IS THERE A NEED FOR "HEALTHY" CHOCOLATE?

Systematic Literature Review and Consumer research in Belgium and in Denmark

Extended Master Thesis

Integrated Food Studies

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“La humanidad también necesita soñadores, para quienes el desarrollo de una tarea sea tan cautivante que les resulte imposible dedicar su atención a su propio beneficio”.

Marie Curie

Para Ruth y Fernando

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Y a mis tres favoritos, Mamá, Tata y Polola, mil gracias por su amor.

Preface

Is there a need for healthy chocolate?

Systematic Literature Review and Consumer Research in Belgium and in Denmark.

The following thesis presents the project developed as part of the Master Program: Integrated Food Studies (IFS), at Aalborg University. The project has two research areas. The first, a Systematic Literature Review conducted in four data bases for the search of themes related to health, sensory characteristics and acceptance and, attitudes towards chocolate. The second area focuses in consumer research, evaluation of the sensory characteristics of five different sugar-content chocolates. The "Attitudes to Chocolate Questionnaire" has been part of the questionnaire.

The present project has been part of an agreement with Barry Callebaut, the "world´s leading manufacturer of high-quality chocolate and cocoa products" (Callebaut, 2015).

Public Health Nutrition, one of the pillars of IFS, has been chosen to be the main area of research in this project.

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Abstract

Is there a need for "healthy" chocolate?

Chocolate has especially properties that help to protect human body against cardiovascular diseases; it increases HDL cholesterol and decrease blood pressure. Chocolate consumption also helps to reduce stress, elevates mood and reduces tiredness.

Objectives: Analyze the relevance of a healthy chocolate based on consumer´s needs, expectations and perceptions.

Methods: The present project studies three areas related to chocolate: Chocolate and its relation to health, Chocolate sensory characteristics and acceptance, and attitudes towards Chocolate. A systematically literature review has been part of this study together with consumer research based on a questionnaire. The questionnaire includes a sensory test of five different sugar-content chocolates. The questionnaire has been applied in Belgium and in Denmark among university students. A sample size of 215 participants has been part of this study.

Results: There is a significant difference when comparing the consideration of dark chocolate as part of a healthy lifestyle among countries. 46.7% of the participants in Belgium consider dark chocolate part of a healthy lifestyle while in Denmark 68.2% does. Danes prefer to eat dark chocolate rather than milk chocolate, and Belgians prefer milk rather than dark chocolate. The liking of the five chocolate samples varies significantly among countries but not by gender. And as it has been found in the literature, there is a contrast when comparing the attitudes towards chocolate among gender. There is a tendency of women craving or feeling guilty after eating chocolate.

Conclusion: Based on this project it can be concluded that there is a need for "healthy" chocolate. The literature supports the health properties that chocolate consumption has and the consumers are willing to purchase a chocolate product with sugar and calories reduced.

Keywords: Chocolate, health, sensory characteristics, attitudes.

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APPENDIX

1 INTRODUCTION

"A cup of this precious drink permits a man to walk for a whole day without food" - Hernán Cortés, 1519" (Corti , Flammer, Hollenberg, & Lüscher, 2009). Chocolate has been consumed for many years; and especially as a drink. The first traces of chocolate consumption dates back to year 1600 BC. The Incas considered it as the drink of gods, Mayas and Aztecas used this famous drink as part of their religious rituals. Chocolate was consumed mixed with water and spices. It is not after the 16th century that chocolate arrives in Europe where people started consumed it in combination with milk and sugar. (Jiménez, 2010).

There is a trend of people becoming overweight and obese. This is causing many diseases, especially related to cardiovascular problems. Kahn & Sievenpiper (2014) stated that since 1970 overweight and obesity have increased due to the diversity of sugar available products. Nowadays sugar and caloric sweetener consumption have decreased and despite this; the percentage of extra body pounds is still increasing (Kahn & Sievenpiper, 2014).

Food has been forever a pleasure, an enjoyable item that takes part of our everyday life. Sugar-content food items such as chocolate are specially related to celebrations like Christmas, birthdays and other special occasions.

For this reason, the aim of this thesis is to analyze the relevance of a healthy chocolate consumer´s needs, expectations and perceptions.

1.1 Project description

The present project studies three areas related to chocolate: Chocolate and its relation to health, Chocolate sensory characteristics and acceptance and attitudes towards Chocolate.

In this work a systematic literature review and consumer research has been conducted. The literature review has included four digital databases where 2062 articles have been reviewed by titles, 523 by abstracts and 215 the entire text. After this process, 60 articles have been included in the study because they have met the established criteria.

After doing the literature review a questionnaire has been developed and applied in Gent - Belgium and in Copenhagen – Denmark to find the determinants for eating chocolate among university students. The questionnaire has three parts: Sensory characteristic analysis of five chocolate samples, questions in relation to health beliefs and the twenty-four statements of the Attitudes to Chocolate questionnaire.

The visit to Barry Callebaut, in Wieze, "the world's leading manufacturer of high-quality chocolate and cocoa products" (Callebaut, 2015) was part of this project too. A short stage whit this company made possible to develop the questionnaire and collect data in Belgium. Besides this, the visit to the company revealed a snapshot of how the food industry is deeply involved with science.

1.2 Barry Callebaut

"1 in 5 chocolate and cocoa products consumed worldwide has Barry Callebaut inside" (Callebaut, 2015).

Barry Callebaut is the leading manufacturer of chocolate and cocoa products in the world with more than 9300 employees in 30 countries and with an annual sale of around 4.8 billion euros. The company is involved from processing cocoa beans to the development of final chocolate products. It is an innovative company that focuses in local preferences, while cooperates with cocoa farming and communities and involves different stakeholders all around the world.

This company stands out because of its innovation. Some of the original products are: Sugar-reduced chocolates, chocolate with stevia, chocolate sweetened with fruit and others.

One of the aims of this project is to test five of the chocolate samples with sugar reduced and without added sugar that have been developed by the Innovation department of this company.

1.3 State of the art

As it was mentioned before, a systematic literature review has been done. The main findings of this process can be seen in the result and discussion of the present project. Some of the relevant insights of these founding can be mentioned below.

In relation to health, it has been found that chocolate consumption even in large quantities improves endothelial, platelet function and reduces blood pressure. This effects might be caused by the flavanols present in the cocoa (Buijsse, Weikert, Drogan, Bergmann, & Boeing, 2010).

Sarriá et al. (2014) states that the content of polyphenols in chocolate, especially flavanols have a potential to improve health, but the effects that chocolate might have like acting as antioxidant, anti-inflammatory can vary from person to person and it always depend on the person´s health and diet.

Chocolate´s studies are really close related with health but it is also related to attitudes, emotions, feelings and beliefs: Polyphenols[1] provide astringency and bitterness to chocolate and this does not fulfill consumer expectations (Harwood, Ziegler, & Hayes, 2013) but there is a health interest in preserving polyphenols content in chocolates. According to Lenfant *et al.* (2013) shape has an influence on chocolates´ characteristics perception like cocoa, caramel, aftertaste and texture. Chocolate shapes are also usually associated to a certain type of chocolate and melting speed. Milk chocolate is usually associated to round shapes while dark chocolate is associated with angular shapes (Ngo, Reeva, & Spence, 2011).

In connection to attitudes towards chocolate: In one of the studies it has been reported that one of the most important reasons for craving chocolate is liking or satisfaction (Osman & Sobal, 2006) but, there are also some cultural, psychosocial and physiological factors that might lead to this (Hormes, Orloff, & Timko, 2014). Macht & Mueller (2007) states that a small amount of chocolate has an influence in improving negative mood just after its consumption and it might be due the chocolate´s palatability[2].

[1] Polyphenol: Act as antioxidant. “They protect cells and body chemicals against damage caused by free radicals” (Net).
[2] Palatability: Refers to palatable – pleasant to taste (Dictionaries, 2015).

2 PROBLEM STATEMENT

The project has been done in collaboration with the chocolate company Barry Callebaut, in Belgium. The scope of this project has been determined together with the company. The finding will serve for the company for future product development and to examine the relevance of a healthy (reformulated) chocolate based on consumer´s needs, expectations and perceptions.

Research question:

What are the determinants for eating chocolate among adults?

Focus on:

- Health
- Sensory characteristics and acceptance
- Attitudes and beliefs towards chocolate.

Sub questions:

- Is there a need to produce a "healthy" chocolate? – Low in calories and low in sugar.
- What are the health benefits and health beliefs in relation to chocolate consumption in Belgium and in Denmark among women and men?
- Does the acceptance and sensory characteristics of five chocolate samples differ among women and men in Belgium and in Denmark?
- Is chocolate consumption influenced by attitudes towards chocolate in Belgium and in Denmark among women and men?

Hypothesis

The determinants for eating chocolate vary by gender (Female – Male) and by country (Belgium and Denmark) among university students.

3 THEORETICAL FRAMEWORK

The concepts, models and definitions presented in this theoretical framework will be used to explain and connect the findings of the systematic literature review and the results from the consumer research (questionnaire).

Defining the Scope

Aalborg University and thereby Integrated Food Studies Master Program work with the Problem Based Learning model (PBL). With this model, it is always necessary to settle a problem to work with. This system helps to define the scope, because, when planning and executing an experiment, it is always necessary to keep a problem in mind. In this case, the problem is the prevalence of overweight and obesity in the whole world causing health problems, especially in the cardiovascular system. Chocolate has been chosen as a case to study because of the agreement with the chocolate company and because chocolate is one of the most craved food items around the world.

It is always necessary to keep the problem in mind and ask the following questions in order to take the first steps in developing the project:

- **Who** will be involved in the project? (Population)
- **What** will be the project about? (Main topic)
- **How** will be answered the research question?
- **When** will it take place?
- **Where** will it take place?
- **Why** is this study important?

Preliminary answers:

- Who – Adults
- What – Chocolate consumption
- How - Systematic Literature Review and Consumer research
- When – November – June 2015
- Where – Belgium and Denmark
- Why – Chocolate has a high content of sugar and calories. It is the most craved food in the world, thus this could have an impact in human health.

To understand the findings of this research it is important to define certain terms and to present some models that will guide the understanding of the results collected. It is presented

below the differences among the terms liking, preference and desire. It is also mentioned the list of statements of the Attitudes to Chocolate Questionnaire that has been used in consumers-questionnaire as an evaluation tool of the participants attitudes. Finally, a list of Emotions that has been previously used by the chocolate company in the first chocolate samples selection is shown.

3.1 FOOD LIKING, PREFERENCE AND DESIRE

There are many aspects that through our life change or develop in relation to food liking or food preference. There are some that are present even when there has not been an exposure before, like for example liking for sweetness, while there are other aspects like socioeconomic and culture that might have an influence of liking a certain product (Mela D. J., 2001). In fact, it has been seen that these aspects play a big role establishing context for sensory experiences (Mela D. J., 2000).

There are internal and external factors that influence food desire and food intake; it is not only hunger (Mela D. J., 2001). Mela (2001) has clustered these factors into three: Current internal state, liking and perceived appropriateness (see figure 1). He defines current internal state as "the immediate momentary psychological (e.g., mood) or physiological (e.g., thirst) state. Liking as a general pleasure for food and perceived appropriateness denotes to context in which food is eaten".

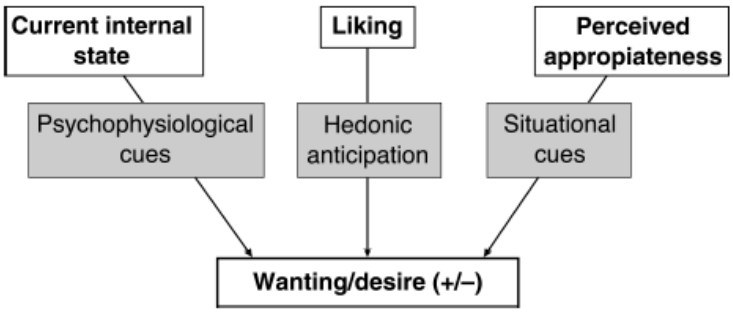

Figure 1 - Simple schematic diagram of factors influencing desire to eat a particular food (Mela D. J., 2001)

LIKING

Nowadays it is important to understand the determinants that lead people to choose and consume a product. It has been stated that the liking for a particular food is the results of combinations of different sensory characteristics that are in connection to a positive or a negative experience (Mela D. J., 2001).There is the prevalence of cultural environment and personal experience when liking a product (Mela D. J., 2000). There are many reasons why we eat and many others that define what we eat.

Mela (2006) proposes a model; a simplified operational schematic combing the influences of liking (pleasure), internal state (psychophysiology), and external stimuli (learned cues) in the acquisition and activation of desire for foods in everyday situation.

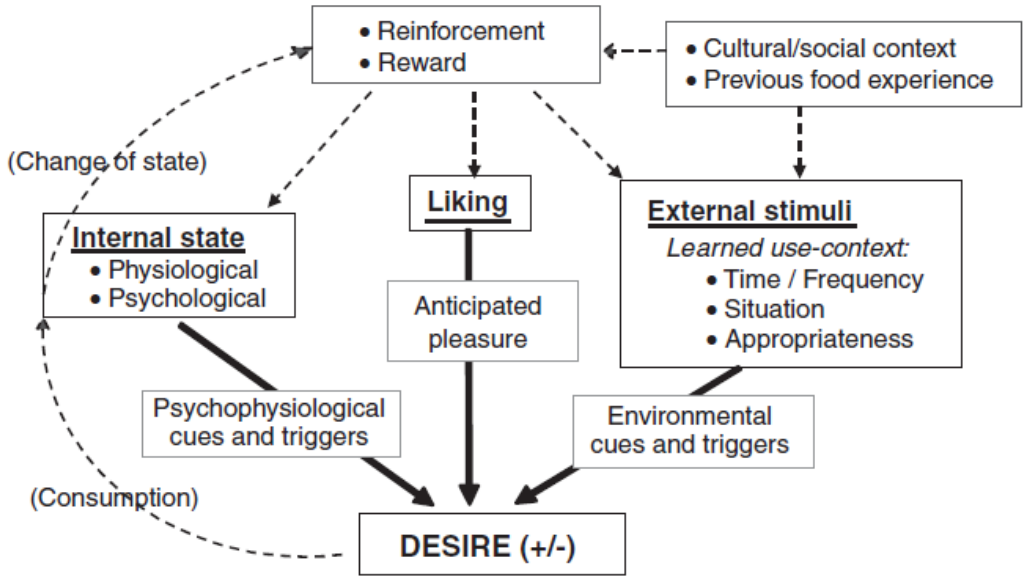

Figure 2 - Simplified operational schematic combining the influences of liking (pleasure), internal state (psychophysiology) and external stimuli (learned cues) in the acquisition and activation of desire for foods in everyday situation (Mela D. J., 2006)

Model interpretation

There is reinforcement or a reward that might lead to the desire of food consumption in three different ways: An internal state, external stimuli or by liking (see figure 2). The internal state is guided by something psychological. The desire will depend on psychophysiological cues and

triggers. While an external stimulus is something that does not belong to the person but has an influence in the decision of desiring or not the product. This could be time, or situation. Cultural, social context and previous food experience might have an influence in the stimulus. However if there is a desire for food addressed by liking, that means that there has been an anticipated pleasure. Someone might not like a food item before the person has experienced it. If the desire becomes a reality then the person would like to consume the product. This could lead to a change of state and for instance feel like a reward or reinforcement. Here is where the cycle begins again.

As it has been stated, food liking changes and develops and it is not merely based in "mere exposure". There are many other factors that could influence these effects such as situation, social environment, post-ingestive effects and even genetic predisposition as it is shown in the figure 3.

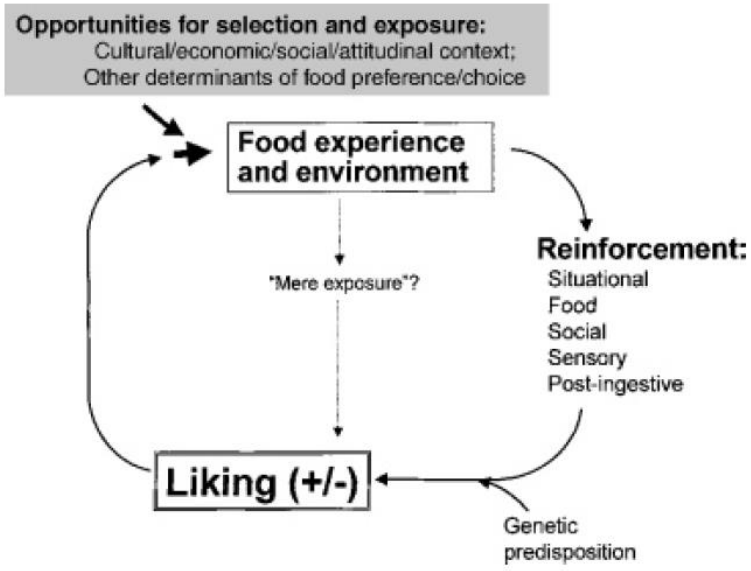

Figure 3 - A simple general scheme for acquisition of food likes (Mela D. J., 2000)

Liking is one of the factors that leads us to eat or select a food item. In his publications, Mela emphasize the importance of differentiate Liking from Desire and Preference.

