles Of 15 Of The World's Major Plant And Animal Fibres | International Year Of Natural Fibres 2009 | International Year Of Natural Fibres 2009*. [online] Available at: <http://www.fao.org/natural-fibres-2009/about/15-natural-fibres/en/> [Accessed 20 Nov. 2019].

Fao.org. 2009b. *Why natural fibres? | International Year of Natural Fibres 2009*. [online] Available at: http://www.fao.org/natural-fibres-2009/about/why-natural-fibres/en/ [Accessed 19 Feb. 2020].

fao.org. 2020. *Despilfarro De Alimentos: Datos Y Cifras Clave*. [online] Available at: <http://www.fao.org/news/story/es/item/196450/icode/> [Accessed 13 April 2020].

Ferreira, E., Quye, A., McNab, H. and Hulme, A., 2002. Photo-oxidation Products of Quercetin and Morin as Makers for the Characterisation of Natural Flavonoid Yellow Dyes in Ancient Textiles. *Dyes in History and Archaelogy*, 18, pp.63-72.

Festa, G., Cuomo, M., Metallo, G. and Festa, A., 2016. The (r)evolution of wine marketing mix: From the 4Ps to the 4Es. *Journal of Business Research*, 69(5), pp.1550-1555.

Fishbein, M. and Ajzen, I., 2010. *Predicting and Changing Behavior - The Reasoned Action Approach*. 1st ed. New York: Taylor and Francis Group, pp.1- 509.

Forbes México, 2019. Solteros, sin hijos y viviendo con sus papás, así son los millennials en México: De las Heras. [online] Available at: https://www.forbes.com.mx/solteros-sin-hijos-y-viviendo-con-sus-papas-asi-son-los-millennials-en-mexico-de-las-heras/ [Accessed 3 Mar. 2020].

Franco-Maass, S., Arredondo-Ayala, G., Cruz-Balderas, Y. and Endara-Agramont, A., 2018. The Use of Dye Plants in a Mazahua Community in Central Mexico. *Economic Botany*, 73(1), pp.13-27.

Gaziulusoy, İ. and Erdoğan Öztekin, E., 2019. Design for Sustainability Transitions: Origins, Attitudes and Future Directions. *Sustainability*, 11(13), pp.1-16.

Gephart, R., 2004. Qualitative Research and the Academy of Management Journal. *Academy of Management Journal*, 47(4), pp.454-462.

Gillham, B., 2007. *Developing A Questionnaire*. 2nd ed. London: Continuum International Publishing Group, pp.1- 112.

globenewswire.com. 2020. *Global Textile Market Outlook 2020-2027*. [online] Available at: <https://www.globenewswire.com/news-release/2020/03/10/1997918/0/en/Global-Textile-Market-Outlook-2020-2027-Manufacturers-Expected-to-Increase-Expenditure-Toward-Establishing-Strategic-Partnerships-with-E-Commerce-Portals.html> [Accessed 24 October 2020].

gob.mx. 2013. *Se desperdician Más de diez mil toneladas de alimentos cada año nn México*. [online] Available at: <https://www.gob.mx/bienestar/prensa/se-desperdician-mas-de-diez-mil-toneladas-de-alimentos-cada-ano-en-mexico> [Accessed 16 Feb. 2020].

Government.nl. n.d. *Government Of The Netherlands - The Rules On Selling Alcoholic Beverages To Young People*. [online] Available at: <https://www.government.nl/topics/alcohol/the-rules-on-selling-alcoholic-beverages-to-young-people> [Accessed 18 October 2020].

Greenpeace East Asia. (2010). *The dirty secret behind jeans and bras*. [online] Available at: http://www.greenpeace.org/eastasia/news/stories/toxics/2010/textile-pollution-xintang-gurao/ [Accessed 24 Sep. 2019].

Grupo Bimbo. 2019. *Futbolito Bimbo, The Largest Social-Responsibility Initiative Of Grupo Bimbo, Opens 2019 Registration In All 32 Mexican States*. [online] Available at: <https://grupobimbo.com/en/futbolito-bimbo-2019> [Accessed 18 October 2020].

Guadarrama-Brito, M. and Galván Fernández, A., 2015. Impacto del uso de agua residual en la agricultura / Impact of wastewater use in agriculture. *Revista Iberoamericana de las Ciencias Biológicas y Agropecuarias*, [online] 4(7). Available at: <https://www.ciba.org.mx/index.php/CIBA/article/view/29/84> [Accessed 28 July 2020].

Haines-Gadd, M., Chapman, J., Lloyd, P., Mason, J. and Aliakseyeu, D., 2018. Emotional Durability Design Nine—A Tool for Product Longevity. *Sustainability*, 10(6), pp.1-19.

Hammersley, M. and Campbell, J., 2012. *What Is Qualitative Research?*. 1st ed. London: Bloomsbury Publishing, [no pagination].

Hao, Z. and Iqbal, A., 1997. Some aspects of organic pigments. *Chemical Society Reviews*, 26(3), pp.203-213.

Harb, C., Pan, J., DeVilbiss, S., Badgley, B., Marr, L., Schmale, D. and Foroutan, H., 2021. Increasing Freshwater Salinity Impacts Aerosolized Bacteria. *Environmental Science & Technology*, 55(9), pp.5731-5741.

Hashim, N., Md Salleh, N., Norazlimi, N., Rahman, A. and Pa'ee, F., 2021. A preliminary study of tourists and vendors perception on the development of tourism souvenirs using natural dye from plants. *IOP Conference Series: Earth and Environmental Science 2020*, 736(1), pp.1-6.

Hernández-Zamora, M., Cristiani-Urbina, E., Martínez-Jerónimo, F., Perales-Vela, H., Ponce-Noyola, T., Montes-Horcasitas, M. and Cañizares-Villanueva, R., 2015. Bioremoval of the azo dye Congo Red by the microalga Chlorella vulgaris. *Environmental Science and Pollution Research*, 22(14), pp.10811-10823.

Hesse-Biber, S., 2010. *Mixed Methods Research: Merging Theory With Practice*. New York: Guilford Press, pp.1-242.

Hill, D., 1997. Is there a future for natural dyes?. *Review of Progress in Coloration and Related Topics*, 27(1), pp.18-25.

Ho, C., Fan, J., Newton, E. and Au, R., 2011. Improving thermal comfort in apparel. In: G. Song, ed., *Improving Comfort in Clothing*, 1st ed. Cambridge: Woodhead Publishing Limited, pp.165-167.

Holme, I., 2006. Sir William Henry Perkin: a review of his life, work and legacy. *Coloration Technology*, 122(5), pp.235-251.

Holmgren, D., 2020. Essence of Permaculture. 2nd ed. [ebook] Melliodora, p.19. Available at:<https://files.holmgren.com.au/downloads/Essence_of_Pc_EN.pdf?_ga=2.233935198.1171431524.1632932483-1388492486.1632932483> [Accessed 29 September 2021].

