The taste of sustainability: *Determining consumer and sensory perception on carob chocolate*

MSc Thesis – report

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Abstract

This research investigated the consumer perception and acceptability on carob chocolate, a cocoa alternative, with a focus on intrinsic and extrinsic attributes. The study aimed to identify key factors influencing consumer acceptance and evaluated the potential of carob chocolate in the Dutch supermarket. A two-parted approach was applied, combining qualitative (n=11) and quantitative (n=38) research methods. Four products were assessed over the research: milk and dark chocolate drops, and milk and dark chocolate pralines.

Qualitative research focused on sustainability awareness, carob knowledge, hedonic expectations and sensory attributes. Whilst the quantitative research measured overall hedonic liking and the sensory attributes categories appearance, aroma, taste and texture.

In accordance with prior literature, in the qualitative part of this study it was revealed that while consumers expressed interest in sustainability, compromising on taste was undesirable. Moreover, awareness of sustainability concerns within the chocolate industry remained limited among participants.

Quantitative results showed that pralines were more positively evaluated, with the milk praline receiving the highest hedonic score (6.711±1.609). Taste and texture were disclosed as the primary drivers for consumer perception, with sweetness, hardness, snap, and smoothness being crucial attributes. The non-tempered drops received a lower acceptability score due to reduced glossiness and while scoring higher on less pleasant texture attributes, like softness. The tempering of the pralines improved overall appearance as well as the overall hedonic perception.

In order to introduce carob chocolate as a successful cocoa alternative, carob chocolate shows potential when launched as an ingredient rather representing itself. Moreover, refining its taste and texture is essential to improve the overall consumer perception.

Keywords: Carob chocolate, Cocoa alternatives, Quality perception, Acceptance, Sustainability, Qualitative methods, Quantitative methods, Intrinsic sensory attributes, Extrinsic sensory attributes

Abbreviations

TFQM	–	Total Food Quality Model
MCD	–	Milk Chocolate Drop
DCD	–	Dark Chocolate Drop
MCP	–	Milk Chocolate Praline
DCP	–	Dark chocolate Praline

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1. Introduction

The demand for chocolate products continues to increase worldwide, yet the supply of cocoa is declining over the years (ICCO, 2024a). During the 2022/2023 season, global cocoa production was estimated at 5.044 million tons (ICCO, 2024a). However, for the 2023/2024 season, the ICCO expects a 13.1% decrease to 4.382 million tons, indicating a total supply deficit of 478,000 tons (ICCO, 2024b). This raises serious concerns about the cocoa industry (Kongor et al., 2024).

The decline of cocoa can be attributed to climate change and ethical concerns. Cocoa beans are very susceptible to various diseases and require stable weather conditions in order to thrive (Matissek et al., 2012). Beyond the sustainable and environmental challenges, the cocoa industry also faces social and ethical problems. These problems include child labour and exposure to several health and safety risks in form of hazardous pesticides (Amadu, 2018; Schmitz & Shapiro, 2012). Additionally, farmers in the cocoa-producing countries experience unfair income distribution (Zbucka Gargas et al., 2023). These sustainability and ethical challenges in the cocoa production have led to increased scrutiny (Bartley, 2020).

In response to these challenges, the sustainability of food production, including that of chocolate, has gained growing attention since the 2000s (Mai, 2014). However, most of the focus has been on consumer perceptions of reusing and recyclable packaging rather than addressing the broader ethical and sustainable problems worldwide (Del Prete & Samoggia, 2020). Certification labels such as Fairtrade, EU Organic, and PlanetProof have been introduced in Dutch supermarkets as a step towards more equitable trading conditions and environmentally responsible practices. These labels play a crucial role in ensuring fair wages for farmers and promoting sustainable agricultural methods yet concerns remain about their overall effectiveness in tackling the industry's problems (Perez, 2021).

One potential solution to the challenges facing the chocolate industry is the introduction of cocoa alternatives such as carob. Carob is a bean primarily harvested in the Mediterranean region (Issaoui et al., 2021). It has strong potential as a cocoa substitute due to its cocoa-like flavours and unique sensory properties, largely resulting from its processing steps (Loullis & Pinakoulaki, 2018). Carob thrives in heat and dry conditions with minimal water usage, yet tolerate adverse conditions like drought too (El Deen et al., 2014). Moreover, it is considered to be more prone against plant diseases compared to cocoa (El Deen et al., 2014).