"**Liking** reflects the immediate experience or anticipation of pleasure from the orosensory stimulation of eating a food (hedonic value or palatability" (Mela D. J., 2006).

Desire or as he calls "Wanting" is the "intrinsic motivation to engage in eating a food, now or in the (near) future" (Mela D. J., 2006).

And **Preference** is considered more an outcome rather than a factor. It is defined as "The selection of food over relevant alternatives at the point of choice, including intrinsic and extrinsic factors (for humans, this may include liking and desire, but also consideration of health values, brand, cost, convenience, etc)" (Mela D. J., 2006).

Liking and preference

Sometimes results of preference / liking test do not show accurate answers because these two words are misunderstood when asking for response of a product. Mela (2000) has given a clear example about this. A sensory analysis might indicate that people prefer lobster instead of canned tuna (liking). However, people could prefer canned tuna to lobster because of different factors like for example, price (preference).

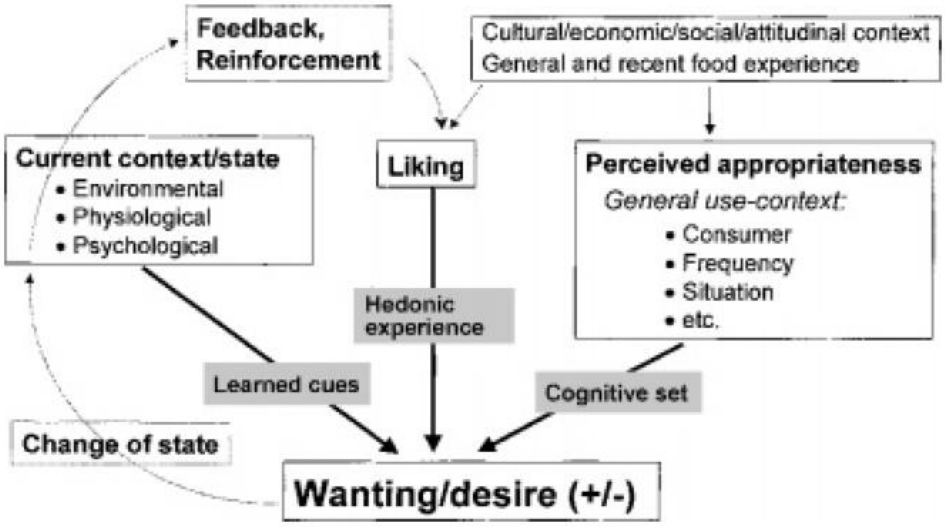

Figure 4 – Schematic diagram of factors influencing "desire" to eat a particular food (Mela D. J., 2000)

Liking and desire

Liking of a product might lead the desire of eating this product but liking it is not enough to predict this desire. For example, someone could like lobster but in a certain day will not feel

like eating lobster. There are many other factors that might bring the desire of consuming a product: Mela (2000) states that desire of a specifically food item could be determinate by learned cues, hedonic experiences or cognitive set (See figure 4). Being learned cues and cognitive set part of the context or the situation (environmental, physiological, and psychological) or perceived opportunities (appropriateness) that might have been influenced by cultural, economic, social or attitudinal context or a food experience.

In the current study liking and preference are measured to find the participants 'consideration about the five different chocolate samples. These results will be used for future product development in the company. The relevance of testing the chocolates among this population is that their opinion will vary from a trained panel and due that they are the possible future consumers, it is important to take into consideration their likings and preferences of the product.

3.2 ATTITUDES TO CHOCOLATE QUESTIONNAIRE

The function of the Attitudes to chocolate questionnaire is to measure three factors related to chocolate intake: Craving, guilt and functional.

The first factor, craving, is linked to emotional eating chocolate and craving itself. This is "associated with acts of compulsion" and "preoccupation with chocolate" (Benton, Karen, & Morgan, 1998).The second factor is guilt. This factor is measured through statements with negative consequences while eating chocolate, including feeling guilty. And the third factor functional approach reflects "a pragmatic approach to chocolate" (Benton, Karen, & Morgan, 1998).

The Attitudes to Chocolate Questionnaire presents twenty-four statements: Ten for craving, ten for guilty and four for functional statements.

CRAVING

- I eat chocolate to cheer me up when I am down
- My desire for chocolate often seems overpowering
- The thought of chocolate often distract me from what I am doing (e.g. watching TV)
- I usually find myself wanting chocolate during the afternoon
- Chocolate often prays in my mind
- Nothing else but chocolate will satisfy my chocolate cravings
- Even when I do not really want any more chocolate I will often carry on eating it
- I often go into a shop for something else and end up buying chocolate
- I often eat chocolate when I am bored
- I like to indulge in chocolate

GUILTY

- I feel unattractive after I have eaten chocolate
- I often feel sick after eating chocolate
- I am often on one kind of diet or another
- I consider chocolate to be high in fat and to be of poor nutritional value
- After eating chocolate I often wish I hadn't
- I feel guilty after eating chocolate
- I feel unhealthy after I have eaten chocolate
- I always look at the calorific value of a chocolate snack before I eat it
- If I resist the temptation to eat chocolate I feel more in control of my life
- I feel depressed and dissatisfied with life after eating chocolate

FUNCTIONAL

- I eat chocolate as a reward when everything is going really well for me
- I eat chocolate only when I am hungry
- I eat chocolate to keep my energy levels up when I am doing physical exercise
- I eat more chocolate in the winter when it is colder

Attitudes were included in this study because of the relevance that has been found in the literature. Many studies reflect on the Attitudes to Chocolate Questionnaire and due to this its statements were included in the questionnaire.

3.3 EMOTIONS ASSOCIATED WITH FOOD

The list of emotions stated in the questionnaire are the same chosen by Barry Callebaut in their chocolate napping session. The twelve listed emotions are described and related to other emotions too. This can be seen in table 1. The company used the description of each of the emotions in the napping session as part of the chocolate evaluation too

It is interesting to include the emotions to perceive how participants feel after eating the chocolate samples. A positive emotion could be related to a positive perception of the chocolate, while a negative emotion could suggest that the participants do not like the chocolate.

Table 1 - Emotions used by Barry Callebaut in their chocolate napping session.

EMOTION	DESCRIPTION
Loving	Passion, affection, attentive, caring, reassured, touched, admiration, respect.
Excited	Adventurous, excited, energetic, lively, terrific, overjoyed, happy.
Sociable	Charming, sociable, passive, light-hearted, relaxed.
Bold	Purposeful, confident, superior, willful.
Aggressive	Arrogant, aggressive, irate, furious.
Disapproving	Jealous, suspicious, horrified, disgusted, disapproving, critical.
Intimidated	Inhibited, shy, inferior, belittled, neglected, alone.
Surprised	Surprised, silly, strange.
Disinterested	Dull, disinterested, confused, absent-minded
Sad	Regretful, nostalgic, heart-stricken, despairing, sad, grumpy, discontented.
Scared	Scared, nervous, anxious.
Tired	Subdued, sluggish, tired.

4 METHODOLOGY

In order to answer the research question: "Is there a need for healthy chocolate in Europe?" the research project was structured in two parts. First, a systematically literature review was conducted in four different and relevant data bases and second, consumer research based on a questionnaire conducted among university students in two countries in Europe: Belgium and Denmark. The following sections will elaborate in detail the methods that have been used.

4.1 Systematic Literature Review

A systematic literature review has been done to identify, select, organize and summarize studies that investigate chocolate in relation to health, sensory characteristics and people´s attitudes. Four databases were chosen: PubMed, Science Direct, Scopus and Web of Science because of their extension and because they overlay cross disciplinary researches.

4.1.1 Focus area

The author together with a colleague started the literature search on November 2014. An articles selection process has been elaborated and it was decided which areas the study should covers. Chocolate was the main topic and together with it the three areas of health, sensory characteristics and attitudes were chosen. This was decided because the three themes reflect a quantitative and a qualitative area however; the three areas are measured solely by quantitative methods.

4.1.2 Search strategy

To identify the relevant studies, key words were established. In table 2 it is stated the group of words and the combinations used in the four databases. As an important factor, the search was directed solely in the last ten years. It means that one of the search criteria is to select the articles only from 2004 to 2014.

Table 2- Keywords used for the search in the databases

Common terms		**Objective**	**Objective + Subjective**	**Subjective**		
Chocolate	Adults	Health	Sensory characteristics	Emotion*	Feeling*	Attitude
Cacao		Macronutrients	Taste	Mood	Pleasure	Perception
"Theobroma cacao"		Nutrition	Liking	Sentiment*	Guilt	Influence
		Diet	Preference	Reaction	Satisfaction	
				Passion	Sensation	
					Excitement	

*Word could have other ending (plural).

The common terms that were used for the search were Adults and Chocolate. Adults because they are the chosen target group and chocolate for being the main topic of this research. Besides chocolate, the terms Cacao and Theobroma cacao were used as synonyms. In each of the three areas a combinations of words were used.

The combinations of words that were used in each of the database are the following:

S1: **Chocolate OR cacao OR "Theobroma cacao"** AND **adults** AND **health OR macronutrients OR nutrition OR diet**

S3: **Chocolate OR cacao OR "Theobroma cacao"** AND **adults** AND **"sensory characteristics" OR taste OR liking OR preference**

S6: **Chocolate OR cacao OR "Theobroma cacao"** AND **adults** AND **feeling* OR pleasure OR guilt OR satisfaction OR sensation OR excitement OR emotion* OR mood OR sentiment* OR reaction OR passion OR attitude OR perception OR influence**

The numbers of hits were collected in a table in order to keep track of the search. See appendix 1

4.1.3 Inclusion criteria

The inclusion criteria were decided together with the colleague in order to delimitate the topic. All the articles should present in their studies the following criteria:

- Chocolate / Cacao related information
- Healthy people
- Adults
- A health, sensory characteristics and acceptance or attitudes and beliefs outcome.
- Enough sample power
- English as the report language
- Only academic research.

4.1.4 Screening articles

The purpose of the articles screening is to discern the obtained hits in order to have a clear and quality outcome. The steps were followed based on the instructions in the books: Doing your literature Review – Traditional and Systematic Techniques by Jill K. Jesson, Lydia Matheson and Fiona M. Lacey (2011) and Systematic Approaches to a successful literature review by Andrew Booth, Diana Papaioannou and Anthea Sutton (2012). The articles were screened following the next steps:

1. Titles examination: From all the gotten hits, the two persons read each one the titles together and decided if the article was relevant or not.

2. Abstracts examination: From the titles that were kept, the abstracts were read. This time the two persons read individually each one of the abstracts. The criteria to keep the articles were established together with the supervisor. To evaluate the study, the article should follow more than one of the following criteria: The aim should be clearly stated, the sample size should be calculated, a standardized outcome measurement

should be used, proper statistical analysis needed to be applied and /or, the study should not show major limitations. One of the criteria that were always taken into account was if the sample size was representative or not in the study. Not all the studies could fit in one sample size criteria because all of them depended on the outcome measurement. For instance, the number considered were: For a consumer acceptance test study was 100 to 200 persons, to measure appetite scores 25 to 60 persons, if biomarkers such as blood or urine were used the number considered was around 20 persons.

3. Entire text examination: From the remaining abstracts, the full text was read. The two persons divided the total number of articles into two. In a period of two weeks the articles were read and then exchanged.

4. Summary tables: After all the articles were read, the summary tables were elaborated (See appendix 2). These tables contain the key points of the articles: Title, author(s), year of publication, aim of the study, country where it was conducted, methods, sample size, and age of the sample. Besides this, the tables included the outcome of the study differentiated by one on the areas which the study was designed: Outcome 1 – health, outcome 2 – sensory characteristics, outcome 3 – attitudes. The two readers worked in half of the articles while the other worked in the other half. Each one of the readers marked already the article as if it should be included or excluded of the study and the reason for this consideration.

5. Final tables: Finally the tables were exchanged and the two readers check the other half of the articles together with the tables. It was necessary to check if all the details were on the tables and the other person´s point of view related with the inclusion or exclusion criteria. If there were differences between the resolutions whether the articles should or not be included in the review the readers had to argued and agreed about the final decision.

4.1.5 Synthesis of articles

To have a general overview of the results, see appendix 3. It presents the summary of the article´s information: Title, author, year of publication, country of origin, participants' age, sample size, outcome (1. Health / 2. Sensory characteristics and acceptance / 3. Attitudes, feeling and emotions), resolution if the article has been included or not and if the article can be found repeated in other database.

A narrative synthesis has been used to summarize the results and synthesizes the evidence found in the articles. It will tell the story of what has been found in relation to chocolate and the three studied areas. The results and the information collected from the literature has been used as a base to develop the questionnaire that has been applied as part of the consumer research.

4.2 Consumer research

A cross-sectional study was conducted among university students in Belgium and in Denmark. A questionnaire was developed to collect quantitative information regarding chocolates sensory characteristics and acceptance, chocolate intake and attitudes towards chocolate.

The initial draft of the questionnaire was performed in Copenhagen, Denmark in February 2015 together with another master student at the same master program. The final questionnaire was elaborated by the author of this thesis in collaboration with Marijke de Brouwer, Innovation Manager and Renata Januszewska, Corporate Sensory Scientist at Barry Callebaut during March 2015 in Wieze, Belgium.

4.2.1 Chocolate samples description

The five chocolates used in the sensory test are chocolates with sugar replacements; except for one, 515. This chocolate is the gold standard chocolate from the company and it was kept in every questionnaire as a reference. Chocolates 981 and 322 are sugar reduced chocolates while 883 and 474 are chocolates without added sugar. Table 3 shows the characteristics of each of the chocolates.

Table 3 - Description of Chocolate samples

BC	Questionnaire	Base	SUR / WAN	Calories	Bulk sugar / sucrose replacement	Flavour modulation
XX5	**515**	Gold standard - Reference	-	-	-	-
XX9	**981**	CMH-66	SUR (Sugar reduced)	Impact on calories	A combination of dietary fibers (FOS/inulin, dextrin)	No
XX3	**322**	CMH-13	SUR (Sugar reduced)	No impact on calories	A dried glucose syrup	Yes
XX8	**883**	CSM-100	WAN (without added sugar non-laxative	Impact on calories	A combination of dietary fibers (FOS/Insulin, dextrin) and sweeteners (maltitol, steviolglycosides) Polyol (maltitol) limited to max 10% in the chocolate to avoid the laxative warning.	Yes
XX4	**474**	CSM-10	WAN (without added sugar non-laxative	Impact on calories	A combination of dietary fibers (FOS/Insulin, dextrin) and sweeteners (maltitol, steviolglycosides) Polyol (maltitol) limited to max 10% in the chocolate to avoid the laxative warning.	Yes

It is important to mention that calories and sugar content vary among the chocolates. Chocolate 322 has more calories than the other three samples. Chocolates 883 and 474 have less sugar than 322 and 981.Table 4 indicates this information.

Table 4 - Chocolates nutritional facts information

Values of 20 g. chocolate	**Kcal.**		**Sugars**		**Fat**		**Saturates**		**Sodium**		**Fibers**	
	g	%	g	%	g	%	g	%	g	%	g	%
515	112	5	10	12	-	-	-	-	-	-	-	-
981	107	5	6.7	7	7.3	10	4.6	23	0.0.	1	3.1	12
322	111	6	4.5	5	7.2	10	4.6	23	0.0	1	0.4	2
883	102	5	2.5	3	7.6	11	4.8	24	0.0	1	4.7	19
474	102	5	2.5	3	7.6	11	4.8	24	0.0	1	4.7	19
*Percent daily values based on an adult´s reference intake												

4.2.2 Questionnaire Design

The questionnaire was designed in three parts: One regarding chocolates characteristics (Sensory test), another with the expectations and beliefs about chocolates (consumer information) and the last one with demographic information. (See appendix 4)

Sensory test

The sensory test was the first part in the questionnaire. The purpose of this section was to collect information regarding consumer acceptance to the different chocolate samples. This was chosen as the first part of the questionnaire to avoid that the participants get influenced by the questions that belong to the second part of the questionnaire.