Hosseini Ravandi, S. and Valizadeh, M., 2011. Properties of fibers and fabrics that contribute to human comfort. In: G. Song, ed., *Improving comfort in clothing*, 1st ed. Oxford: Woodhead Publishing Limited, pp.61-78.

Humphreys, P., Samson, A., Roser, T. and Cruz-Valdivieso, E., 2009. *Co-Creation: New Pathways To Value: An Overview*. [online] LSE Enterprise, pp.1-22. Available at: <http://www.portugalglobal.pt/PT/RoadShow/Documents/2016/GuimaraesCo_creationNewPathways_to_value_An_overview.pdf> [Accessed 15 July 2019].

H&M. n.d. *Garment Collecting*. [online] Available at: <https://www2.hm.com/en_us/women/campaigns/16r-garment-collecting.html> [Accessed 17 October 2020].

IDC. 2020. *Las Plataformas De E-Commerce Durante La Cuarentena*. [online] Available at: <https://idconline.mx/corporativo/2020/06/01/las-plataformas-de-e-commerce-durante-la-cuarentena> [Accessed 25 September 2020].

INEGI, Secretaría de Comunicaciones y Transportes, Instituto Federal de Telecomunicaciones, 2019. *EN MÉXICO HAY 74.3 MI LLONES DE USUARIOS DE INTERNET Y 18.3 MILLONES DE HOGARES CON CONEXIÓN A ESTE SERVICIO: ENDUTIH 2018*. [online] Available at: <https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2019/OtrTemEcon/ENDUTIH_2018.pdf> [Accessed 26 September 2020].

INEGI, 2016. *Panorama Sociodemográfico De Aguascalientes 2015*. [online] Aguascalientes, pp.6-41. Available at:

<https://www.inegi.org.mx/contenido/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/inter_censal/panorama/702825082000.pdf > [Accessed 24 March 2020].

INEGI, 2018a. *Encuesta Nacional De Ingresos Y Gastos De Los Hogares*. [online]. Available at: <https://www.inegi.org.mx/contenidos/programas/enigh/nc/2018/doc/enigh2018_ns_presentacion_resultados.pdf> [Accessed 24 March 2020].

INEGI, 2018b. *ENCUESTA NACIONAL DE INGRESOS Y GASTOS DE LOS HOGARES (ENIGH) 2018- CIUDAD DE MÉXICO*. [online]. Available at: <https://www.inegi.org.mx/contenidos/programas/enigh/nc/2018/doc/enigh2018_ns_presentacion_resultados_cdmx.pdf> [Accessed 24 March 2020].

INEGI, 2018c. *ENCUESTA NACIONAL DE INGRESOS Y GASTOS DE LOS HOGARES (ENIGH) 2018- AGUASCALIENTES*. [online] Available at: <https://www.inegi.org.mx/contenidos/programas/enigh/nc/2018/doc/enigh2018_ns_presentacion_resultados_ags.pdf> [Accessed 24 March 2020].

INEGI, 2018d. *ENCUESTA NACIONAL DE INGRESOS Y GASTOS DE LOS HOGARES (ENIGH) 2018- JALISCO*. [online]. Available at: <https://www.inegi.org.mx/contenidos/programas/enigh/nc/2018/doc/enigh2018_ns_presentacion_resultados_jal.pdf> [Accessed 24 March 2020].

INEGI, 2019. *INEGI PRESENTA LA ESTADÍSTICA DE MATRIMONIOS 2018 CON INFORMACIÓN DE 501 298 MATRIMONIOS*. [online] Available at:

<https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2019/EstSociodemo/EstadisticasMatrimonios2019_09.pdf> [Accessed 24 March 2020].

inegi.org.mx. 2015. *Población*. [online] Available at: <https://www.inegi.org.mx/temas/estructura/> [Accessed 2 March 2020].

inegi.org.mx. 2019a. *Nupcialidad*. [online] Available at: <https://www.inegi.org.mx/temas/nupcialidad/> [Accessed 2 March 2020].

inegi.org.mx. 2019b. *Agricultura*. [online] Available at: <https://www.inegi.org.mx/temas/agricultura/> [Accessed 19 September 2021].

Investopedia. 2019. *Top 25 Developed And Developing Countries*. [online] Available at: <https://www.investopedia.com/updates/top-developing-countries/#mexico> [Accessed 2 August 2020].

Irwin, T., Tonkinwise, C. and Kossoff, G., 2013. *Transition Design: Re-Conceptualizing Whole Lifestyles*. " *Head, Heart, Hand: AIGA Design Conference,* Minneapolis, October 12, 2013. Available at: http://www.aiga.org/video-HHH-2013- irwin-kossoff-tonkinwise

Irwin, T., 2015. Transition Design: A Proposal for a New Area of Design Practice, Study, and Research. *Design and Culture*, 7(2), pp.229-246.

Irwin, T., 2018. The Emerging Transition Design Approach. In: *Design as a catalyst for change - DRS International Conference*. [online] Limerick: Design Research Society, pp.969-970. Available at:

<https://dl.designresearchsociety.org/cgi/viewcontent.cgi?article=1589&context=drs-conference-papers> [Accessed 29 September 2021].

iSMA, ESMA and AASM, 2013. *Consensus Definition Of Social Marketing*. pp. 1-3 [online] Available at: <https://www.i-socialmarketing.org/assets/social_marketing_definition.pdf> [Accessed 3 April 2020].

İşmal, Ö., 2017. Greener natural dyeing pathway using a by-product of olive oil; prina and biomordants. *Fibers and Polymers*, 18(4), pp.773-785.

Johnson, R., Onwuegbuzie, A. and Turner, L., 2007. Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, 1(2), pp.112-133.

Johnston, A., 1997. *Color by accident*. 6th ed. [ebook] Lake Oswego, pp.7-95. Available at: <http://annjohnston.net/dev/wp-content/uploads/2019/11/Color_By_Accident_AJohnston.pdf> [Accessed 28 May 2021].

Kadolph, S. and Casselman, K., 2004. In the Bag: Contact Natural Dyes. *Clothing and Textiles Research Journal*, 22(1-2), pp.15-21.

KAIKU. n.d. *KAIKU*. [online] Available at: <https://kaiku.bio/home> [Accessed 22 May 2021].

Kant, R., 2012. Textile dyeing industry an environmental hazard. *Natural Science*, 04(01), pp.22-26.

Kantarworldpanel.com. 2018. *¿Cómo es el consumo de ropa y calzado de los mexicanos? - Mexico - Kantar Worldpanel*. [online] Available at: https://www.kantarworldpanel.com/mx/Noticias-/Consumo-de-ropa-y-calzado-de-los-mexicanos [Accessed 6 Mar. 2020].

Keracol.co.uk. 2019. *Keracol*. [online] Available at: <https://www.keracol.co.uk/> [Accessed 22 May 2021].

Khattab, T., Abdelrahman, M. and Rehan, M., 2019. Textile dyeing industry: environmental impacts and remediation. *Environmental Science and Pollution Research*, 27(4), pp.3803-3818.