All these issues raise the question why there are so few alternatives to cocoa in the food industry. The uncertainty on the feasibility of replacing cocoa in chocolate products needs to be investigated. In this research, a qualitative study will be conducted to investigate the consumers perception and awareness on sustainability as well as expectations on (cocoa-free) chocolate. In addition to this, a quantitative sensory study will be carried out to gain deeper insights into consumer preferences. The carob chocolate used in this research is provided by the company Choruba. Moreover, the aim of the study is the following:

To explore how consumers perceive cocoa-free chocolate made with carob.

To answer this aim the following research questions are put together, divided into two subgroups, qualitative and sensory research questions. The main research question that overlaps all sub research questions is:

How do consumers perceive carob chocolate as an alternative to cocoa chocolate?

With the following sub-research questions

Sub -RQs (Qualitative consumer research questions)

RQ1. How do consumers' existing preferences for traditional chocolate products affect their perception of cocoa-free chocolate?

RQ2. What are the key intrinsic and extrinsic factors that influence the consumer perception of cocoa-free chocolate?

Sub-RQs (Sensory science research questions)

RQ3. What sensory attributes most strongly impact consumer liking of cocoa-free chocolate?

RQ4. In which product form (pure chocolate vs. as an ingredient) does cocoa-free chocolate, aligns the best with consumer expectations?

2. Theoretical framework

The consumer perception is both very complex and multi-dimensional when it comes to product acceptability or rejection (Rai et al., 2023). This dynamic process is influenced by various factors with intricated interactions between them (Costell et al., 2010). These factors can come from food related variables such as sensory attributes all the way to food packaging, and environmental and personal variables, like religion age, attitude, health as well as regional differences (Rai et al., 2023).

2.1 Total Food Quality Model

To understand this all better, a useful model to investigate the consumer perception is the Total Food Quality Model (TFQM) (Brunsø et al., 2002; Grunert et al., 1995). The TFQM is a structured model to evaluate the general consumer perception on food products. This is done by considering both expected quality, which is measured before consumption, and experienced quality, which can be obtained after consumption. The outline of the general scheme of this model can be seen in **Error! Reference source not found.**.