Five chocolate samples were tested among the participants. The samples were chosen by the company before hand and after in an internal napping session. The five chocolates have a three digit code from Barry Callebaut. The chocolates were re-coded with three different numbers for this project. In the report only the new codes will be used.

Based on the company´s experience only four chocolates were tasted per participant to avoid flavor saturation in mouth. There was always one chocolate in all the questionnaires, chocolate 515 (XX5). The other four chocolate samples were randomly allocated in the questionnaires but following a pattern. This can be seen in table 5. 7-point Likert scale was used to measure liking of chocolates and 5-point Likert scales were used to measure Sweetness, Milkiness, Smoothness, Caramel flavour, Cacao flavour and Special aftertaste.

Table 5 - Distribution of chocolates in the plate

PLATE	1st	2nd	3rd	4th
1	**Reference**	**1**	**2**	**3**
2	**4**	**Reference**	**1**	**2**
3	**3**	**4**	**Reference**	**1**
4	**2**	**3**	**4**	**Reference**

Consumer Attitude to Chocolate and Health perception

The second part of the questionnaire included different types of questions related with the other two areas of the study: Health, and attitudes to chocolate. An important component of this part of the questionnaire is the Attitudes to Chocolate Questionnaire´s statements (question twenty-two). In this question participants need to rank statements in a 5-point Likert scale according to their opinions. The list of these twenty-four statements is from the "Attitude to Chocolate Questionnaire" developed by David Benton, Karen Greenfield and Michael Morgan (1998). This is a validated questionnaire that assess chocolate craving by measuring three factors. One of them is **craving**. This was "associated with acts of compulsion" and "preoccupation with chocolate" (Benton, Karen, & Morgan, 1998). Another factor called **guilt** is associated with negative experiences and the last factor, **functional approach** reflects "a pragmatic approach to chocolate" (Benton, Karen, & Morgan, 1998).

Demographic information

At the end of the questionnaire, demographic information (age, gender, education, height, weight and nationality) was asked. Also as part of this section of the questionnaire the question: "Do you have children?" was presented.

4.2.3 Pilot test

A pilot test of the questionnaire was conducted in Wieze, Belgium in March 2015 during the visit to the company. The participants of this test were twenty employees who are close involved with the chocolate production from different departments in the company and three extra persons who are not related to the company. All the comments and feedback were collected and used to develop the final questionnaire.

4.2.4 Participants

The questionnaire has been applied in two different universities and two different cities: At KU Leuven, Campus Gent (KAHO Sint–Lieven) and at Aalborg University (AAU), Campus Copenhagen. In both places the same concept was presented. The experiment took place in one of the canteens at the universities; people were invited personally to participate when they walk through the canteen. At AAU some flyers were placed on the tables in a different canteen where the experiment took place in order to gather more people. All the participants were university students, professor or part of the staff. All of them participated voluntarily in the test. The test took around 10 – 15 minutes per participant. The instructions were indicated in the questionnaires and also a short introduction was given verbally. All the information was presented in English in both places.

4.2.5 Ethical considerations

Ethical considerations were made. The participants gave their consent to participate in the experiment and for being part of the pictures. Complete anonymity of participants has been kept.

The information given from Barry Callebaut is also confidentially. This report only shows what the company agrees to be public. Chocolate samples and recipes are not going to be fully described.

4.2.6 Data management and Statistical Analysis

The data has been organized and analyzed in Microsoft Excel 2010 and in SPSS (IBM SPSS Statistics 22.0). Prior the analysis the data was cleaned. One questionnaire has been left out of the study because of the lack of information about gender and country, relevant characteristics for the data analysis.

For the data analysis the questions were organized in three different areas (See appendix 4):

- Questions related to **health** (10, 11, 12, and 16).
- Questions related to **sensory characteristics and acceptance** (1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 15, 17, 18, 19, and 23).
- Questions related to **attitudes, emotions and beliefs** (14, 20, 21, and 22).

In the first part of the questionnaire (Sensory test), the variables that were chosen for the data analysis are: Liking, sweetness, milkiness, smoothness, caramel flavour, cacao flavour and special aftertaste as dependent variables and gender and nationality as independent variables.

For the second part of the questionnaire (Consumer information), gender and nationality were also chosen as the independent variables to associate and compare the results of these questions.

Descriptive statistics, Chi square and General Linear Model (GLM) have been used to analyze the data. Descriptive statistics will give a general overview of the chocolate samples and general information about the participants. Chi square will be used to analyze attitudes to chocolate questionnaire crossing the information from the statements with country and gender. GLM model will present the interaction among the dependent and independent variables. Three fixed factors have been chosen for the analysis: Gender, Country and Chocolate Sample. The interactions will be in pairs and these interactions will be removed if no significance has been found; this will be done starting from the highest value. Bonferroni test is going to be applied and Post-Hoc Test to compare chocolate samples differences. A significance level of 0.5% has been established.

5 RESULTS

The results from the systematic literature review and the questionnaire will be presented below. The combination of these findings will guide to answer the question: Is there a need for "healthy" chocolate?

5.1 Literature Review

The results of this systematic literature review will show the key points presented in scientific articles about the determinants for eating chocolate among adults. These results will specifically display what is already identified about chocolate in relation to health, sensory characteristics and acceptance, and attitudes and beliefs. These points will be used as based and inspiration for the questionnaire development.

A total of 2062 hits were obtained in the four databases: PubMed, Science Direct, Scopus and Web of Science. Figure 5 shows the study selection process.

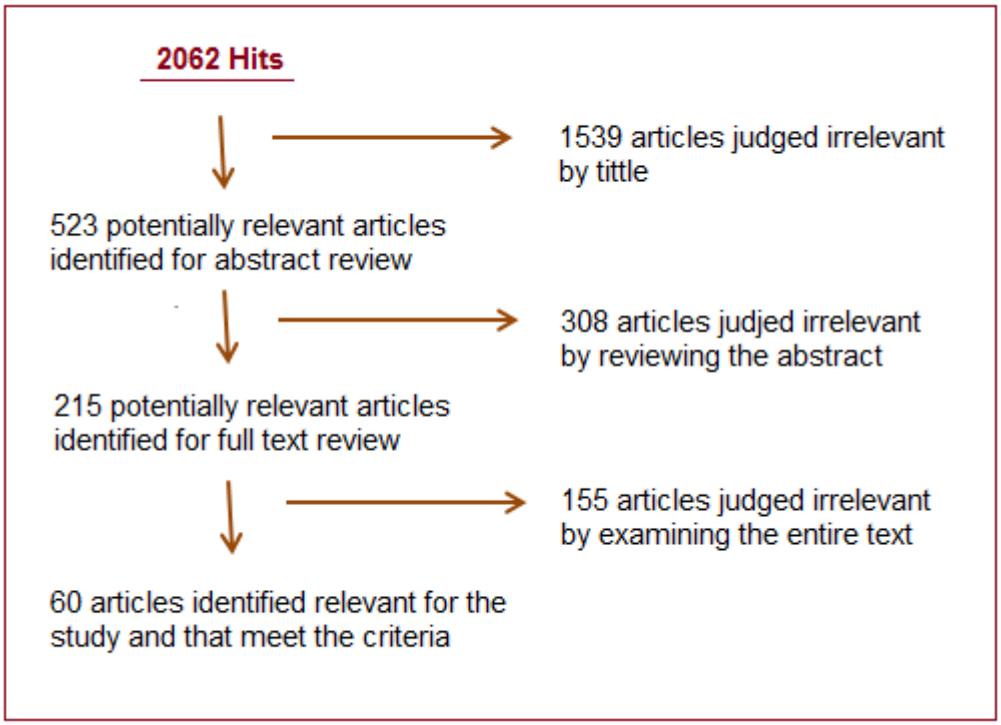

Figure 5 - Flowchart of the study selection process - Inspired by Desch et al. (2010)

In total sixty articles met the criteria and were identified as relevant. A table containing the details of each of these articles is presented in appendix 5. The articles were classified according to the three areas studied in the project: Health, Sensory Characteristics and Acceptance and Attitudes towards chocolate. Tables with their respective details can be found in appendix 2.

5.1.1 Studies in relation to Health and Chocolate

"Although chocolate is considered typically as a food people should indulge in only occasionally, several short-term experimental studies suggest that chocolate, already in amounts of several grams per day, improves endothelial and platelet function, and reduces blood pressure and markers of inflammation. Flavanols in cocoa are thought to be responsible for these effects" (Buijsse, Weikert, Drogan, Bergmann, & Boeing, 2010).

Chocolate is a food item that might to be consumed in a regular basis however, it has been found that its intake even in large quantities improves endothelial, platelet function and reduces blood pressure. This effects might be caused by the flavanols present in the cocoa (Buijsse, Weikert, Drogan, Bergmann, & Boeing, 2010).

Five reviews have been part of the selected articles. One of them focus in the effects of cocoa flavonoids in the diet. It sustains that consumption of cocoa flavonoids is beneficial for human health; they act as cardiovascular protectors, antioxidants that might even prevent tumoural processes (Lamuela-Raventós, Romero-Pérez, Andrés-Lacueva, & Tornero, 2005). Another review shows the positive influence of cocoa products like dark chocolate or cocoa beverages on reducing blood pressure but, before considering cocoa products as a treatment for hypertension it is necessary to state the appropriate dose of flavanols in the product (Desch, y otros, 2010). A third review states that dark chocolate, after fruits and vegetables, is one of the providers of polyphenols in the diet in America. Dark chocolate vary on polyphenols content that is why from a Public Health Nutrition perspective, it cannot be established a recommended amount of intake because the content of polyphenols in a chocolate depends of the origin of the cacao origin and also from the manufacturing process (Rusconi & Conti, 2010). The fourth article also reviews the properties of the polyphenols, but in this case the

focus is to relate the polyphenols property to decrease fat absorption or synthesis in human bodies which can help to reduce risk factors for cardiovascular diseases or diabetes type II, especially dark chocolate. As it was stated in the article before, more research is necessary before suggesting a specific amount of dark chocolate as part of diet. While Fernández-Murga et al. (2011) has explained in the review that there are still some inconsistences due there is still not enough epidemiological data related to chocolate studies, also that there are many studies based solely on diet and the results could be just a causal relationship. They have also suggested to be aware on recommending chocolate consumption due that its manufacturing involves sugar, mainly in milk chocolate, and this increases chocolate caloric content.

Sarriá et al. (2014) states that content of polyphenols in chocolate, especially flavanols have a potential to improve health, but the effects that chocolate might have like acting as antioxidant, anti-inflammatory can vary from person to person and it always depend on the person´s health and diet. There are also many studies that relate chocolate with cardiovascular health. Epidemiological studies support the idea that food with flavonoids-content can reduce the risk of cardiovascular diseases (Al-Safi, Ayoub, Al-Doghim, & Aboul-Enein, 2011). Many of the studies associate this property to cocoa polyphenols' content. Frequent chocolate consumption is associated with a low prevalence of coronary heart disease (Djoussé, Hopkins, North, Pankow, Arnett, & Ellison, 2011). Kurlandsky et al. (2006) proposes that chocolate consumption together with almonds improved serum triacylglycerol levels. Corti et al. (2009) conclude that cocoa has a cardiovascular effect and might be due its polyphenols content; however it is important to differentiate that its content can vary from cacao to a processed product, chocolate, since during the manufacturing process the polyphenol content can decrease. And oddly a study conducted by Martínez-López et al. (2014) have concluded that regular consumption of cocoa products have an influence in preventing cardiovascular problems without any anthropometric change in a Spanish-Mediterranean diet.

In relation to blood pressure, Daily dark chocolate consumption increases HDL (Martin, y otros, 2012). The polyphenol content in cocoa powder could contribute to elevate HDL cholesterol and reduce the LDL cholesterol (Baba, y otros, 2007). In their study Baba et al. (2007) their results suggest that 13 grams of chocolate (or more) for a four period week increase HDL and decrease LDL concentrations. Dark chocolate is associated with reducing

blood pressure (Al-Safi, Ayoub, Al-Doghim, & Aboul-Enein, 2011) but milk chocolate is the most frequently consumed (Buijsse, Weikert, Drogan, Bergmann, & Boeing, 2010).

Chocolate has also effects in the skin, a study conducted by Heinrich et al. (2006) has found that cocoa powder consumption, high in flavanol content (326 mg/d) the skin surface of the participants have significant increase blood flow or cutaneous and subcutaneous tissues, and it has increase skin density and hydratation, plus, it has decrease skin roughness when comparing to the participants who consumed a low flavanols drink. Despite this, other study presents that chocolate consumption could be beneficial for photoprotection against UV light but the study has not demonstrate statistically significant results (Mogollon, Boivin, Lemieux, Blanchet, Claveau, & Dodin, 2014).

Among other results, cocoa flavanols could have prebiotic benefits, and with this study it has been proved that cocoa drink consumption has increased gut microflora in humans. (Tzounis, Rodriguez-Mateos, Vulevic, Gibson, Kwik-Uribe, & Spencer, 2011). Dark chocolate or liquid cocoa particularly because of the polyphenol content, mostly flavanoids improves endothelial function and reduces blood pressure. Sugar-free products could have a greater effect (Faridi, Njike, Dutta, Ali, & Katz, 2008) (Njike, y otros, 2011).

Cocoa flavanols could improve visual and cognitive functions because of its high flavanols concentration (Field, Williams, & Butler, 2011). Chocolate consumption could lower the risk of preeclampsia in pregnant women (Triche, Grosso, Belanger, Darefsky, Benowitz, & Bracken, 2008). Consumption of a moderate amount of chocolate could reduce inflammation and act as cardiovascular protection (Giuseppe, y otros, 2008), it could also reduce the risk of diabetes, however it is necessary to experiment more in this field (Greenberg, 2015).

A study conducted by Martin et al. (2009) state that consumption of dark chocolate (40 grams a day for two weeks) could modify the metabolism and increase gut microbial activities. It has also stated that dark chocolate consumption could normalize stress-related effects in human metabolism (Martin, y otros, 2009).

5.1.2 Studies in relation to Sensory characteristics and Acceptance of Chocolate

"Our most surprising result was that proportionally, more men than women reported a desire to consume more chocolate despite having significantly lower chocolate craving and liking scores" (Nasser, y otros, 2011)

The articles related to sensory characteristics and acceptance show different outcomes.

First, According to Lenfant *et al.* (2013) shape has an influence on chocolates´ characteristics perception like cocoa, caramel, aftertaste and texture. Chocolate shapes are also usually associated to a certain type of chocolate and melting speed. Milk chocolate is usually associated to round shapes while dark chocolate is associated with angular shapes (Ngo, Reeva, & Spence, 2011). And an elongated chocolate shape (thin plate) will melt faster than a compact shape (sphere) (Lenfant, Hartmann, Watzke, Breton, Loret, & Martin, 2013). Lenfant *et al.* (2013) also states that if a chocolate melts fast, it will lose its form faster. Melting and air circulation in mouth plays an important role in chocolate aroma release and its flavour perception.

Second, in relation to consumption, chocolate has a psychoactive effect that is related to the desire to eat more of it. Different chocolate characteristics like sugar and cocoa content have an impact in the desire of chocolate consumption (Nasser, y otros, 2011). In the study conducted by Nasser *et al.* (2011), men had a lower score than women according to liking and chocolate craving nevertheless, men had a desire to eat more chocolate.

Third, Polyphenols provide astringency and bitterness to chocolate and this does not fulfill consumer expectations (Harwood, Ziegler, & Hayes, 2013) but there is a health interest in preserving polyphenols content in chocolates.

Finally, two details from these articles should be mentioned: Methylxanthines may have an influence in chocolate liking, especially in dark chocolate (Smit & Blackburn, 2005). And in order to produce a dark chocolate product, especially when the cocoa is from a single origin, it is relevant to know the target market preferences (Torres-Moreno, Tarrega, Costell, & Blanch, 2012).

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5.1.3 Studies in relation to Attitudes towards Chocolate

"Craving for chocolate is not hunger dependent, nor easily satisfied by other foods or substances. Eating chocolate can boost positive mood states, but these mood improving qualities of chocolate are likely to be short-lived and may be accompanied by simultaneous increases in negative affect particularly guilt. Feeling of guilt and ambivalence about chocolate consumptions may arise because the attractive sensory appeal of chocolate must be weighed against its potentially unhealthy nutritional properties (e.g., high fat and sugar content), and the stigma associated with unrestrained overindulgence of chocolate." (Cartwright & Stritzke, 2008)

Attitudes to Chocolate Questionnaire

Müller et al. (2008) and Gucht et al. (2014) have evaluated the psychometric properties of the Attitudes to Chocolate Questionnaires (ACQ). Müller et al. (2008) have assessed the German version of the questionnaire by analyzing the exploratory and confirmatory factors while the seconds have analyzed the Dutch version by relating the factors with other eating-related questionnaires. The factors that have been analyzed are Guilt and Craving. Guilt deals with the negative consequences of chocolate eating and guilt itself (Müller, Dettmer, & Macht, 2008) and craving relates to the amount of chocolate eaten (Gucht, Soetens, Raes, & Griffith, 2014). It has been confirmed the validity of the German and the Dutch version of the questionnaire.