KOH, J., 2011. Dyeing of cellulosic fibres. In: M. Clark, ed., *Handbook of Textile and Industrial Dyeing: Volume 2 Applications of Dyes.* Cambridge: Woodhead Publishing, pp.129-146.

Konica Minolta Sensing Americas. n.d. *Identifying Color Differences Using L*A*B* Or L*C*H* Coordinates*. [online] Available at: <https://sensing.konicaminolta.us/blog/identifying-color-differences-using-l-a-b-or-l-c-h-coordinates/> [Accessed 14 Feb. 2020].

Koren, L., 2004. Wabi- Sabi: Japanese culture of simplicity. In: S. Brown and M. Maya Kumar, ed., *The beauty of craft : a Resurgence anthology*, 1st ed. Totnes: Green, pp.186-187.

Kotler, P. and Zaltman, G., 1971. Social Marketing: An Approach to Planned Social Change. *Journal of Marketing*, 35, pp.3-12.

Kwon, T., Choo, H. and Kim, Y., 2019. Why do we feel bored with our clothing and where does it end up?. *International Journal of Consumer Studies*, 44(1), pp.1-13.

Lauterborn, B., 1990. New marketing litany; Four P's passe; C-words take over. *Advertising Age*, p.26.

Lee, J. and Mitchell, A., 2011. Quercetin and Isorhamnetin Glycosides in Onion (Allium cepaL.): Varietal Comparison, Physical Distribution, Coproduct Evaluation, and Long-Term Storage Stability. *Journal of Agricultural and Food Chemistry*, 59, pp.857-863.

Lobos, A. and Babbitt, C., 2013. Integrating Emotional Attachment and Sustainability in Electronic Product Design. *Challenges*, 4(1), pp.19-33.

Maanen, J., 1979. Reclaiming Qualitative Methods for Organizational Research: A Preface. *Administrative Science Quarterly*, 24(4), pp.520-526.

Marchand, A. and Walker, S., 2008. Product development and responsible consumption: designing alternatives for sustainable lifestyles. *Journal of Cleaner Production*, 16(11), pp.1163-1169.

Martínez-Flórez, S., González-Gallego, J., Culebras, J. and Tuñón, M., 2002. Los flavonoides: propiedades y acciones antioxidantes. *Nutrición Hospitalaria*, 17(6), pp.271-278.

Mason, M. 2010, "Sample size and saturation in PhD studies using qualitative interviews", *Forum qualitative Sozialforschung,* vol. 11, no. 3, pp.1-19.

Mckelvey, K., 2017. *ABC News- #Hereforyou Campaign*. [online] ABC News. Available at: <https://abcnews.go.com/Health/instagram-launches-hereforyou-campaign-mental-health awareness/story?id=47262825> [Accessed 18 October 2020].

Mercawise, 2014. *Encuesta Sobre Calidad De Servicio Y Atención En Las Tintorerías En México*. [online] Mercawise. Available at: <https://www.mercawise.com/estudios-de-mercado-en-mexico/encuesta-sobre-calidad-de-servicio-y-atencion-en-las-tintorerias-en-mexico> [Accessed 13 August 2020].

Merriam, S., 2009. *Qualitative Research: A Guide To Design And Implementation*. 3rd ed. San Francisco: Jossey-Bass, pp.1-304.

Meza Orozco, N., 2018. *Millennials Transforman Negocio De Tintorerías | Reporte Indigo*. [online] Reporte Indigo. Available at: <https://www.reporteindigo.com/indigonomics/millennials-transforman-negocio-de-tintorerias-habitos-consumo-tecnologias-recoleccion-ropa-domicilio/> [Accessed 13 August 2020].

Michie, S., van Stralen, M. and West, R., 2011. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(42), pp.1-11.

Mogra, D., 2013. An overview on floral diversity of Arawali forest: A potential source for natural dyes. *Journal of Applied and Natural Science*, 5(2), pp.516-521.

Morrisons. 2020a. *Alcohol*. [online] Available at: <https://www.morrisons-corporate.com/cr/policy/alcohol/> [Accessed 17 October 2020].

Morrisons. 2020b. *Plastics*. [online] Available at: <https://www.morrisons-corporate.com/cr/policy/plastics/> [Accessed17 October 2020].

Moult, J., Allan, S., Hewitt, C. and Berners-Lee, M., 2018. Greenhouse gas emissions of food waste disposal options for UK retailers. *Food Policy*, 77, pp.50-58.

Mouri, C., Mozaffarian, V., Zhang, X. and Laursen, R., 2014. Characterization of flavonols in plants used for textile dyeing and the significance of flavonol conjugates. *Dyes and Pigments*, 100, pp.135-141.

Neuman, W., 2014. *Social Research Methods: Qualitative And Quantitative Approaches*. 7th ed. Harlow: Pearson Education Limited, pp.1-594.

NIH.GOV. 2020. *COVID-19 Treatment Guidelines*. [online] Available at: <https://www.covid19treatmentguidelines.nih.gov/whats-new/> [Accessed 18 October 2020].

Npi.gov.au. 2009. *Formaldehyde*. [online] Available at: <http://www.npi.gov.au/resource/formaldehyde> [Accessed 25 August 2020].

Nse.amai.org. 2018. *¿Cuántos Niveles Socioeconómicos Hay Y Cuáles Son Sus Principales Características?*. [online] Available at: <https://nse.amai.org/uncategorized/cuantos-niveles-socioeconomicos-hay-y-cuales-son-sus-principales-caracteristicas/> [Accessed 4 March 2020].

O'Connor, R., 2019. Warnings and packaging. *Tobacco Control*, [online] 28(e1), pp.e1-e2. Available at: <https://tobaccocontrol.bmj.com/content/tobaccocontrol/28/e1/e1.full.pdf> [Accessed 18 October 2020].

Ochoa Neira, M., 2012. México, principal productor de cebolla. *El Economista*, [online] Available at: <https://www.eleconomista.com.mx/opinion/Mexico-principal-productor-de-cebolla-20121218-0005.html> [Accessed 18 March 2020].

Odom, W. and Pierce, J., 2009. *Improving With Age: Designing Enduring Interactive Products,* ACM, pp.3793-3798.

Panche, A., Diwan, A. and Chandra, S., 2016. Flavonoids: an overview.*Journal of Nutritional Science*, 5(47), pp.1-15.

Patel, B., 2011. Natural dyes. In: M. Clark, ed., *Handbook of Textile and Industrial Dyeing: Volume 1 Principles, Processes and Types of Dyes*. Cambridge: Woodhead Publishing, pp.395-424.

Pedgley, O., Şener, B., Lilley, D. and Bridgens, B., 2018. Embracing Material Surface Imperfections in Product Design. *International Journal of Design*, 12(3), pp.21-33.

Pędzik, M., Bednarz, J., Kwidziński, Z., Rogoziński, T. and Smardzewski, J., 2020. The Idea of Mass Customization in the Door Industry Using the Example of the Company Porta KMI Poland. *Sustainability*, 12(9), pp.1-14.