Another study presents the evaluation of the French version of the Orientation towards Chocolate Questionnaire (OCQ). Rodgers et al. (2011) have evaluated the psychometric properties by using a confirmatory analysis of the factors. Guilt and craving were associated with chocolate consumption and eating disorder patterns. There are also other relevant findings that will be followed reported

CRAVING

Craving could be defined as a strong desire for food and a compulsive wish to eat. (Hormes & Timko, 2011). Chocolate is the most craved food item and in North America, chocolate craving is significant common in women when comparing to other countries. It has been seen that these – are usually related to eating disorders and especially in women (Hormes, Orloff, & Timko, 2014).

In one of the studies it has been reported that one of the most important reasons for craving chocolate is liking or satisfaction (Osman & Sobal, 2006) but, there are also some cultural, psychosocial and physiological factors that might lead to this (Hormes, Orloff, & Timko, 2014). Like, results show that American culture encourages to more chocolate craving among women than men (Osman & Sobal, 2006) and especially during the menstrual cycle (Hormes & Timko, 2011). It has been stated that chocolate craving increase in women who have been chocolate deprived and high cravers increase anxiety even independent of chocolate deprivation (Moreno-Dominguez, Rodríguez-Ruiz, Martín, & Warren, 2012).

Chocolate craving has been considered harmless in comparison to cigarettes, alcohol and drugs; however this is leading to increase food consumption thus, obesity particularly in women (Hormes & Timko, 2011).

MOOD

It has also been seen that chocolate might influence in peoples´ mood. Chocolate is the food item that is usually craved when a depressive mood is present (Macht & Mueller, 2007). Macht & Mueller (2007) also states that a small amount of chocolate has an influence in improving negative mood just after its consumption and it might be due the chocolate´s palatability. However in another experiment Macht and Dettmer (2006) have demonstrate that chocolate do not only influence positively in emotional changes but also negatively. An interesting finding by Judelson et al. (2013) is that despite theobromine and caffeine share many structural characteristics; Theobromine does not have an influence in mood and vigilance as caffeine does. Nevertheles, high dose of theobromine could have negative effects on mood and even increase heart rate (Baggott, y otros, 2013).

Nevertheless, cognitive functions may improve with cocoa flavanols consumption because it has been found that they influence positively in these physiological processes. It has been suggested that 520 mg of cocoa flavanols can help to a better cognitive performance and mood (Scholey, French, Morris, Kennedy, Milne, & Haskell, 2010) even if it is unclear if this effect is due its sensory characteristics or the pharmacological action of its constituents (Scholey & Owen, 2010).

EMOTIONS

In relation to mood, many studies have been eliminated due to the criteria. An experiment conducted in Saudi Arabia, it has been found that chocolate has positive effects when improving depression symptoms (Aziz, Al-Muwallad, & Mansour, 2011).

There are two concepts that need to be clarified: Emotional eating and restrained eating. Emotional eating is when food consumption might help to cope the stress; and restrained eating means to avoid food consumption to reduce o maintain body weight (Macht & Mueller, 2007). Macht & Mueller (2007) indicate that emotional eaters crave or increase their chocolate consumption whereas restrained eaters feel guilty after eating chocolate. A curious finding is that restrained eaters find dark chocolate more pleasant than other chocolates and that this might be due they are used to consume this type of chocolate.

BODY IMAGES

Chocolate cause different reactions, particularly in women (Durkin, Hendry, & Stritzke, 2013).

As it has been presented in other studies, it is possible to affect behavioral responses towards chocolate. This has been used as an advertisement strategy to induce chocolate consumption (Durkin, Hendry, & Stritzke, 2013). In the study presented by Durkin et al.; they conclude that high restraint chocolate consumers exposed to thin models consume the most compared to low restraint participants. In another study, Durkin et al. (2012), suggest that chocolate association to larger models images can decrease approach and guilty in relation to chocolate while having thin models in chocolate advertisements can increase craving but also avoidance and guilt.

ENERGY

In the study conducted by Martin et al (2012), it has been found that milk chocolate decrease anxiety in high anxiety participants and that dark chocolate increased anxiety and energy in low anxiety participants.

It has been found that dark chocolate trigger a satiety feeling more than milk chocolate does and for instance lower the future energy intake. It has also been proved that dark chocolate reduces appetite for sweet snacks (Akyol, Dasgin, Ayaz, Buyuktuncer, & Besler, 2014).

5.2 Questionnaire

The results obtained from the questionnaire have been organized according the three research areas. Questions 10, 11, 12, 16, 20 and 21 are related to **Health**, questions 1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 15, 17, 18, 19 and 23 to **Sensory Characteristics and Acceptance** and questions 14 and 22 to **attitudes, emotions and beliefs** to chocolate. The demographic information is presented at the beginning of this chapter.

Notes:

- It is necessary to mention that one of the questionnaires has been discarded from the results because of lack of information, especially in the demographic section.
- Question 13 has not been part of the analysis. The information collected with this question is for the company use.
- Question 9 has also not been part of the analysis because in many cases the information has not been clear stated (See appendix 6).

DEMOGRAPHIC RESULTS

In this study 215 persons participated in this study. 49% of the participants did the test in Belgium, and 51% of the participants did the test in Denmark. In Belgium all the participants where Belgian while in Denmark; some international students were part of the experiment (See figure 6).

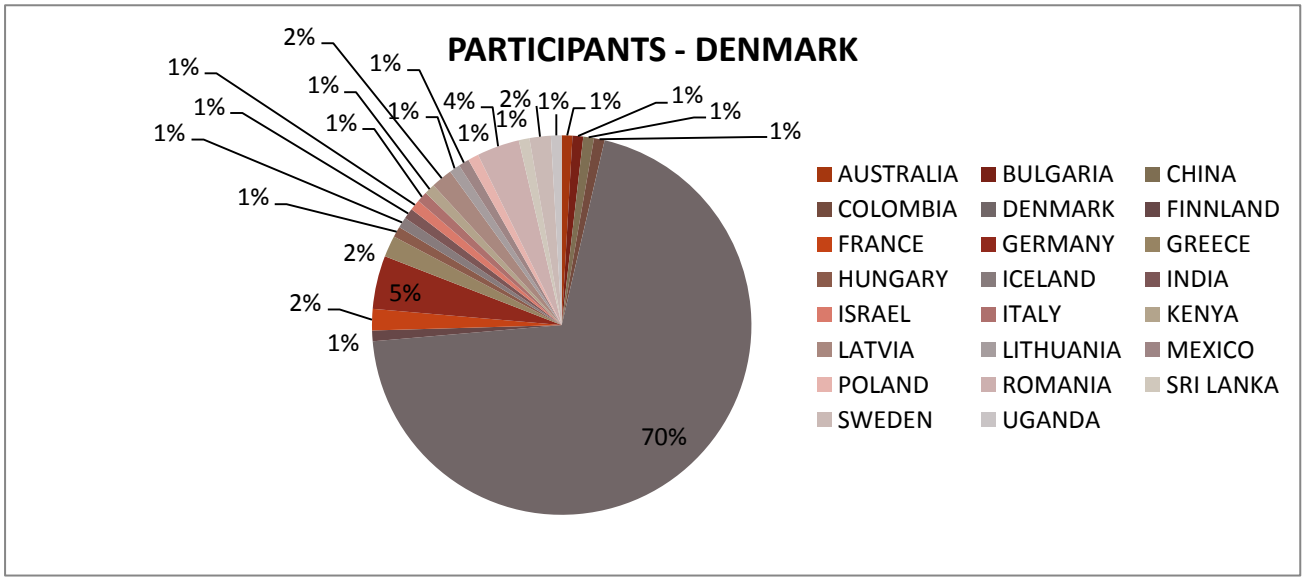


Figure 6 - Participants in Denmark

The mean age of the sample is 25.1 ± 7.9. 48.4% of the sample are women and 51.6% are men. 47.4% of the participants are cursing a bachelor program and the same a percentage are cursing a master program. 2.8% of the sample are PhD students and the remaining percentage (2.4%) has not marked an educational level. The mean of the BMI is 22.6 ± 3.6. 85.6% of the sample does not have children.

CHOCOLATE CONSUMPTION

It has been found that there is no significant difference when comparing frequency of chocolate consumption and gender (P-value 0.209) as well as with countries (P-value 0.056). Nevertheless it is important to have an overview of how often chocolate is consumed in Belgium and in Denmark (See figure 7). Most of the participants eat chocolate two to four times a week, once a week or at least once a month. There are few participants who do not eat chocolate or consume less than once a month while in the other hand there is a 11.6% of the participants who eat chocolate once a day and 5.1% who eat chocolate two or three times a day.

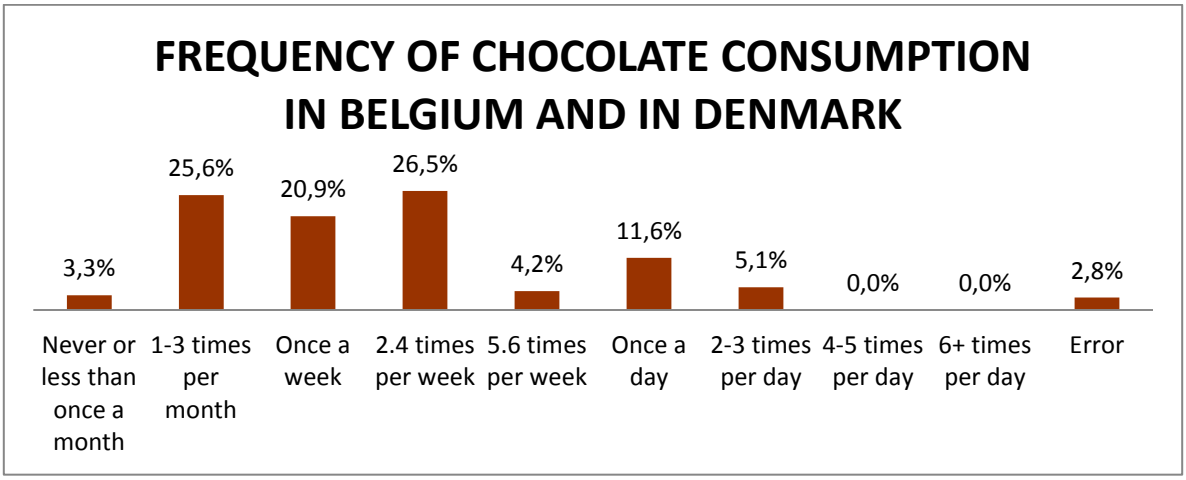


Figure 7 - Frequency of chocolate consumption in Belgium and in Denmark

MILK CHOCOLATE

There is no significant difference when comparing country (P-value = 0.193) and gender (P-value = 0.506) with liking of eating milk chocolate. However, it is important to know that 76.7% of the participants in total like to eat milk chocolate.

When comparing preference among white, milk and dark chocolate there is a significant difference among countries (P-value 0.035) but there is no significance difference among gender (P-value 0.178). As it can be seen in table 8, Belgians prefer to eat milk chocolate while in Denmark participants prefer to eat dark chocolate.

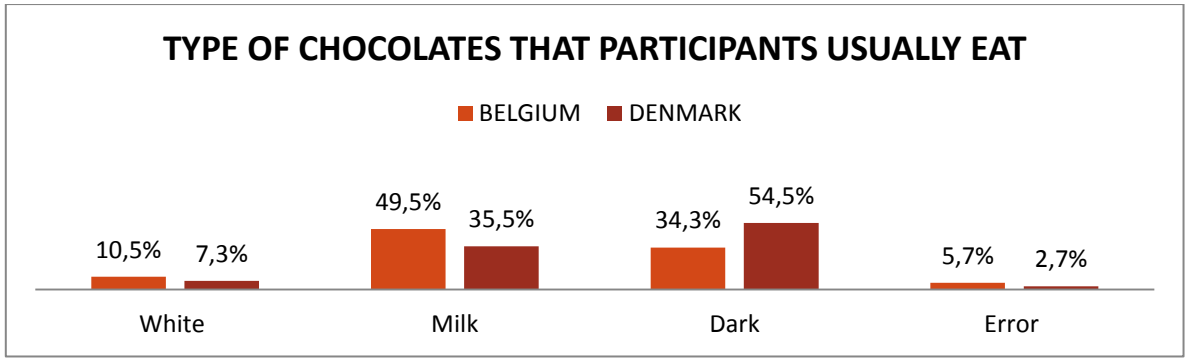


Figure 8 - Type of chocolates that participants usually eat

BRANDS

The chocolate brands that usually participants prefer are Cote D´Or in Belgium and Lind and Marabou in Denmark. From all the mentioned brands, Jacques and Milka are common eaten in both countries. Figure 9 and 10 present the chocolate brands that are usually bought in Belgium and in Denmark.

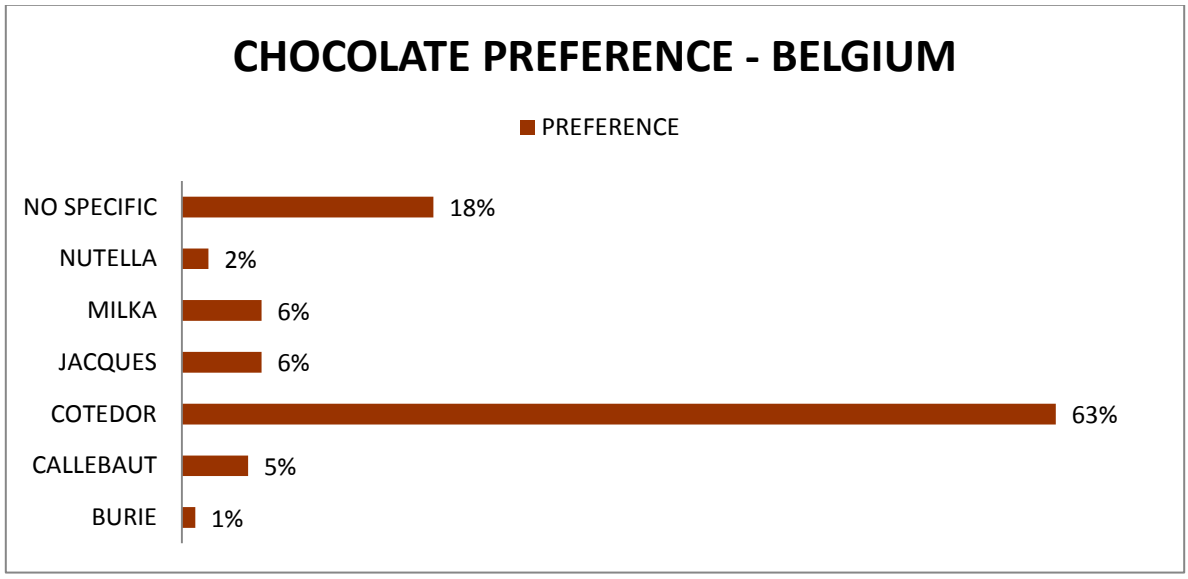


Figure 9 - Preferred chocolate brands in Belgium

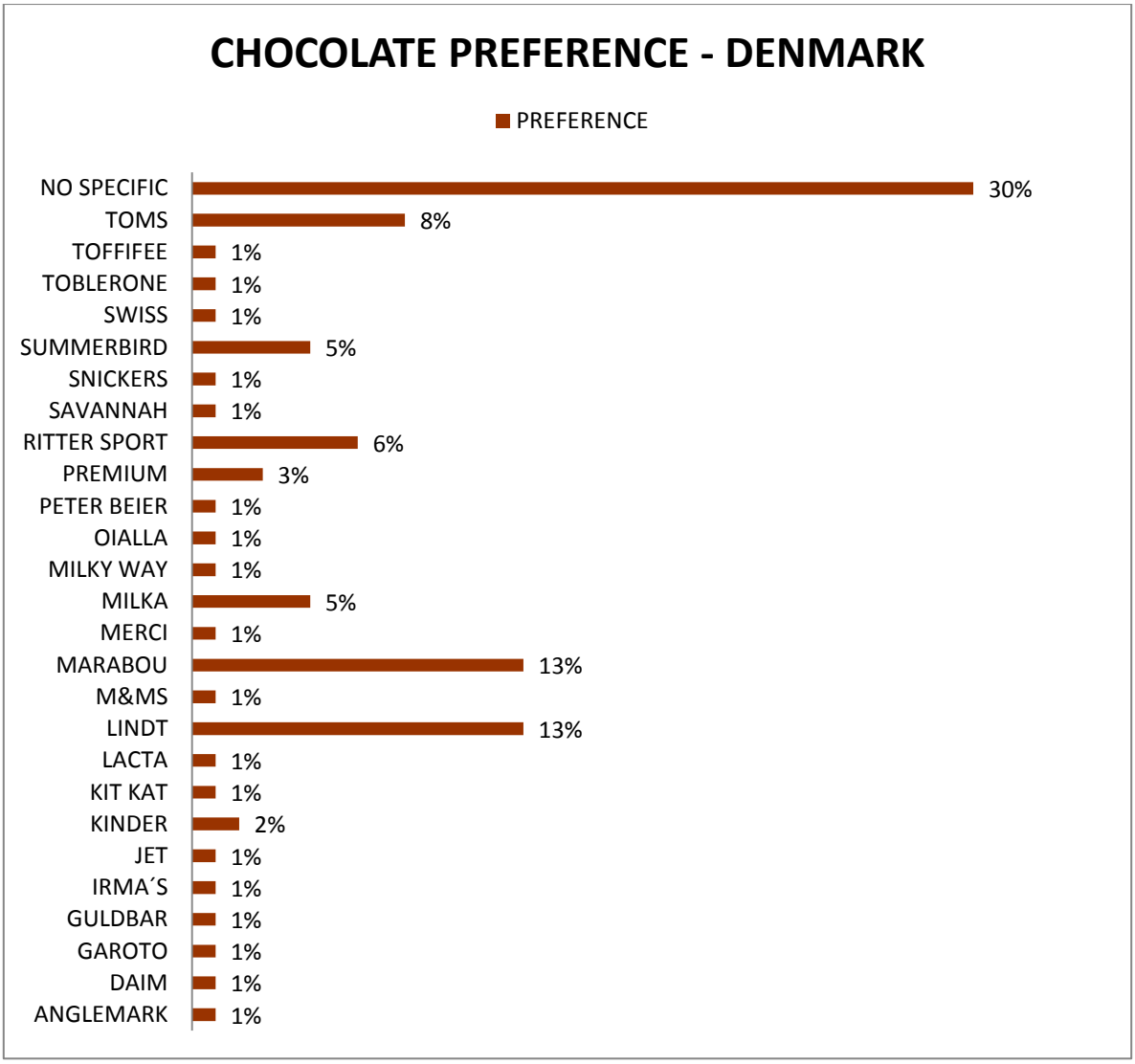


Figure 10 - Preferred chocolate brands in Denmark

CHOCOLATE PRODUCTS

From the list of chocolate products mentioned in the questionnaire, chocolate bars are mostly eaten. In figure 11 it is presented the list of the chocolate products that participants usually eat in Belgium and in Denmark. Some of the participants have also mentioned consumption of callets, chocolate eggs, pastry chocolate, and pastilles for recipes.

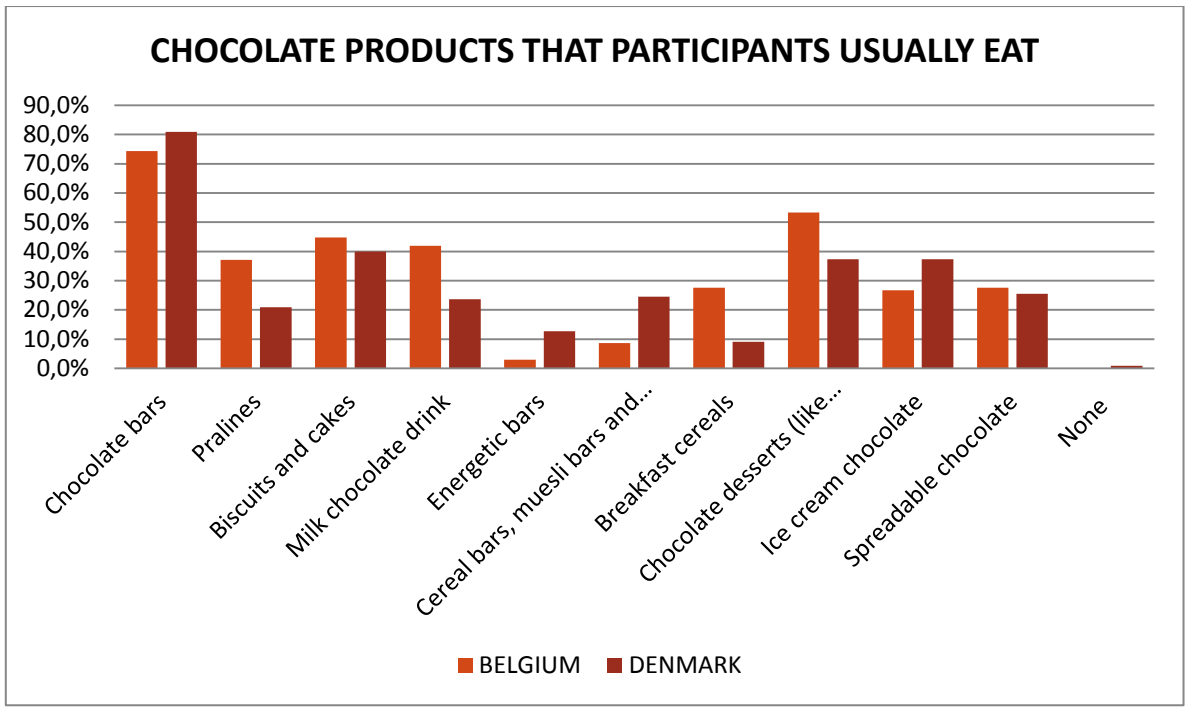


Figure 11 - Chocolate products that are usually eaten in Belgium and in Denmark

IMPORTANT CHARACTERISTICS WHEN CHOOSING CHOCOLATE OR CHOCOLATE PRODUCTS

Question 23 investigates what is important when choosing a chocolate or a chocolate product (chocolate cake, cookies, ice cream, etc.). Participants ranked their opinion in a 5-point Likert scale from not important at all to really important.

Table 6 presents the mode and the percentage of the characteristics presented in the questionnaire. For future analysis the characteristics have been organized in four areas according to: Sensory characteristics, content/ingredients, added value and product design.

Table 6 - Importance of characteristics when choosing chocolate or chocolate products

	Mode	% of participants
Sensory characteristics		
Taste	Really important	69.8
Mouth feeling / texture	Important	48.4
Sweetness	Important	48.4
Smell	Neutral	30.7
Color	Neutral	34.9
Content / Ingredients		
Low in sugar	Not important	27.9
Low in fat	Not important	29.8
Low in calories	Not important	28.4
Cocoa content	Neutral	26.5
Gluten free	Not important at all	59.1
Absence of additives	Neutral	28.8
Vegan or no animal ingredients.	Not important at all	50.7
High protein content	Not important at all	36.7
Low carb content	Not important at all	36.3
High flavanols / polyphenols content	Neutral	36.3
Added value		
Organic	Neutral	33.0
Fair trade	Neutral	32.6
Ethical and environmental friendly	Neutral	30.7
Sustainable	Neutral	40.5
Limited processing /Authentically cooked.	Neutral	33.5
Product design		
Price	Important	45.3
Brand loyalty	Neutral	31.2
Packaging	Important	32.6
Size	Important	43.3

SENSORY CHARACTERISTIS, ACCEPTANCE AND LIKING OF CHOCOLATES

The data collected in the first part of the questionnaire reflects the sensory characteristics, acceptance, and liking of the chocolate. It has been found that there are some interactions between the groups (Chocolate samples – Country and Gender – Country), however no interaction has been found between Chocolate samples – Gender (See table 7).

Table 7 - P-values of significant interactions between characteristics and variables. Bonferroni - General Linear Model

	Chocolate samples	Gender	Country	Chocolate samples * Country	Gender * Country
Liking	0.000	0.820	0.515	0.036	n/s
Sweetness	0.000	0.585	0.001	n/s	n/s
Milkiness	0.000	0.266	0.190	n/s	n/s
Smoothness	0.000	0.013	0.807	n/s	n/s
Caramel flavour	0.000	0.019	0.691	n/s	n/s
Cacao flavour	0.000	0.684	0.000	n/s	0.018
Special aftertaste	0.011	0.187	0.001	n/s	n/s

CHOCOLATES AND COUNTRY

There was a significant difference in liking when comparing Chocolate samples – Country. Table 8 shows the mean and the standard deviation from these comparisons.

Table 8 - Difference between countries associating chocolate characteristics with different chocolate samples

	BELGIUM										DENMARK										
	515		981		322		883		474		515		981		322		883		474		P-value
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	
Liking*	5.20	1.58	4.85	1.38	4.55	1.43	4.31	1.53	5.14	1.26	4.83	1.67	5.08	1.51	5.14	1.55	4.41	1.65	4.97	1.30	0.036
Sweetness**	3.33	0.76	2.81	0.77	2.92	0.81	2.62	0.78	2.65	0.70	3.64	0.78	2.93	0.84	3.21	0.72	2.54	0.91	2.90	0.95	n/s
Milkiness**	3.13	0.77	2,78	0.75	2.87	1.01	2.55	0.88	2.80	0.74	3.19	0.78	2.93	0.85	3.16	0.80	2.49	0.96	2.67	0.87	n/s
Smoothness /Melting behavior**	3.02	0.54	2.88	0.82	2.72	0.89	2.62	0.63	2.78	0.62	3.02	0.71	2.86	0.88	2.79	0.92	2.52	0.90	2.77	0.75	n/s
Caramel flavour**	2.71	0.94	2.49	0.98	2.53	1.14	2.55	1.19	2.23	0.86	2.87	1.07	2.39	0.94	2.38	1.04	2.28	1.14	2.20	0.87	n/s
Cacao flavour**	2.36	0.68	2.66	0.82	2.53	0.89	2.96	0.96	2.70	0.79	2.04	0.69	2.32	0.84	2.22	0.77	2.52	1.02	2.34	0.83	n/s
Special aftertaste**	2.86	0.77	2.73	0.84	2.74	1.00	3.04	1.06	2.85	0.80	2.57	1.01	2.54	1.05	2.61	0.89	2.88	1.26	2.39	0.93	n/s

*Mean values of 7-point Likert Scale ranging from “Dislike very much” to “Like very much”.

**Mean values of 5-point Likert Scale ranging from “Not at all sweet / milky / smooth / caramel flavour / intense (special aftertaste)” to “Way too much sweet / milky / smooth / caramel flavour / intense (special aftertaste)”

The Post-Hoc Test applied to the chocolates samples show differences in regards of liking and the six mentioned characteristics: Sweetness, milkiness, smoothness, caramel flavour, cacao flavour and special aftertaste. Pairwise comparison revealed the differences among chocolate samples. These effects can be found in table 9.

Table 9 - Mean differences between chocolate samples, liking and characteristics

		Liking	Sweetness	Milkiness	Smoothness	Caramel flavour	Cacao flavour	Special aftertaste
322	474	-	.30*	.29*	-	-	-	-
	515	-	-.42***	-	-.26*	-.35*	-	-
	883	.49*	.50***	.50***	-	-	-.37**	-
	981	-	-	-	-	-	-	-
474	322	-	-.30*	-.29*	-	-	-	-
	515	-	-.72***	-.43***	-.25*	-.58***	.32**	-
	883	.70**	-	-	-	-	-	-.34*
	981	-	-	-	-	-	-	-
515	322	-	.42***	-	.26*	.35*	-	-
	474	-	.72***	.43***	.25*	.58***	-.32**	-
	883	.66**	.92***	.64***	.45***	.39**	-.54***	-
	981	-	.62***	.30**	-	.35**	-.29**	-
883	322	-.49*	-.50***	-.50***	-	-	.37**	-
	474	-.70**	-	-	-	-	-	.34*
	515	-.66**	-.92***	-.64***	-.45***	-.39**	.54***	-
	981	-.61**	-.29*	-.34**	-.30**	-	-	.32*
981	322	-	-	-	-	-	-	-
	474	-	-	-	-	-	-	-
	515	-	-.62***	-.30**	-	-.35**	.29**	-
	883	.61**	.29*	.34**	.30**	-	-	-.32*

*p < .05.
**p <. 01.
***p < .001.

RESULTS INTERPRETATION

The results presented in table 9 – Mean differences between chocolate samples, liking and characteristics can be interpreted like:

LIKING

Chocolate 883 is the least liked chocolate.

SWEETNESS

Chocolate 515 is the sweetest sample. 322 is consider sweeter than 474 and 883. Chocolate 981 is sweeter than 883.

MILKINESS

Chocolate 515 is milkier than 474, 883 and 981. 322 is milkier than 474 and 883. Chocolate 981 is milkier than 883

SMOOTHNESS

Chocolate 515 is smoother than 322, 474 and 883. Chocolate 981 is smoother than 883.

CARAMEL FLAVOUR

Chocolate 515 has more caramel flavour than all the other chocolates.

CACAO FLAVOUR

Chocolate 515 has less cacao flavour than 474, 883 and 981. Chocolate 883 has more cacao flavour than 322.

SPECIAL AFTERTASTE

Chocolate 883 is the only chocolate that has an special aftertaste in contrast to 474 and 981.

To get a general overview of the samples, figures of each one of the chocolates according to each one of the studied characteristics can be found in Appendix 7. These figures suggest a tendency that can be used for future product development.

LESS SUGAR AND LESS CALORIES

In relation to questions 10, when asking the participants: "If the chocolate that you liked the most has an affordable price and less calories. Would you buy it?" Seventy eight percent (78.1%) of the participants would buy this chocolate.

In relation to question 11, if the chocolate that they liked the most has an affordable price and less sugar, 71.2% of the participants would buy the chocolate.

Also, according to question 12, if the chocolate with less sugar is available, people would prefer that is naturally sweetened (48.8%). Twenty-five percent (24.7%) indicated that would like that the chocolate is free from artificial sweeteners and 18.1% has no added sugar.

FOR A HEALTHY LIFESTYLE: DARK OR MILK CHOCOLATE?

Questions 20 and 21 of the questionnaire look into participants' perception in relation to dark and milk chocolate as part of a healthy lifestyle.

There is a significant difference when comparing the consideration of dark chocolate as part of a healthy lifestyle among the two countries (P-Value 0.004). 46.7% of the participants in Belgium consider dark chocolate part of a healthy lifestyle while in Denmark 68.2% does. When referring to milk chocolate there is no significant difference among countries (P-value 0.601). In Belgium 8.6% and in Denmark 12.7% of the participants consider milk chocolate part of a healthy lifestyle.

There is also no significant difference when comparing the consideration of dark chocolate as part of a healthy lifestyle among genders (P-Value 0.053). Fifty-three percent (52.7%) of men and 66% of women consider dark chocolate as a part of a healthy lifestyle, while 12.7% of men and 5.9% of women consider white chocolate as part of a healthy lifestyle (P-Value 0.191).

ATTITUDES, EMOTIONS AND BELIEFS

FEELINGS

There is a significant difference when comparing Feelings by country (P-value = 0.050) but not when comparing feelings by gender (P-value =0.565). Most of the participants felt loving, excited and sociable, some of them surprised but also disinterested and tired after the chocolate tasting (See figure 12).

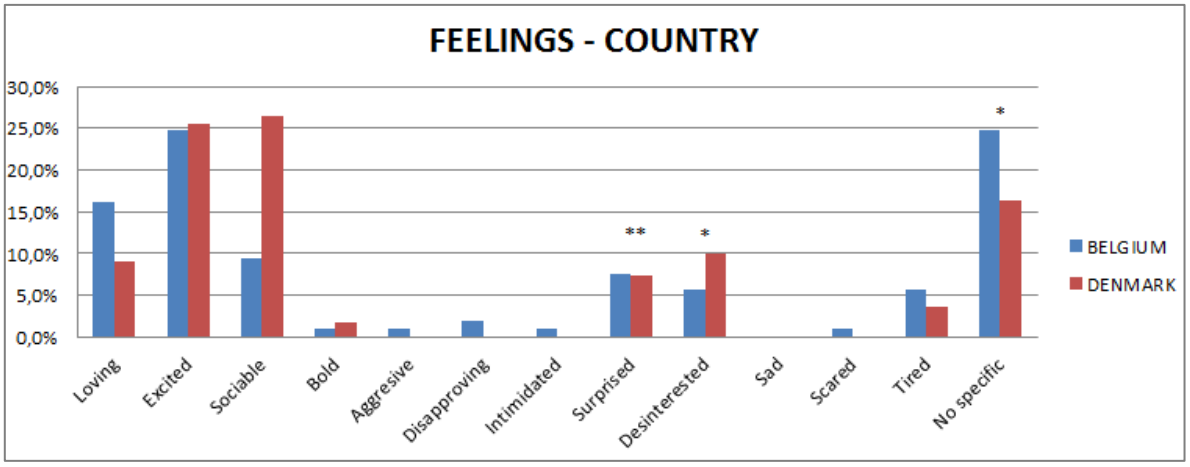


Figure 12 - Feelings after tasting the chocolate samples

*p < .05.
**p < .001.