Pérez, M., 2015. Cada año México desperdicia 37% de alimentos; podría dar de comer a 7 millones. *La Jornada*, [online] p.33. Available at: <https://www.jornada.com.mx/2015/05/26/sociedad/033n1soc> [Accessed 4 April 2016].

Pew Research Center, 2014. *Millennials In Adulthood: Detached From Institutions, Networked With Friends*. [online] pp. 1-68. Available at: <https://www.issuelab.org/resources/17455/17455.pdf> [Accessed 4 March 2020].

Polyphenols.com. n.d.a *Quercetin 3,4'-Diglucoside - Polyphenols*. [online] Available at: <https://polyphenols.com/flavonols/quercetin-3-4-diglucoside-article166-171.html> [Accessed 6 August 2020].

Polyphenols.com. n.d.b *Quercetin 4'-Glucoside - Polyphenols*. [online] Available at: <https://polyphenols.com/flavonols/quercetin-4-glucoside-article165-171.html> [Accessed 6 August 2020].

Polyphenols.com. n.d.c *Pelargonidin Chloride - Polyphenols*. [online] Available at: <https://polyphenols.com/pelargonidin-products/pelargonidin-chloride-article108-158.html> [Accessed 6 August 2020].

Prahalad, C. and Ramaswamy, V., 2004. Co-creating unique value with customers. *Strategy & Leadership*, 32(3), pp.4-9.

Prusinski, L., 2012. Wabi-Sabi, Mono no Aware, and Ma: Tracing Traditional Japanese Aesthetics Through Japanese History. *Studies on Asia*, 2(1), pp.25-49.

PureGym. 2020. *Trainsafe* [online] Available at: <https://www.puregym.com/landing/trainsafe/> [Accessed 17 October 2020].

Rai, H., Bhattacharyya, M., Singh, J., Bansal, T., Vats, P. and Banerjee, U., 2005. Removal of Dyes from the Effluent of Textile and Dyestuff Manufacturing Industry: A Review of Emerging Techniques With Reference to Biological Treatment. *Critical Reviews in Environmental Science and Technology*, 35(3), pp.219-238.

Razzouk, R. and Shute, V., 2012. What Is Design Thinking and Why Is It Important?. *Review of Educational Research*, 82(3), pp.330-348.

Rehman, F., Adeel, S., Shahid, M., Bhatti, I., Nasir, F., Akhtar, N. and Ahmad, Z., 2013. Dyeing of $\gamma$-irradiated cotton with natural flavonoid dye extracted from irradiated onion shells (*Allium cepa*) powder. *Radiation Physics and Chemistry*, 92, pp.71-75.

Reid, N., Hawkins, E., Liu, W., Page, M., Webster, H., Katsikitis, M., Shelton, D., Wood, A., O'Callaghan, F., Morrissey, S. and Shanley, D., 2021. Yarning about fetal alcohol spectrum disorder: Outcomes of a community-based workshop. *Research in Developmental Disabilities*, 108, p.103810.

Rengasamy, R., 2011. Improving moisture management in apparel. In: G. Song, ed., *Improving comfort in clothing*, 1st ed. Oxford: Woodhead Publishing Limited, pp.182-215.

Researchandmarkets.com. 2019. *Natural Dyes Market - Global Outlook And Forecast 2019-2024*. [online] Available at: <https://www.researchandmarkets.com/research/w7fz67/global_natural?w=12> [Accessed13 Oct. 2019].

SAGARPA, 2017a. *5TO INFORME DE LABORES 2016-2017*. pp.1-143. [online] Available at: https://www.gob.mx/cms/uploads/attachment/file/255710/5TO_INFORME_2017_web.pdf

SAGARPA, 2017b. *Algodón Mexicano*. Ciudad de México, pp.1-11 [online] Available at: https://www.gob.mx/cms/uploads/attachment/file/257068/Potencial-Algod_n.pdf

Saldaña Fabela, P. and Gómez Balandra, M., 2016. Caracterización de fuentes puntuales de contaminación del río Atoyac. XXX Congreso Interamericano de Ingeniería Sanitaria y Ambiental. AIDIS Available at: http://www.bvsde.paho.org/bvsaidis/ uruguay30/MX08163_Saldana_Fabela.pdf, [no pagination].

Samanta, A. and Agarwal, P., 2009. Application of natural dyes on textiles. *Indian Journal of Fibre & Textile Research*, 34, pp.384-399.

Samanta, A. and Konar, A., 2011. Dyeing of Textiles with Natural Dyes. *Natural Dyes*, pp.29-56.

Sanders, E. and Stappers, P., 2008. Co-creation and the new landscapes of design. *CoDesign*, 4(1), pp.5-18.

Saxena, S. and Raja, A., 2014. Natural Dyes: Sources, Chemistry, Application and Sustainability Issues. In: S. Muthu, ed., *Roadmap to Sustainable Textiles and Clothing : Eco-Friendly Raw Materials, Technologies, and Processing Methods*, 1st ed. Hong Kong: Subramanian Senthilkannan Muthu, pp.37-80.

Schultz, S., Kleine, R. and Kernan, J., 1989. "These Are A Few of My Favorite Things"- Towards and Explication of Attachment as a Consumer Behavior Constrcut. *Advances in Consumer Research*, 16, pp.359-366.

Secretaría de Agricultura y Desarrollo Rural, 2020. *Quien Tiene Ovejas... Tiene Lana* [online] Available at: https://www.gob.mx/agricultura/articulos/quien-tiene-ovejas-tiene-lana?idiom=es.

Secretaría de Medio Ambiente y Recursos Naturales, Comisión Nacional del Agua, 2013. *Normas Oficiales Mexicanas NOM-001-SEMARNAT-1996 NOM-002-SEMARNAT-1996 NOM-003-SEMARNAT-1997*. Ciudad de México, pp.5-29. [online] Available at: http://www.conagua.gob.mx/CONAGUA07/Publicaciones/Publicaciones/SGAA-15-13.pdf.

Sekar, N., 2011. Direct dyes. In: M. Clark, ed., *Handbook of Textile and Industrial Dyeing: Volume 1 Principles, Processes and Types of Dyes*, 1st ed. Cambridge: Woodhead Publishing Limited, pp.425- 445.

Seminis. 2018. *Seminis*. [online] Available at: <https://www.seminis.mx/la-cebolla-en-el-campo-mexicano-mercado-y-produccion/> [Accessed 29 October 2020].

Shahid, M., Shahid-ul-Islam and Mohammad, F., 2013. Recent advancements in natural dye applications: a review. *Journal of Cleaner Production*, 53, pp.310-331.

Steen, M., 2013. Co-Design as a Process of Joint Inquiry and Imagination. *Design Issues*, 29(2), pp.16-28.

Steffen, W. and Hughes, L., 2013. *The Critical Decade 2013: Climate Change Science, Risks And Responses.*. Climate Commission Secretariat, pp.1-112.