ATTITUDES TO CHOCOLATE QUESTIONNAIRE

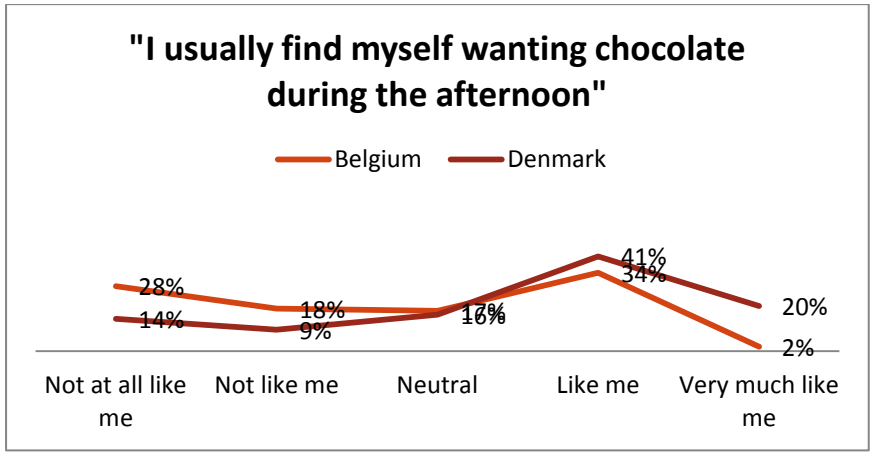
Table 10 shows the results obtained when comparing the Attitudes towards chocolate between countries and gender. There are few differences when comparing the statement between countries but, interesting there are many differences in the results when comparing by gender.

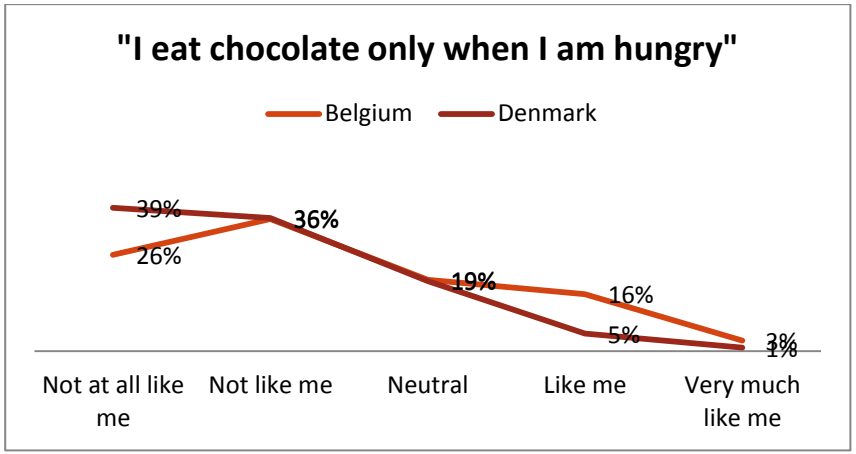
Table 10 - P-values of significant interactions between countries and gender on Attitudes to Chocolate Questionnaire (Chi-square)

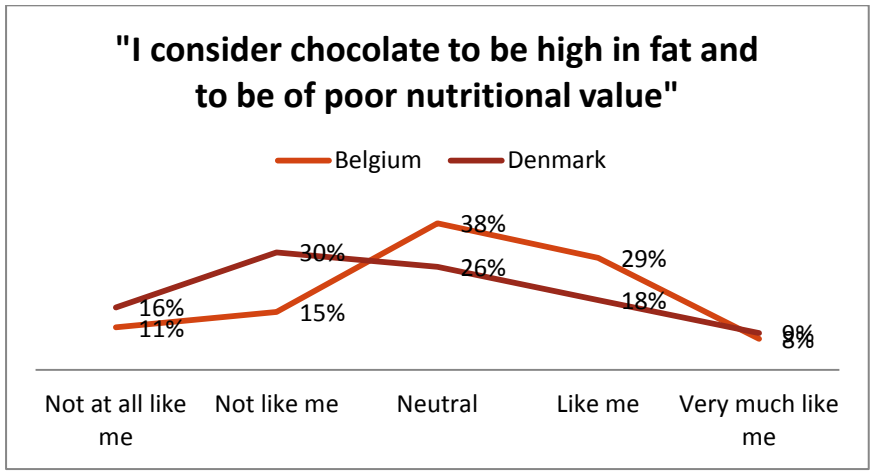
STATEMENTS	DIFFERENCE COUNTRIES	DIFFERENCE GENDERS	FACTOR
I eat chocolate to cheer me up when I am down.	n/s	0.000	Craving
My desire for chocolate often seems overpowering.	n/s	0.002	Craving
I feel unattractive after I have eaten chocolate.	n/s	0.007	Guilt
I often feel sick after eating chocolate.	n/s	n/s	Guilt
I eat chocolate as a reward when everything is going really well for me.	n/s	0.027	Functional
I am often on one kind of diet or another	n/s	n/s	Guilt
The thought of chocolate often distracts me from what I am doing (e.g. watching TV).	n/s	n/s	Craving
I usually find myself wanting chocolate during the afternoon.	0.000	0.001	Craving
I consider chocolate to be high in fat and to be of poor nutritional value.	0.025	n/s	Guilt
After eating chocolate I often wish I hadn´t.	n/s	0.002	Guilt
I feel guilty after eating chocolate	n/s	0.001	Guilt
I eat chocolate only when I am hungry.	0.047	0.029	Functional
Chocolate often preys on my mind.	n/s	0.000	Craving

I feel unhealthy after I have eaten chocolate.	n/s	0.002	Guilt
I always look at the calorific value of a chocolate snack before I eat it	n/s	n/s	Guilt
If I resist the temptation to eat chocolate I feel more in control of my life.	n/s	0.003	Guilt
Nothing else but chocolate will satisfy my chocolate cravings.	n/s	0.017	Craving
Even when I do not really want any more chocolate I will often carry on eating it.	n/s	n/s	Craving
I eat chocolate to keep my energy levels up when I am doing physical exercise.	n/s	n/s	Functional
I eat more chocolate in the winter when it is colder.	n/s	n/s	Functional
I often go into a shop for something else and end up buying chocolate.	n/s	n/s	Craving
I feel depressed and dissatisfied with life after eating chocolate.	n/s	n/s	Guilt
I often eat chocolate when I am bored.	n/s	n/s	Craving
I like to indulge in chocolate.	n/s	n/s	Craving

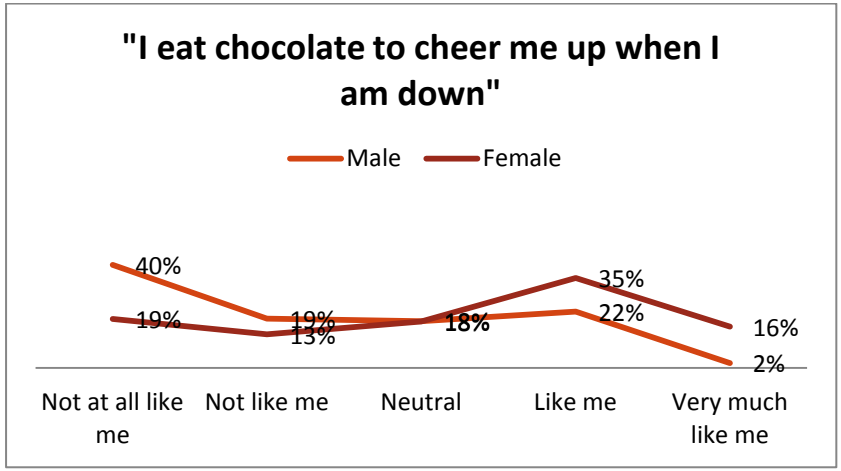
The figures below show the significant findings of the Attitudes to Chocolate Questionnaire among countries and among gender. In both countries participants usually want chocolate during the afternoon and they do not tend to eat chocolate when they are hungry. A marked difference is that Belgian participants tend to consider chocolate to be high in fat and poor in nutritional value, more than Danes.

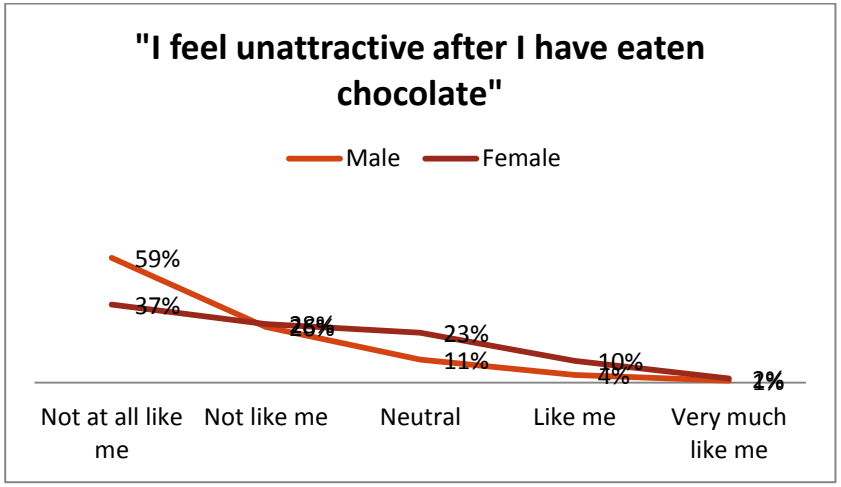


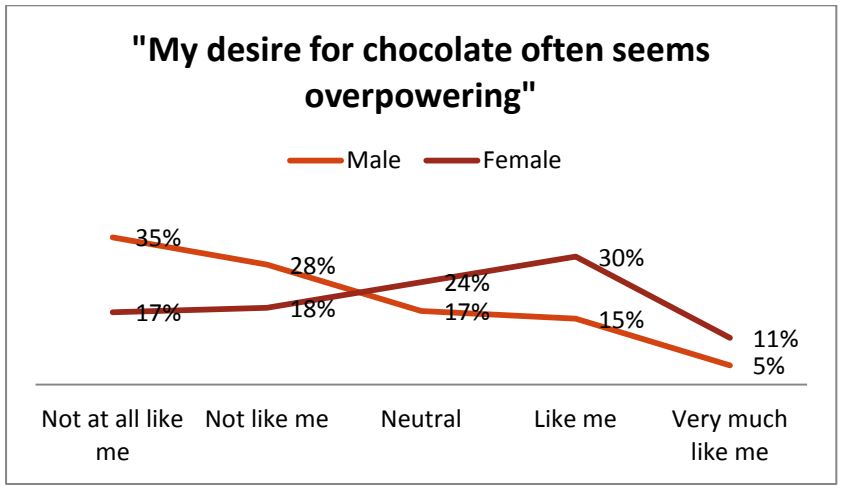


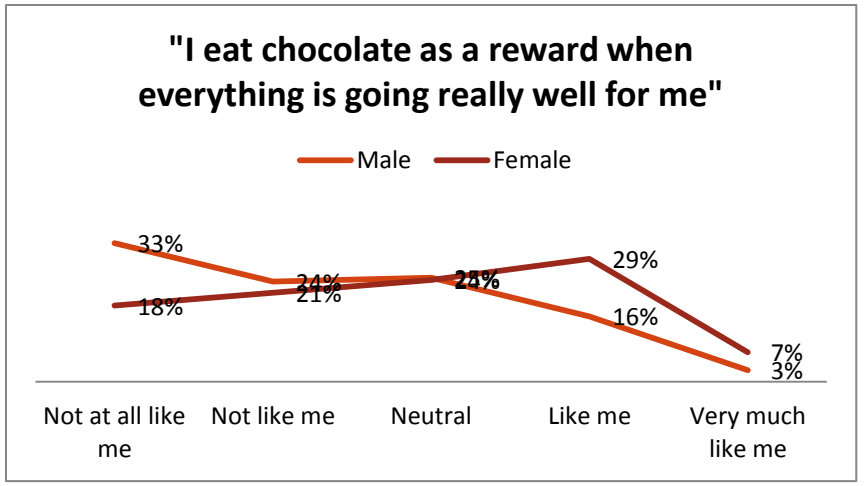


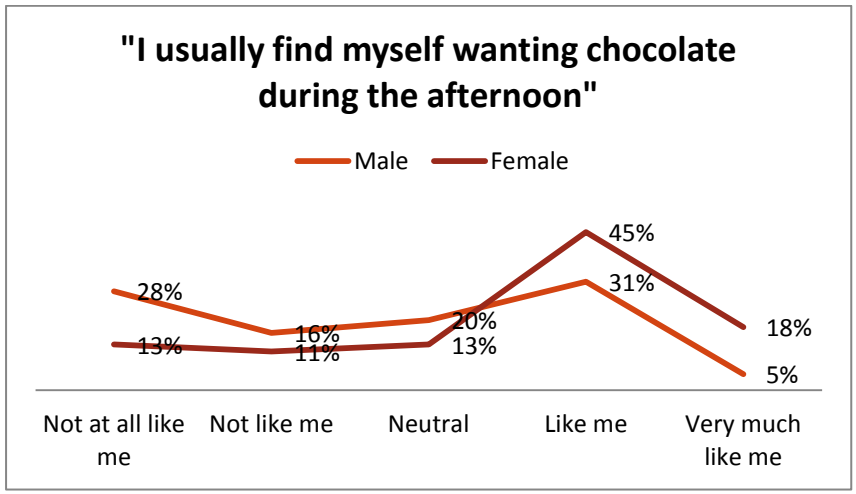
It is possible to see a tendency where women feel more “like” or “very much like” the statements than men. The following graphics show the significant differences among men and women. Five of the results are related to craving, five to guiltiness and two to functional factors.

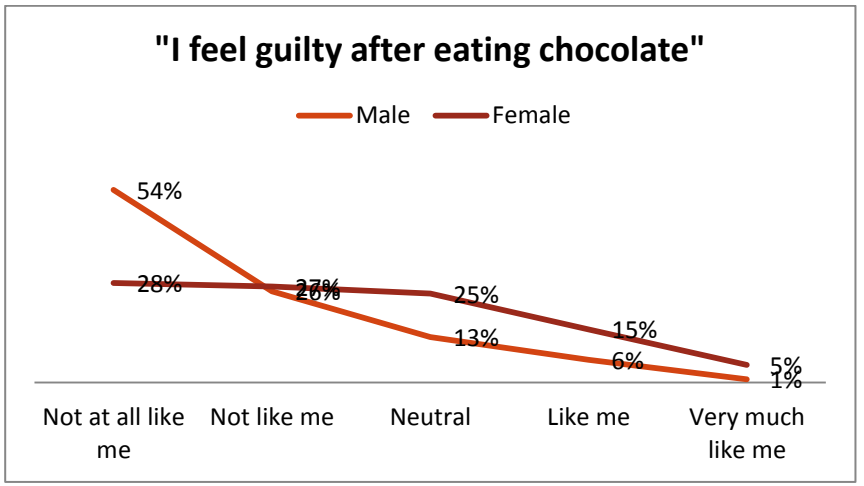


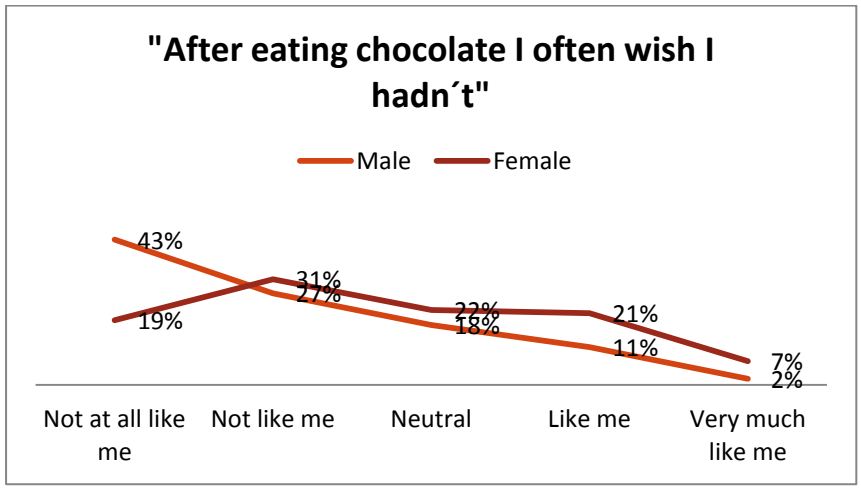


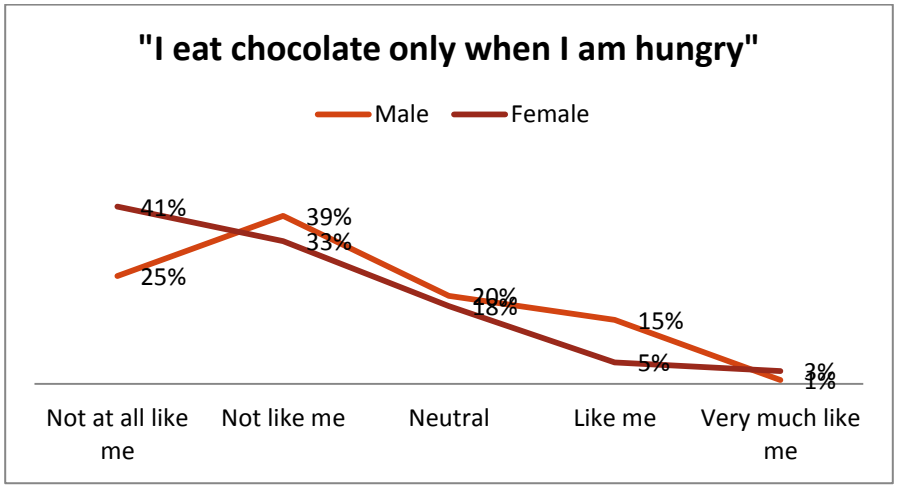


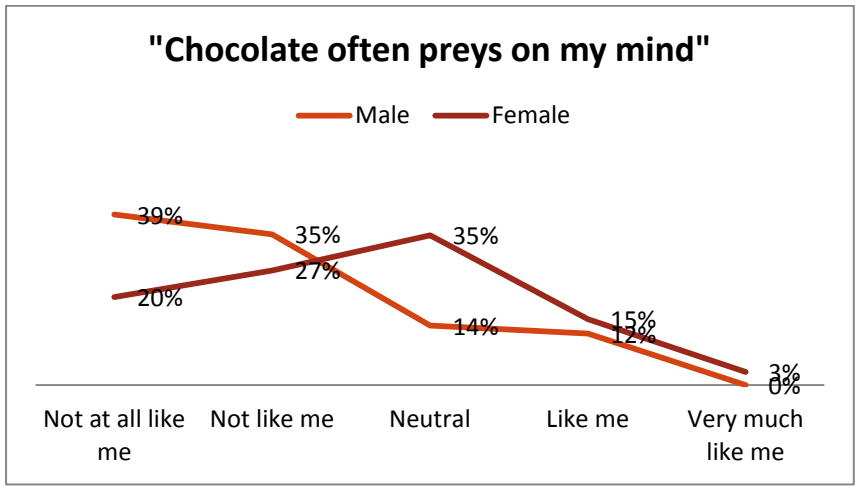


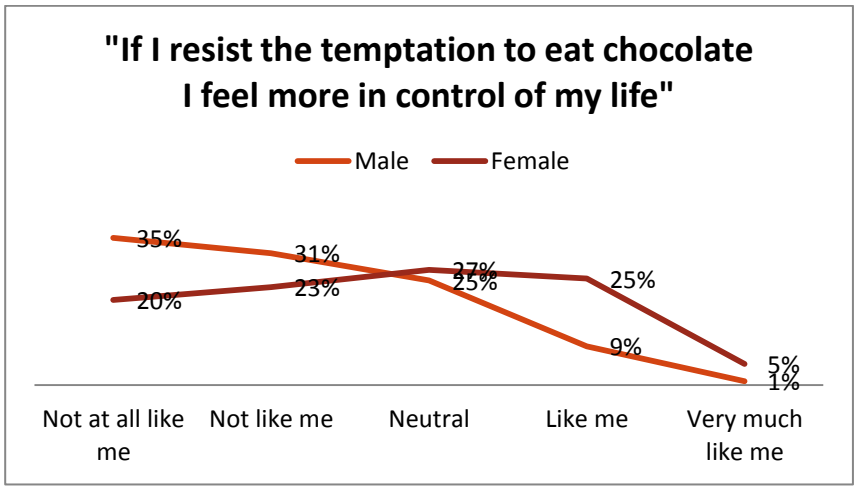

"I usually find myself wanting chocolate during the afternoon"
Male
Female
28%
16%
20%
31%
18%
13%
11%
13%
5%
45%
Not at all like me
Not like me
Neutral
Like me
Very much like me

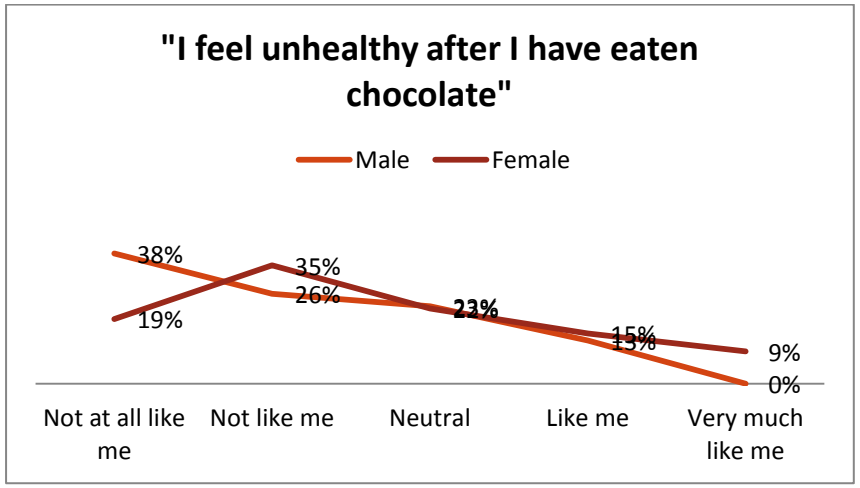

"I feel guilty after eating chocolate"
Male
Female
54%
28%
25%
15%
13%
6%
5%
1%
Not at all like me
Not like me
Neutral
Like me
Very much like me

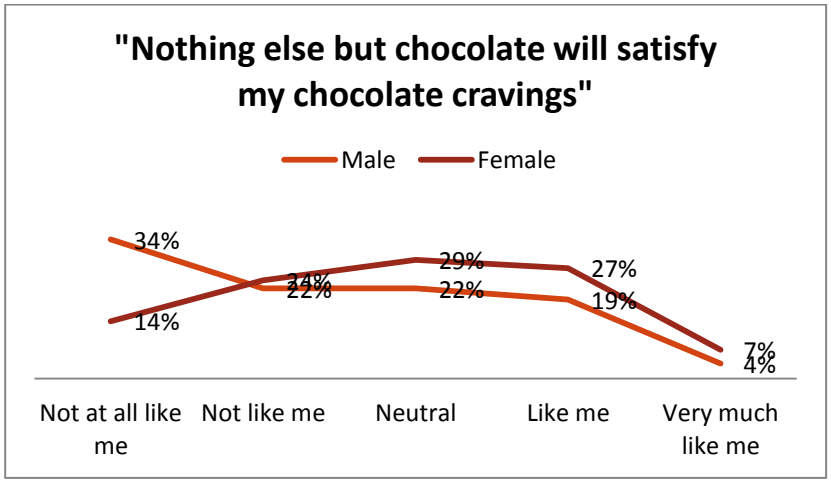

"After eating chocolate I often wish I hadn´t"
Male
Female
43%
31%
27%
22%
18%
21%
11%
7%
2%
19%
Not at all like me
Not like me
Neutral
Like me
Very much like me


"I eat chocolate only when I am hungry"
Male
Female
41%
39%
33%
25%
20%
18%
15%
5%
3%
1%
Not at all like me
Not like me
Neutral
Like me
Very much like me


"Chocolate often preys on my mind"
Male
Female
39%
35%
27%
20%
35%
14%
15%
12%
3%
0%
Not at all like me
Not like me
Neutral
Like me
Very much like me


"If I resist the temptation to eat chocolate I feel more in control of my life"
Male
Female
35%
31%
20%
23%
27%
25%
25%
9%
5%
1%
Not at all like me
Not like me
Neutral
Like me
Very much like me


"I feel unhealthy after I have eaten chocolate"
Male
Female
38%
35%
26%
19%
23%
15%
13%
9%
0%
Not at all like me
Not like me
Neutral
Like me
Very much like me


"Nothing else but chocolate will satisfy my chocolate cravings"
Male
Female
34%
14%
22%
29%
22%
27%
19%
7%
4%
Not at all like me
Not like me
Neutral
Like me
Very much like me

6 DISCUSSION

The aim of this thesis was to analyze the relevance of a healthy chocolate based on consumer´s needs, expectations and perceptions.

This project had two steps. First, a systematically literature was conducted in four digital databases. After screening, sixty articles were selected to be part of this study because of their relevance and they have met the criteria. The articles were organized following the three areas of the project: Health, sensory characteristics and attitudes towards chocolate.

The second step was the consumer research by applying a questionnaire in Belgium and in Denmark. The study was conducted in two universities, at KU Leuven, Campus Gent (KAHO Sint–Lieven) in Gent and at Aalborg University (AAU) in Copenhagen.

Based on the systematic literature review, it has been found that chocolate has a positive effect in human health. Chocolate has especially properties that help to protect human body against cardiovascular diseases; it increases HDL cholesterol and decrease blood pressure. Chocolate consumption also helps to reduce stress, elevates mood and reduces tiredness. However, some people after eating chocolate feel guilty or have a negative attitude.
It has also been found that chocolate is the most craved food in the world, especially among women and it is hard to be replaced by other item. Surprisingly, it has been found that craving for chocolate has no relation with a higher BMI.

In relation to the questionnaire, some remarkable differences have been found when applying the questionnaire in Belgium and in Denmark. In relation to chocolate preference, Danish participants prefer dark chocolate rather than milk chocolate, opposite result than Belgians. The preferred chocolate brand in Belgium is Cote D'Or while in Denmark there is no really a specific brand. The liking of the product varies significant according to country. In Belgium they like the most chocolate 515 the Gold Standard Chocolate, no sugar reduced, while in Denmark the most liked is 322, sugar reduced chocolate with no impact on calories. There is also a significant difference among countries, 68.2% Danes consider dark chocolate as part of a healthy lifestyle while in Belgium less than half of the participants do.

In relation to attitudes towards chocolate, there are significant differences among gender but not about country. As it is stated in the literature women crave chocolate more than men and feel guilty after doing it.

In relation to the hypothesis: "The determinants for eating chocolate vary by gender and by country among university students" has been verified. The results will be discussed referring to the three areas of the study: Health, sensory characteristics and acceptance and attitudes towards chocolate.

HEALTH

While combining the results from the literature review with the results from the questionnaire it appears evident that Danes consider dark chocolate as part of a healthy lifestyle, for instance they prefer to eat this kind of chocolate. It could be assumed that this is because environment has an influence in their preferences. As Mela states there are external stimuli that are learned, or cultural aspects that might influence these decisions. In Denmark there is a tendency to eat healthy, consume organic products and to do physical activity as part of their daily life routine. All of these characteristics might have an influence in deciding what kind of food items should be consumed.

On the other hand there is a preferece in Belgium for eating milk chocolate. This could also be due to the cultural or social context. The data gathered from the questionnaire shows that less than half of the Belgian participants do not consider dark chocolate as part of a healthy lifestyle and this could be the reason why they do not choose to consume dark chocolate.

All Participants like milk chocolate. This type of chocolate has higher amount of sugar and calories content. When it was asked, if participants would buy the chocolate that they like the most with an affordable price and with less calories, 78% of the participants will do it. The same tendency can be seen with sugar. 71.2% of the participants will buy the chocolate that they liked the most, with an affordable price and with less sugar. These results show that participants are willing to purchase a healthier chocolate, reduced in calories and reduced in sugar and with an affordable price. For instance,, an important fact related to these results is also price. Participants have ranked it as an important characteristic when choosing a chocolate product.

SENSORY CHARACTERISTICS AND ACCEPTANCE

In relation to sensory characteristics and acceptances, the liking of the chocolate samples differs significantly among countries. In Belgium participants liked the most the Gold Standard Chocolate, 515. This is the reference chocolate, no sugar reduced, nor calories. In Denmark, participants liked the most chocolate 322, a sugar reduced chocolate that has no impact on calories. As Mela states, liking a product is a combination of different sensory characteristics. There are many reasons why a product is chosen. It could also be something psychological; participants could remind a specific flavour or relate with a special occasion. When comparing the chocolates by liking and preferences it could be considered that participants like the milk chocolate samples and even though, they prefer to consume dark chocolate instead for their healthy properties. When comparing liking and desire, 76, 7% of the participants like milk chocolate but it could be possible that in the day when the questionnaire was applied, they did not feel like eating chocolate as other days.

There are many characteristics influencing food liking. One of them is taste. 69.8% of all the participants agree that taste is a "really important" characteristic when choosing a chocolate or a chocolate product. There are also other characteristics that have been ranked as important like mouth feeling/texture or sweetness.

ATTITUDES TOWARDS CHOCOLATE

As it has been found in the literature, there is a contrast when comparing the attitudes towards chocolate among gender. There is a tendency of women craving or feeling guilty after eating chocolate. Some statements that show significant differences are for example: "I eat chocolate to cheer me up when I am down", "Chocolate often prays in my mind", "I feel guilty after eating chocolate", "My desire for chocolate often seems overpowering" or "I feel unhealthy after I have eaten chocolate". This match accurately with what has been stated in the literature.

Another part of the questionnaires was related to feelings after eating the chocolate samples. Mela states that current internal state as mood or emotions affect food desire and intake. Significan differences were found among countries when testing the chocolate samples like they felt surprised or disinterested. Some other feelings that were also indicated in the questionnaire were: Loving, excited and sociable.

The most important from these findings are the differences of chocolate liking according to country. It varies from sample to sample and differ in each of the characteristics. This needs to be taken into account when developing a product for an specific target group, in this case per country.

An important finding is also that participants are aware of health related issues and are willing to purchase a product low in sugar and in calories. This could be interpreted as a willing to taking care of their health.

A relevant finding is to prove that participants´ answers in relation to attitudes towards chocolate match exactly as what the literature has exposed. Women tend to crave chocolate, feel guilty and these results do not differ among country but they do among gender.

Strengths and Limitations

There are many strengths in this project. One of them is systematic literature review. It provides an organized insight on what has been already studied in the field and it presents a clear way on how to analyze the collected information. Another is the questionnaire applied in two countries and the sample size. It gives the opportunity to compare and analyze the data and it is even better when the purpose is to develop a product where different target are going to be included.

The visit to Barry Callebaut is also a strong point of this project. It gives the opportunity to see the "problem" that needs to be solved within this project. It provides a different perspective on how to study a case.

There also some limitations that needs to be considered. The reference list of the studies was not fully checked while screening the articles in the literature review. The lack of time was an impediment to work closer with the company and to get more input conferring the project. Some details that need to be taken into account is that nationality was not asked in the questionnaire in Belgium and it was assumed that all the participants were Belgians.

7 CONCLUSION AND FUTURE PERSPECTIVES

This project focused in the determinants of eating chocolate among adults. This research is the base to determinate the liking of five different chocolate samples among university students. Significant differences have been found among gender and countries in relation to the chocolates. The participants liked the chocolates, some more than others and these results give a different outcome than from a trained panel and it is necessary to take into account for future product development. Non-sensory trained people present genuine preference for a specific product because they do not only analyze the samples with their senses; they also relate chocolate taste, sweetness, and the other characteristics with memories, emotions, and feelings.

With this project and with its findings, it can be concluded that there is a need for "healthy" chocolate. The literature supports the health properties that chocolate consumption has and the consumers are willing to purchase a chocolate product with sugar and calories reduced.

Future perspectives

This project focused mainly in one pillar of IFS, Public Health Nutrition nevertheless, Food Design and Food Policy are also important fields that it is necessary to take into account in the future to obtain a holistic point of view. Food Design could for example be involved in the development of the product. As it was stated in the results packaging is an important fact related with the product. Food Policy could involve different stakeholders and the regulations around this field.