Stenmarck, A., Jensen, C., Quested, T., Moates, G., Buksti, M., Cseh, B., Juul, S., Parry, A., Politano, A., Redlingshofer, B., Scherhaufer, S., Silvennoinen, K., Soethoudt, H., Zübert, C. and Östergren, K.,

2016. *Estimates Of European Food Waste Levels* [ebook] Stockholm: Fusions, pp.1-79. Available at: http://www.eufusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf [Accessed 16 Oct. 2018].

Stintzing, F. and Carle, R., 2004. Functional properties of anthocyanins and betalains in plants, food, and in human nutrition. *Trends in Food Science & Technology*, 15(1), pp.19-38.

support.snapchat.com. n.d. *Snapchat Support*. [online] Available at: <https://support.snapchat.com/es/a/my-story> [Accessed 6 October 2020].

Tamayo, A., 2017. Guarderías de empresa. *El Financiero*, [online] Available at: <https://www.elfinanciero.com.mx/monterrey/guarderias-de-empresa> [Accessed 18 October 2020].

Tapp, A. and Spotswood, F., 2013. From the 4Ps to COM-SM: reconfiguring the social marketing mix. *Journal of Social Marketing*, 3(3), pp.206-222.

Taylor, S., Bogdan, R. and DeVault, M., 2015. *Introduction To Qualitative Research Methods: A Guidebook And Resource*. 4th ed. New Jersey: Wiley, pp.1-423.

Tian, K., Bearden, W. and Hunter, G., 2001. Consumers' Need for Uniqueness: Scale Development and Validation. *Journal of Consumer Research*, 28(1), pp.50-66.

Tonkinwise, C., 2015. Design for Transitions–from and to what?. *Design Philosophy Papers*, 13(1), pp.85-92.

Toprak, T. and Anis, P., 2017. Textile Industry's Environmental Effects and Approaching Cleaner Production and Sustainability: an Overview. *Journal of Textile Engineering & Fashion Technology*, 2(4), pp.429-442.

Tsaknaki, V. and Fernaeus, Y., 2016. Expanding on Wabi-Sabi as a Design Resource in HCI. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*, pp.5970-5983.

Uddin, M., 2014. Effects of Different Mordants on Silk Fabric Dyed with Onion Outer Skin Extracts. *Journal of Textiles*, 2014, pp.1-8.

Ubuntoo.com. 2021. *KAIKU*. [online] Available at: <https://ubuntoo.com/solutions/kaiku-2> [Accessed 22 May 2021].

United Nations, 2019. *World Economic Situation And Prospects 2019*. [online] New York, p.170. Available at: <https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/WESP2019_BOOK-web.pdf> [Accessed 23 October 2020].

United Nations, 2020. *United Nations Comprehensive Response To COVID-19: Saving Lives, Protecting Societies, Recovering Better*. [online] Available at: <https://www.unwto.org/sites/default/files/news/pdf/Comprehensive-COVID-report-mock-up-v4.pdf> [Accessed 23 October 2020].

Vankar, P., Shanker, R. and Wijayapala, S., 2009. Dyeing of cotton, wool and silk with extract of Allium cepa. *Pigment & Resin Technology*, 38(4), pp.242-247.

Water resources group, 2018. *LOCAL INNOVATIONS FOR GLOBAL WATER SECURITY*. Water Resources Group Annual Report. [online] p.89. Available at: https://www.2030wrg.org/wp-content/uploads/2019/04/WRG_ANNUAL-REPORT-WEB_FINAL.pdf [Accessed 3 May 2019].

Who.int. n.d. *Mental Health And COVID-19*. [online] Available at: <https://www.who.int/teams/mental-health-and-substance-use/covid-19> [Accessed 23 October 2020].

World Bank Group, 1998. *Glossary Of Environmental Terms*. Pollution Prevention and Abatement Handbook. [online] p.443. Available at: <http://siteresources.worldbank.org/INTENVASS/2145841115356570828/20480327/WorldBankPollutionPreventionandAbatementHandbookGlossaryofEnvironmentalTerms1998.pdf> [Accessed 6 September 2017].

World Bank, 2014. *The Bangladesh Responsible Sourcing Initiative: A new model for green growth?*. [online] Wahington, pp.1-79. Available at: <http://documents1.worldbank.org/curated/en/614901468768707543/pdf/922610WP0P11950DEL0FOR0GREEN0GROWTH.pdf> [Accessed 4 Sep. 2017].

worldbank.org. 2018. *Taxing Tobacco: A Win-Win For Public Health Outcomes And Mobilizing Domestic Resources*. [online] Available at: <https://www.worldbank.org/en/topic/tobacco/brief/taxing-tobacco-a-win-win-for-public-health-outcomes-mobilizing-domestic-resources> [Accessed 18 October 2020].

worldbank.org. 2020a. *Water In Agriculture*. [online] Available at: <https://www.worldbank.org/en/topic/water-in-agriculture> [Accessed 28 July 2020].

worldbank.org. 2020b. *Agriculture And Food*. [online] Available at: <https://www.worldbank.org/en/topic/agriculture/overview#1> [Accessed 6 November 2020].

World Health Organization, n.d. *How To Wear A Non-Medical Fabric Mask Safely*. [online] Available at: <https://www.who.int/images/default-source/health-topics/coronavirus/clothing-masks-infographic--web---part-1.png?sfvrsn=679fb6f1_26> [Accessed 17 October 2020].

Yee-Batista, C., 2013. *Un 70% De Las Aguas Residuales De Latinoamérica Vuelven A Los Ríos Sin Ser Tratadas*. [online] World Bank. Available at: <https://www.bancomundial.org/es/news/feature/2014/01/02/rios-de-latinoamerica-contaminados> [Accessed 9 November 2020].

Zubairu, A. and Mshelia, Y., 2015. Effects of Selected Mordants on the Application of Natural Dye from Onion Skin (*Allium cepa*). *Science and Technology*, 5(2), pp.26-32.

**Figures**

Alihosseini, F. and Sun, G., 2011.*Chemical structure of anthocyanidine colorants (a) and their glycoside form (b)* [image].

Alihosseini, F. and Sun, G., 2011.*Chemical structures of main flavonol colorants* [image].

Ardanuy, M., Faccini, M., Amantia, D., Aubouy, L. and Borja, G., 2014. Preparation of durable insecticide cotton fabrics through sol–gel treatment with permethrin. *Surface and Coatings Technology*, 239, pp.132-137.

Beesk, N., Perner, H., Schwarz, D., George, E., Kroh, L. and Rohn, S., 2010. *Chemical structures of quercetin and its major glucosides in onions (Allium cepa L.)* [image].

Clark, M., 2011. *Typical dyeing profile*. [image].

Dharma Trading Co., 2019. *C.I. Acid Blue 45*. [image] Available at: <http://www.npi.gov.au/resource/formaldehyde> [Accessed 28 August 2020].

Festa, G., Cuomo, M., Metallo, G. and Festa, A., 2016. *A reconsideration of the (wine) marketing mix*. [image].

Hesse-Biber, S., 2010. *Explanatory sequential design*. [image].

Hesse-Biber, S., 2010. *Exploratory sequential design*. [image].