8 Bibliography

Akyol, A., Dasgin, H., Ayaz, A., Buyuktuncer, Z., & Besler, H. T. (2014). B-Glucan and dark chocolate: A randomized crossover study on short-term satiety and energy intake. *Nutrients 6*, 3863-3877.

Al-Safi, S. A., Ayoub, N. M., Al-Doghim, I., & Aboul-Enein, F. H. (2011). Dark chocolate and blood pressure: A novel study from Jordan. *Current Drug Delivery 8*, 595-599.

Aziz, N. H., Al-Muwallad, O. K., & Mansour, E. K. (2011). Neurotic depression and chocolate among female medical students at college of medicine, Taibah University Almadinah Almnawwarah, Kingdom of Saudi Arabia. *Journal of Taibah University Medical Sciences 6*, 139-147.

Baba, S., Natsume, M., Yasuda, A., Nakamura, Y., Tamura, T., Osakabe, N., y otros. (2007). Plasma LDL and HDL cholesterol and oxidized LDL concentrations are altered in normo- and hypercholesterolemic humans after intake of different levels of cocoa powder. *The Journal of Nutrition 137*, 1436-1441.

Baggott, M. J., Childs, E., Hart, A. B., Bruin, E., Palmer, A., Wilkinson, J. E., y otros. (2013). Psychopharmacology of theobromine in healthy volunteers. *Psychopharmacology 228*, 109-118.

Benton, D., Karen, G., & Morgan, M. (1998). The development of the attitudes to chocolate questionnaire. *Pergamon Vol. 24 No. 4*, 513-520.

Buijsse, B., Weikert, C., Drogan, D., Bergmann, M., & Boeing, H. (2010). Chocolate consumption in relation to blood pressure and risk of cardiovascular disease in German adults. *European Hearth Journal 31*, 1616-1623.

Buijsse, B., Weikert, C., Drogan, D., Bergmann, M., & Boeing, H. (2010). Chocolate consumption in relation to blood pressure and risk of cardiovascular disease in German adults. *European Heart Journal 31*, 1616-1623.

Callebaut, B. (2015). *About us: Barry Callebaut*. Recuperado el 11 de May de 2015, de Barry Callebaut: https://www.barry-callebaut.com/about-us

Camfield, D., Scholey, A., Pipingas, A., Silberstein, R., Kras, M., Nolidin, K., y otros. (2012). Steady state visually evoked potential (SSVEP) topography changes associated with cocoa flavanoll consumption. *Physiology & Behavior 105*, 948-957.

Cartwright, F., & Stritzke, W. G. (2008). A multidimensional ambivalence model of chocolate craving: Construct validity and associations with chocolate consumption and disordered eating. *Eating Behaviors 9*, 1-12.

Corti , R., Flammer, A. J., Hollenberg, N. K., & Lüscher, T. F. (2009). Cocoa and Cardiovascular Health. *Circulation 119*, 1433-1441.

Desch, S., Schmidt, J., Kobler, D., Sonnabend, M., Eitel, I., Sareban, M., y otros. (2010). Effect of cocoa products on blood pressure: Systematic Review and Meta-Analysis. *American Journal of Hypertension 23*, 97-103.

Dictionaries, O. (2015). *Oxford Dictionaries*. Recuperado el 3 de June de 2015, de Oxford Dictionaries: http://www.oxforddictionaries.com/es/definicion/ingles_americano/palatable

Djoussé, L., Hopkins, P. N., Arnett, D. K., Pankow, J. S., Borecki, I., North, K. E., y otros. (2011). Chocolate consumption is inversely associated with calcified atherosclerotic plaque in the coronary arteries: The NHLBI Family Heart Study. *Clinical Nutrition 30*, 38-43.

Djoussé, L., Hopkins, P. N., North, K. E., Pankow, J. S., Arnett, D. K., & Ellison, R. C. (2011). Chocolate consumption is inversely associated with prevalent coronary heart disease: The National Heart, Lung and Blood Institute Family Heart Study. *Clinical Nutrition 30*, 182-187.

Durkin, K., Hendry, A., & Stritzke, W. G. (2013). Mixed selection. Effectsof body images, dietary restraint, and persuasive messges on females´orientations towards chocolate. *Appetite 60*, 95-102.

Durkin, K., Rae, K., & Stritzke, W. G. (2012). The effect of images of thin and overweight body shapes on women´s ambivalence towards chocolate. *Appetite 58*, 222-226.

Farhat, G., Drummond, S., Fyfe, L., & Al-Dujaili, E. (2014). Review Dark Chocolate: An obesity paradox or a culprit for weight gain? *Phytotherapy Research 28*, 791-797.

Faridi, Z., Njike, V. Y., Dutta, S., Ali, A., & Katz, D. L. (2008). Acute dark chocolate and cocoa ingestion and endothelial function: A randomized controlled crossover trial. *The American Journal of Clinical Nutrition 88*, 58-63.

Fernández-Murga, L., Tarín, J., García-Perez, M., & Cano, A. (2011). The impact of chocolate on cardiovascular health. *Maturitas 69*, 312-321.

Field, D. T., Williams, C. M., & Butler, L. T. (2011). Consumption of cocoa flavanols result in an acute improvement in visual and cognitive functions. *Physiology & Behavior 103*, 255-260.

Giuseppe, R. d., Castelnuovo, A. D., Centritto, F., Zito, F., Curtis, A. D., Costanzo, S., y otros. (2008). Regular consumption of dark chocolate is associated with low serum concentrations of C-reactive protein in a healthy italian population. *The Journal of Nutrition 138*, 1939-1945.

Greenberg, J. A. (2015). Chocolate intake and diabetes risk. *Clinical Nutritioin 34*, 129-133.

Gucht, D., Soetens, B., Raes, F., & Griffith, J. W. (2014). The Attitudes to Chocolate Questionnaire. Psychometric properties and realtionship with consumption, dieting, disinhibition and thought suppression. *Appetite 76*, 137-143.

Harwood, M. L., Ziegler, G. R., & Hayes, J. E. (2013). Tolerance for high flavanol cocoa powder in semisweet chocolate. *Nutrients 5*, 2258-2267.

Heinrich, U., Neukam, K., Tronnier, H., Sies, H., & Stahl, W. (2006). Long-term ingestion of high flavanol cocoa provides photoprotection against UV-induced erythema and improves skin condition in women. *The Journal of Nutrition 136*, 1565-1569.

Hormes, J. M., & Timko, C. A. (2011). All cravings are not created equal. Correlates of menstrual versus non-cyclic chocolate craving. *Appetite 57*, 1-5.

Hormes, J. M., Orloff, N. C., & Timko, C. A. (2014). Chocolate craving and disordered eating. Beyond the gender divide? *Appetite 83*, 185-193.

Jesson, J. K., Matheson, L., & Lacey, F. M. (2011). *Doing your literature review.* Sage.

Jiménez, B. (10 de July de 2010). *El parraíso del chocolate de los Inas*. Recuperado el 2 de June de 2015, de El Mundo: http://www.elmundo.es/america/2010/07/10/noticias/1278791705.html

Judelson, D. A., Preston, A. G., Miller, D. L., Muñoz, C. X., Kellogg, M. D., & Lieberman, H. R. (2013). Effect of Theobromine and Caffeine on Mood and Vigilance. *Journal of Clinical Psychopharmacology 33*, 499-506.

Kahn, R., & Sievenpiper, J. L. (2014). Dietary sugar and body weight: Have we reached a crisis in the epidemic of obesity and diabetes? *Diabetes Care 37*, 957-962.

Kurlandsky, S. B., & Stote, K. S. (2006). Cardioprotective effects of chocolate and almond consumption in healthy women. *Nutrition Research 26*, 509-516.

Lamuela-Raventós, R., Romero-Pérez, A. I., Andrés-Lacueva, C., & Tornero, A. (2005). Review: Health effects of cocoa flavonoids. *Food Sci Tech Int 11*, 159-176.

Lenfant, F., Hartmann, C., Watzke, B., Breton, O., Loret, C., & Martin, N. (2013). Impact of the shape on sensory properties of individual dark chocolate pieces. *LWT - Food Science and Technology 51*, 545-552.

Macht , M., & Mueller, J. (2007). Interactive Effects of Emotional and Restrained Eating on Responses to Chocolate and affect. *The Journal of Nervous and Mental Disease 195*, 1024-1026.

Macht, M., & Dettmer, D. (2006). Everyday mood and emotions after eating a chocolate bar or an apple. *Appetite 46*, 332-336.

Macht, M., & Mueller, J. (2007). Immediate effects of chocolate on experimentally induced mood states. *Appetite 49*, 667-674.

Martin, F.-P. J., Antille , N., Rezzi , S., & Kochhar, S. (2012). Everyday eating experiences of chocolate and non-chocolate snacks impact postprandial anxiety, energy and emotional states. *Nutrients 4*, 554-567.

Martin, F.-P. J., Montoliu, I., Nagy, K., Moco, S., Collino, S., Guy, P., y otros. (2012). Specific dietary preferences are linked to differing gut microbial metabolic activity in response to dark chocolate intake. *Journal of Proteome Research 11*, 6252-6263.

Martin, F.-P. J., Rezzi, S., Peré-Trepat, E., Kamlage, B., Collino, S., Leibold, E., y otros. (2009). Metabolic effects of dar chocolate consumption on energy, gut microbiota, and stress-related metabolism in free-living subjects. *Journal of Proteome Research 8*, 5568-5579.

Martínez-López, S., Sarriá, B., Sierra-Cinos, J. L., Goya, L., Mateos, R., & Bravos, L. (2014). Realistic intake of a flavanol-rich soluble cocoa product increases HDL-cholesterol without inducing anthropometric changes in healthy and moderately hypercholesterolemic subjects. *Food & Function 5*, 364-374.

Mela, D. J. (1999). Food choice and intake: the human factor. *Proceedings of the Nutrition Society 58*, 513-521.

Mela, D. J. (2000). Why do we like what we like? *Journal of Science of Food and Agriculture 81*, 10-16.

Mela, D. J. (2001). Determinants of Food Choice: Relationships with Obesity and Weight Control. *Obesity Research Vol. 9 Suppl.*, 249-255.

Mela, D. J. (2006). Eating for pleasure or just wanting to eat? Reconsidering sensory hedonic responses as a driver of obesity. *Appetite 47*, 10-17.

Mogollon, J. A., Boivin, C., Lemieux, S., Blanchet, C., Claveau, J., & Dodin, S. (2014). Chocolate flavanols and skin photoprotection: A parallel, double-blind, randomized clinical trial. *Nutrition Journal 13*, 66.

Moreno-Dominguez, S., Rodríguez-Ruiz, S., Martín, M., & Warren, C. S. (2012). Experimental effects of chocolate deprivation on cravings, mood, and consumption in high and low chocolate-cravers. *Appetite 58*, 111-116.

Müller, J., Dettmer, D., & Macht, M. (2008). The Attitudes to Chocolate Questionnaire: Psychometric properties and relatioship to dimensions of eating. *Appetite 50*, 499-505.

Nanetti, L., Raffaelli, F., Tranquilli, A., Fiorini, R., Mazzanti, L., & Vignini, A. (2012). Effect of consumption of dark chocolate on oxidative stress in lipoproteins and platelets in women and in men. *Appetite 58*, 400-405.

Nasser, J. A., Bradley, L. E., Leitzsch, J. B., Chohan, O., Fasulo, K., Haller, J., y otros. (2011). Psychoactive effects of tasting chocolate and desire for more chocolate. *Physiology & Behavior 104*, 117-121.

Net, M. (s.f.). *Definition of Polyphenol*. Recuperado el 3 de June de 2015, de Medicine Net: http://www.medicinenet.com/script/main/art.asp?articlekey=16619

Neufingerl, N., Zebregs, Y. E., Shuring, E. A., & Trautwein, E. A. (2013). Effect of cocoa and theobromine consumption on serum HDL-cholesterol concentrations: a randomized controlled trial. *The American Journal of Clinical Nutrition 97*, 1201-1209.

Ngo, M. K., Reeva, M., & Spence, C. (2011). Assessing the shapes and speech sounds that people associate with chocolate samples varying in cocoa content. *Food Quality and Preference 22*, 567-572.

Njike, V. Y., Faridi, Z., Shuval, K., Dutta, S., Kay, C. D., West, S. G., y otros. (2011). Effects of sugar-sweetened and sugar-free cocoa on endothelial function in overweight adults. *International Journal of Cardiology 149*, 83-88.

Osman, J. L., & Sobal, J. (2006). Chocolate cravings in American and Spanish individuals: Biological and cultural influences. *Appetite 47*, 290-301.

Rodgers, R. F., Stritzke, W. G., Bui , E., Franko, D. L., & Chabrol, H. (2011). Evaluation of the French version of the orientation towards chocolate questionnaire: Chocolate-related guilt and ambivalence are associated with overweight and disordered eating. *Eating Behaviors 12*, 254-260.

Rodríguez , S., Fernández, M. C., Cepeda-Benito, A., & Vila, J. (2005). Subjective and physiological reactivity to chocolate images in high and low chocolate cravers. *Biological Psychology 70*, 9-18.

Rusconi, M., & Conti, A. (2010). Theobrima cacao L., the Food of the Gods: A scientific approach beyond myths and claims. *Pharmacological Research 61*, 5-13.

Sarriá, B., Martínez-López, S., Sierra-Cinos, J. L., Garcia-Diz, L., Goya, L., Mateos, R., y otros. (2015). Effects of bioactive constituents in functional cocoa products on cardiovascular health in humans. *Food Chemistry 174*, 214-218.

Sarriá, B., Martínez-López, S., Sierra-Cinos, J. L., García-Diz, L., Mateos, R., & Bravo, L. (2014). Regular consumption of a cocoa product improves the cardiometabolic profile in healthy and moderately hypercholesterolaemic adults. *British Journal of Nutrition 111*, 122-134.

Scholey, A. B., French, S. J., Morris, P. J., Kennedy, D. O., Milne, A. L., & Haskell, C. F. (2010). Consumption of cocoa flavanols results in acute improvements in mood and cognitive performance during sustained mental effort. *Journal of Psychopharmacology 24*, 1505-1514.

Scholey, A., & Owen, L. (2010). Effects of chocolate on cognitive function and mood: A systematic review. *Nutrition Reviews 71*, 665-681.

Shiina, Y., Funabashi, N., Lee, K., Murayama, T., Nakamura, K., Wakatsuki, Y., y otros. (s.f.). Acute effect of oral flavonoid-rich dark chocolate intake on coronary circulation, as compared with non.flavonoid white chocolate, by transthoracic Doppler echocardiography in healthy adults. 424-429.

Smit, H. J., & Blackburn, R. J. (2005). Reinforcing effects of caffeine and theobromine as found in chocolate. *Psychopharmacology 181*, 101-106.

Smit, H. J., Gaffan, E. A., & Rogers, P. J. (2004). Methylxanthines are the psycho-pharmacologically active constituents of chocolate. *Psychopharmacology 176*, 412-419.

Styn, M. A., Bovbjerg, D. H., Lipsky, S., & Erblich, J. (2013). Cue-induced cigarette and food craving: A common effect? *Addictive Behaviors 38*, 1840-1843.

Tokede, O. A., Ellison, C. R., Pankow, J. S., North, K. E., Hunt, S. C., Kraja, A. T., y otros. (2012). Chocolate consumption and prevalence of metabolic syndrome in the NHLBI Family Heart Study. *e-SPEN Journal 7*, 139-143.

Torres-Moreno, M., Tarrega, A., Costell, E., & Blanch, C. (2012). Dark chocolate acceptability: inflience of cocoa origin and processing conditions. *J Sci Food Agric 92*, 404-411.

Triche, E. W., Grosso, L. M., Belanger, K., Darefsky, A. S., Benowitz, N. L., & Bracken, M. B. (2008). Chocolate consumption in pregnancy and reduced likelihood of preeclampsia. *Epidemiology 19*, 459-464.

Tzounis, X., Rodriguez-Mateos, A., Vulevic, J., Gibson, G. R., Kwik-Uribe, C., & Spencer, J. P. (2011). Prebiotic evaluation of cocoa-derived flavanols in healthy humans by using a randomized, controlled, double-blind, crossover intervention study. *The American Journal of Clinical Nutrition 93*, 62-72.

Vlachopoulos, C., Aznaouridis, K., Alexopoulos, N., Economou Emmanuel, A. I., & Stefanadis, C. (2005). Effect of dark chocoalte on arterial function in healthy individuals. *American Journal of Hypertension, Ltd.*, 785-791.