Hesse-Biber, S., 2010. *Integrating methods in a sequential exploratory design*. [image].

Hesse-Biber, S., 2010. *Parallel mixed methods design.* [image].

Hesse-Biber, S., 2010. *Philosophical Standpoints In The Research.* [image].

KOH, J., 2011. *Direct dyeing profile.* [image].

Merriam, S., 2009. *Epistemological perspectives.* [image].

Merriam, S., 2009. *Interview structure continuum.* [image].

Michie, S., van Stralen, M. and West, R., 2011. *The behaviour change wheel.* [image].

Michie, S., van Stralen, M. and West, R., 2011. *The COM-B system- a framework for understanding behaviour.* [image].

Panche, A., Diwan, A. and Chandra, S., 2016. *Basic skeleton structure of flavonoids and their classes*. [image].

Pew Research Center, 2019. *The Generations Defined*. [image] Available at: <https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins/> [Accessed 4 March 2020].

Prahalad, C. and Ramaswamy, V., 2004. *The new frame of reference for value creation.* [image].

Rehman, F., Adeel, S., Shahid, M., Bhatti, I., Nasir, F., Akhtar, N. and Ahmad, Z., 2013. *Structure of Quercetin* [image].

Saldaña Fabela, P. and Gómez Balandra, M., 2016. *Wastewater discharge into the Atoyac River* [image].

Sanders, E. and Stappers, P., 2008. *A snapshot in time and emerging design practices.* [image].

Textile Learner, 2014. *Chemical Structure Of Cotton*. [image] Available at: <https://textilelearner.blogspot.com/2014/10/chemical-composition-of-cotton-fiber.html> [Accessed 17 Oct. 2018].

Uddin, M., 2014. *Chemical structure of pelargonidin.* [image].

## Appendix 1. Questionnaire in Spanish

¿CÓMO ES EL VÍNCULO CON MI ROPA?

Hola, si eres una mujer Mexicana dentro de los 18 y 33 años, te invito a contestar el siguiente cuestionario, solo tomará 10 minutos de tu tiempo.
Las preguntas son parte de un proyecto de doctorado en Inglaterra. El objetivo es analizar la relación que tenemos con nuestra ropa para proporcionar una alternativa de teñido textil sustentable y al mismo tiempo proporcionar una experiencia gratificante. Toda la información recopilada será confidencial.

Quieres participar?

☐ Si

☐ No

1. Edad

☐ 18 - 21 años

☐ 22 - 25 años

☐ 26 - 29 años

☐ 30 - 33 años

2. Lugar de residencia? (Se desplegará una lista de todos los estados de México para seleccionar)
Estado: ________________

3. Situación sentimental

☐ Soltera

☐ Casada

☐ En unión libre

4. Tienes hijos?

☐ Sí

☐ No

5. Vives con tus padres?

☐ Sí

☐ No

6. Cuál es tu ocupación actual? (Puedes elegir más de una opción de ser necesario)

☐ Estudiante

☐ Empleado del sector privado

☐ Empleado del sector público

☐ Emprendedor/ Self-employed

☐ Desempleado

7. ¿Cuántos focos tienes en casa? contando techo, paredes y lámparas de escritorio
☐ 5 o menos
☐ Entre 6 y 10
☐ Entre 11 y 15
☐ Entre 16 y 20
☐ 21 o más

8. ¿ Las influencers te motivan a comprar ropa de la que ellas usan?
☐ Sí
☐ No
☐ No se que es una influencer

9. ¿Por cuál medio compras tu ropa?
☐Online/ Tienda virtual
☐ Tienda física o establecimiento

10. ¿Cuánto gastas en 1 prenda de ropa en promedio?
☐ 300 pesos o menos ☐ De 500 a 1000 pesos
☐ De 300 a 500 pesos ☐ 2000 pesos o más

11. ¿Al comprar ropa busca fibras naturales (algodón, lino, lana, seda)?
☐Sí
☐No

12. Identifica los 3 factores principales que consideras al comprar ropa
☐ Precio
☐ Calidad
☐ Marca
☐ Tela
☐ Color
☐ En tendencia
☐ Que me quede bien
☐ Cuidado del medio ambiente/ huella ambiental
¿Cuál de los tres seleccionados es el más importante para ti?____________________

13. ¿Con qué frecuencia compras ropa para ti?
☐ Una vez a la semana
☐ 1-2 veces al mes
☐ 1-2 veces al año
☐ Más de 3 veces al año

14. Al comprar ropa, ¿piensas en las consecuencias que tu compra tendrá en el medio ambiente?
☐ Sí ☐ No

15. Al realizar una compra, ¿cuánta influencia tiene en tu decisión que la empresa se preocupe por el medio ambiente?
☐ Mucha
☐ Un poco
☐ Ninguna

16. ¿Cuánto consideras que las actividades de teñido de las compañías de ropa contribuyen al daño ambiental, en particular a la contaminación de agua?
☐ Mucho
☐ Un poco
☐ Nada
☐ No lo sé

17. ¿Cuánto interés tienes en el cuidado del medio ambiente?
☐ Muy poco
☐ Regular
☐ Mucho

18. ¿Qué importancia tiene para ti el color al comprar ropa?
☐ Mucha
☐ Algo
☐ Un poco
☐ Ninguna

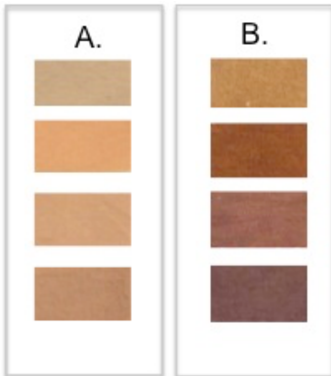
19. ¿Conoces la diferencia entre los tintes naturales y sintéticos?
☐ Sí
☐ No

20. ¿Alguna vez has comprado ropa teñida naturalmente?
☐ Sí
☐ No
☐ No lo se

Si elegiste no, ¿por qué?
☐ Nunca he estado en una tienda que ofrezca ropa teñida naturalmente
☐ No sé la diferencia entre tintes naturales y sintéticos
☐ Prefiero tintes sintéticos
☐ No me gustan los tintes naturales

21. ¿Qué paleta de colores te gusta más?

☐ A ☐ B




Si elegiste la paleta B, ¿preferirías comprar colores más intensos sabiendo que para aumentar su color, se agregan productos químicos metálicos, los cuales tienen un efecto negativo en el medio ambiente, particularmente en la contaminación del agua?

☐ Sí ☐ No

22. ¿Usarías ropa teñida naturalmente sin productos químicos metálicos, sabiendo que tienen un impacto ambiental menos negativo, pero sabiendo que su color puede desvanecerse con bastante rapidez?

☐ Sí ☐ No

23. Si pudieras tener la posibilidad de usar ropa que debido a su fuente de tinte nunca proporcionará un tono de color estándar, lo que significaría, por ejemplo, que dentro del mismo modelo de una camiseta, el tono de color sería totalmente diferente entre unas y otras, te interesaría?

☐ Sí, me gustaría comprar un producto diferente al resto

☐ No, prefiero productos estandarizados que brindan las mismas características

24. ¿Comprarías una camiseta que tuviera variaciones de color, es decir diferente intensidad en algunas partes?

☐ Sí, me gustaría un producto que tuviera variaciones de tono dentro de la misma prenda

☐ No, prefiero productos estandarizados que proporcionan el mismo tono en toda prenda

25. Si supieras que el desperdicio de alimentos de frutas y verduras puede ser un recurso natural para teñir tu ropa, y además estaría libre de productos químicos metálicos, ¿sería probable que la compraras?

☐ Sí ☐ No

- Si elegiste SÍ, ¿cuál sería el principal factor de relevancia en su compra?

☐ Estoy interesado en un producto que sea único y no en un producto estandarizado donde muchas personas tienen exactamente el mismo producto

☐ No me gustan los productos químicos

☐ Sentiría que estoy creando un impacto positivo en el medio ambiente

-Si elegiste NO, ¿cuál será la razón principal para tomar esta decisión?

☐ Las marcas de ropa que suelo comprar no usan estos tintes

☐ No me gusta la idea de usar desperdicios de frutas y verduras para teñir mi ropa

☐ El impacto ambiental no es importante para mí

Si NO te gusta la idea de que se usen desperdicios de fruta o verdura para teñir tu ropa, ¿cambiarias de opinión si fueras parte del proceso de diseño?

☐ Sí

☐ No

☐ A mi SÍ me gusta la idea

Si NO te gusta la idea de que se usen desperdicios de fruta o verdura para teñir tu ropa, ¿cambiarias de opinión si fueras parte del proceso de diseño de color?

☐ Sí

☐ No

☐ A mi SÍ me gusta la idea

26. ¿Cuánto influiría en tu decisión de compra al saber que una tienda de ropa que tiñe prendas de forma natural te ofrezca la posibilidad de enviarte recetas para que puedas volver a teñir tu ropa en casa con el desperdicio de frutas y verduras sin productos químicos añadidos, una vez que el color natural anterior se desvanezca?

☐ Mucho

☐ Algo

☐ Un poco

☐ Nada

27. ¿Tienes una prenda favorita?

☐ Sí ☐ No

En caso afirmativo:
¿por cuánto tiempo la posees?

☐ 1 año o menos

☐ 2-3 años

☐ 4- 5 años

☐ 5 años o más

¿la usas activamente?

☐ Sí ☐ No

28. ¿Tienes alguna prenda de ropa que crees te trae alegría?

☐ Sí

☐ No

29. ¿Tienes alguna prenda de ropa que crees te trae suerte?

☐ Sí

☐ No

30. ¿Crees que la ropa tiene el poder de cambiar tu estado de ánimo?

☐ Sí

☐ No

31. ¿Has personalizado tu ropa?

☐ Sí ☐ No

En caso afirmativo, cómo: ______________________________

32. ¿Alguna vez teñiste o cambiaste el color de una prenda?

☐ Sí ☐ No

33. Si pudieras renovar, volver a teñir, remodelar una prenda existente que ya no usas, para volver a usarla, ¿lo harías?

☐ Sí

☐ No

34. Si pudieras cambiar continuamente el color de tu prenda favorita, ¿lo harías?

☐ Sí

☐ No

35. Si supieras que puedes cambiar el color de tu prenda favorita sin afectar negativamente el medio ambiente/ la contaminación del agua, ¿lo harías?

☐ Sí

☐ No

36. Si pudieras ser parte del diseño de color de tu prenda de vestir, ¿cambiaría tu experiencia al usarla?

☐ Sí

☐ No

¿Si es Sí por qué? ________________________________

Gracias por tomarse el tiempo para participar, sus respuestas son extremadamente valiosas

## Appendix 2. Questionnaire in English

HOW IS THE RELATIONSHIP WITH MY CLOTHING?

Hi, if you are a Mexican female and under the age range of 18-34 years old, you are invited to answer the following questionnaire which would not take more than 10 minutes of your time!

The questions presented are part of a doctorate project-taking place in England, the research aims to analyse the relationship we have with our clothing in order to provide a more sustainable colouring alternative and at the same time a more joyful experience. All information collected will be anonymised.

Do you want to participate?
□Yes
□ No

1. Age
□ 18 - 21 years old
□ 22 - 25 years old
□ 26 - 29 years old
□ 30 - 33 years old

2. Where do you live? (A list of all the states of Mexico will be displayed - select one)

State: ______________________________________________

3. Which is your relationship status?
□ Single
□ Married
□ Free union

4. Do you have children?
□ Yes
□ No

5.Do you live with your parents?
□ Yes
□ No

6. What is your current situation? (You can choose more than one option if applicable)
□ Student
□ Private sector employee
□ Public sector employee
□ Entrepreneur/ Self-employed
□ Unemployed

7. Counting all the light bulbs that you use to lighten your home, including ceiling, walls, and desk lamps, how many light bulbs do you have in your house?
□ 5 or less
□ Between 6 and 10
□ Between 11 and 15
□ Between 16 and 20
□ 21 or more

8. Do you consider what influencers wear, in order to buy similar clothing?
□ Yes
□ No
□ I do not know what does influencer mean

9. How do you prefer to buy clothing?
□ Online
□ On store

10. How much do you spend on one garment on average?
□ 300 pesos or less □ 500 to 1000 pesos
□ 300 to 500 pesos □ 2000 pesos or more

11. When buying clothes do you look for natural fibres (cotton, linen, wool, silk)?
□Yes
□No

12. Identify the 3 main factors that you consider when buying new clothes
□ Price
□ Quality
□ Brand
□ Fabric
□ Colour
□ On Trend
□ Good fit
□ Environmental footprint
Which one of the three selected, is the most important for you? ____________________

13. How often do you buy clothes for you?
□ Once a week
□ 1-2 times a month
□ 1-2 times a year
□ More than 3 times a year

14. When buying clothes, do you think of the consequences that your purchase will have on the environment?
□ Yes □ No

15. When making a purchase, how much influence on your decision on whether or not the company cares for the environment?
□ A lot
□ Some
□ Not at all

16. How much do you consider the dyeing activities of clothing companies contribute to environmental damage, water pollution in particular?
□ A lot
□ Some
□ None
□ I do not know

17. How much interest do you have in the care of the environment?
□ Very little
□ Regular
□ Very strong

18. How important is for you colour when buying clothing?
□ A lot
□ Some
□ A little
□ Not at all

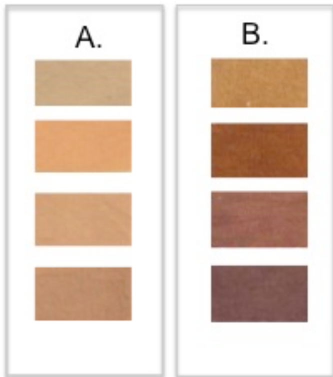
19. Do you know the difference between natural and synthetic dyes?
□ Yes
□ No

20. Have you ever purchased naturally dyed clothing?
□ Yes
□ No
□ I do not know

If you chose no, why?
□ I've never been to a store that offers naturally dyed clothing
□ I do not know the difference between natural and synthetic dyes
□ I prefer synthetic dyes
□ I do not like natural dyes

21. Which color palette do you prefer?

☐ A ☐ B




If you chose the palette B, would you still prefer to buy brighther colours knowing that in order to increase their colour, metallic chemicals are added, having consequently a negative effect on the environment and water pollution in particular?

☐ Yes ☐ No

22. Would you wear naturally dyed clothing without metallic chemicals added, being aware they have a less negative environmental impact, but knowing that its colour may fade quite quickly?

☐ Yes ☐ No

23. If you could have the possibility of wearing clothing that due to its dye source will never provide an standard colour shade, meaning for example that within the same model of a T-shirt, the colour shade would be totally different between each other, would you buy it?

☐ Yes, I would like to buy a product that is different from the rest

☐ No, I prefer standardise products that provide the same characteristics

24. Would you buy a t-shirt that varies it shade in some parts?

☐ Yes, I would like to buy a product that provide shade variations

☐ No, I prefer standardise products that provide the same exact shade within a garment

25. If you knew, that food waste from fruits and vegetables can be a natural resource to dye your clothes, and in addition does not contain metallic chemicals, would you be more likely to buy?

☐ Yes ☐ No

- If you chose YES, which would be the main factor of relevance in your purchase?

☐ I´m interested in a product that can be unique and not a standardised product where lots of people have exactly the same product.

☐ I do not like chemicals

☐ I feel I am creating a positive impact on the environment

- If you chose NO, which will be the main reason for making this decision?
☐ The clothing brands I usually buy from don´t use these dyes
☐ I do not like the idea of using food waste to dye my clothing
☐ Environmental impact is not important to me

If you DO NOT like the idea of using food waste to dye your clothing, will you change your mind if you become part of the design process?
☐ Yes
☐ No
☐ I did like the idea

If you DO NOT like the idea of using food waste to dye your clothing, will you change your mind if you become part of the colour design process?
☐ Yes
☐ No
☐ I did like the idea

26. How much would influence your purchase decision knowing that a clothing store of naturally dyed garments offers you the possibility of sending recipes for you to re-dye your clothes at home, once the previous natural colour fades using food waste and no added chemicals?
☐ A lot
☐ Some
☐ A little
☐ Not at all

27. Do you have a favourite piece of clothing?
☐ Yes ☐ No

If yes, for how long do you own it?
☐ 1 year or less
☐ 2-3 years
☐ 4- 5 years
☐ 5 years or more

If yes, do you actively use it?
☐ Yes ☐ No

28. Do you have a certain piece of clothing that you believe brings you joy?
☐ Yes
☐ No

29. Do you have a certain piece of clothing that you believe brings you luck?
☐ Yes
☐ No

30. Do you believe clothing has the power to change your mood?
□ Yes
□ No

31. Have you customised your clothing?
□ Yes □ No
If yes how: ______________________________

32. Have you ever re-dyed or changed the colour of a garment?
□ Yes □ No

33. If you could renovate, re-dye, refashioned an existing garment that you no longer use, in order to use it again, will you do it?
□ Yes
□ No

34. If you could continuously change the colour of your favourite piece of clothing will you do it?
□ Yes
□ No

35. If you know that changing the colour of your favourite piece of clothing can be done without adversely affecting the environment/waterways will you do it?
□ Yes
□ No

36. If you could be part of the colour design of a piece of clothing, would it change the experience of wearing it?
□ Yes
□ No
If yes why? ________________________________

Thank you for taking time to participate, your answers are extremely valuable ☺

**Appendix 3. Pilot version of the workshop questionnaire**

1. Were the workshop steps easy to follow?

☐ Yes

☐ No

- If not, which step was confusing?

  ☐ 1

  ☐ 2

  ☐ 3

  ☐ 4

  ☐ 5

  ☐ 6

  ☐ 7

  ☐ 8

2. Was it easy to collect the organic waste?

☐ Yes

☐ No

- If no,why?__________________________________________________

3. Do you like the new appearance of your garment?

☐ Yes

☐ No

4. Was the outome what you expected?

☐ The outcome was as I expected

☐ The outcome was surprising

- If the outcome was surprising, did you like it or not?

  ☐ Yes

  ☐ No

5. Why did you choose this specific garment to re-dye?

______________________________________________________________

6. Would you wear the garment that you dyed?

☐ Yes

☐ No

- If yes,why?____________________________________________________________
- If no,why?____________________________________________________________

7. Would you repeat this activity with another garment that you no longer use?

☐ Yes

☐ No

8. Would you recommend / invite more people to do this activity?

☐ Yes

☐ No

9. Did you enjoy the experience?

☐ Yes

☐ No

- If YES, what did you like the most??

☐ The new appearence of my garment

☐ Being part of the design process

☐ Using food waste

☐ The uniqueness of the patterns and colours

☐ Other

______________________________________________________________________

- If NOT, what did you not like?

______________________________________________________________________

10. Would you change something in the process?

☐ Yes

☐ No

- If, YES, what?________________________________________________________

Thank you for taking the time to participate, your answers are extremely valuable ☺

## Appendix 4. Post-questionnaire (Two months post the DIY domestic natural dyeing workshop workshop)

1. In the past 2 months, how often have you bought clothes for you?
□ Not bought any clothes (go to Q4)
□ Once a week
□ 1-2 times a month
□ 1-2 times a year
□ More than 3 times a year

2. In the past 2 months, when buying clothes have you looked for natural fibres (cotton, linen, wool, silk)?
□Yes
□No

3. In the past 2 months, when buying clothes have you thought of the consequences that your purchase will have on the environment?
□ Yes □ No

4. Have you wore the garment that you dyed in the workshop activity?
☐ Yes
☐ No
- If yes,do you believe you personal involvement has influenced you to wear it?
☐ Yes
☐ No

5. Have you repeated the workshop activity with another garment that you no longer use, in order to use it again?
☐ Yes
☐ No

- If no, are you willing to do it?
☐ Yes
☐ No

6. Did the information received at the workshop about the negative impacts that metallic chemical additives have on Mexican waterways, increase your awareness with regards to the environmental impacts of the dyeing activities from the textile industry?
□ Yes
□ No

7. Did the information received at the workshop about the negative impacts that metallic chemical additives have on Mexican waterways, increase your awareness about the difference between natural and synthetic dyes?
□ Yes
□ No

8. Are you now more willing to accept quick colour fading in a garment knowing that this fading is because it has been dyed with natural dyes without metallic chemical additives added?
□ Yes
□ No

9. Are you now more willing to accept colour variation in a garment after being aware this is because it has been dyed with natural dyes without metallic chemical additives added?
□ Yes
□ No

10. Are you now more willing to buy garments that have been dyed with domestic food waste?
□ Yes
□ No

Thank you for taking the time to participate!