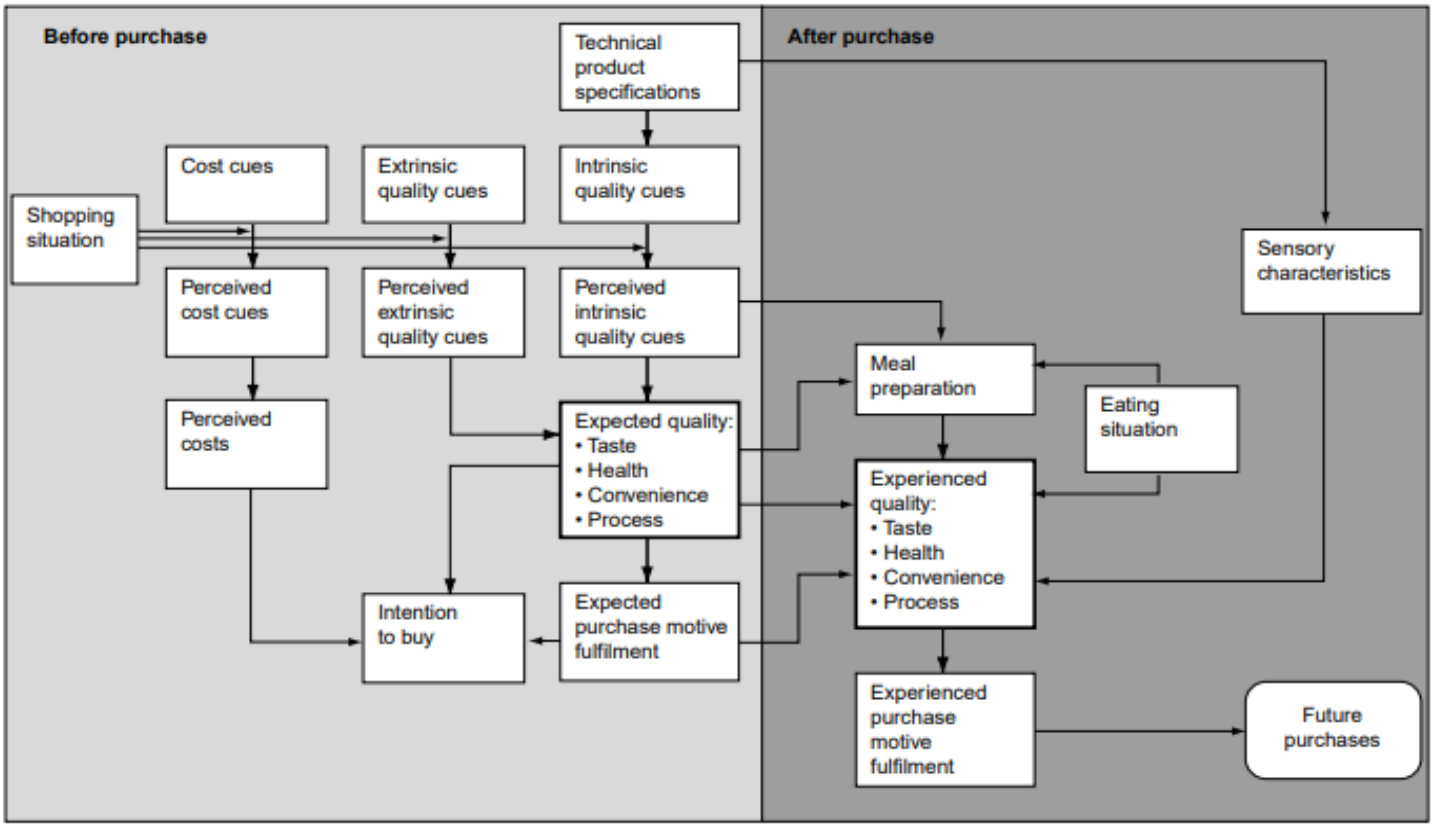

Figure 1. The Total Food Quality Model (TFQM)

In this research, the TFQM is applied to investigate how consumers perceive chocolate made with carob. The focus will be on both intrinsic as extrinsic cues, and how that shapes the expected quality. Together with the experienced quality, important sensory characteristics can be studied. This combined with experienced quality, can form a clearer consumer perception, which influences the purchasing motive.

2.1.1 Cues

Both cues before and after the purchase can influence the end perception on cocoa free chocolate, and both intrinsic as extrinsic quality cues are of major importance before any purchasing. While the intrinsic quality cues focus more on technical and physical specifications of a chocolate product, the extrinsic

food quality cues are mainly affected by branding, labels, and packaging (Brecic et al., 2017; Grunert, 2005).

2.1.1.1 Intrinsic quality cues

Taste, texture, appearance, aroma all fall under the guise of intrinsic quality cues. In general, intrinsic cues strongly affect the perceived quality and are often associated with higher quality food products when positively perceived (Gunaratne et al., 2019).

Taste

Taste, albeit different for everyone, is seen as the most important intrinsic cue for chocolate consumption (Del Prete & Samoggia, 2020). Previous experiences can influence an individual's taste formation, as well as emotions and habits (Thaichon et al., 2018). Consumers do not want to compromise on the taste but rather settle on other factors such as healthiness and brands (Thaichon et al., 2018). On the other hand, both intrinsic and extrinsic cues can strengthen the perception of taste. Extrinsic cues such as sustainability labelling can have a positive reinforcement on the chocolate taste (Enax et al., 2015). This mutual reinforcement also works the other way, when the taste satisfies the consumer the perception of sustainability labelling improves as well. Perceived quality on taste also differs within different types of chocolate. The higher the concentration in cocoa in chocolate, the higher the expected bitterness in a product (Thamke et al., 2009). This perceived bitterness impacts the perceived quality based mainly on personal preferences.

Carob based chocolate is considered to be sweeter than cocoa chocolate, as it has a higher carbohydrates content, which can alter consumer perception (Ku & Liu, 2024). This can be perceived more positively for milk chocolate in comparison to dark chocolate, where the consumer looks for a more bitter taste (Rawat et al., 2024).

Texture

Part of the appeal with chocolate is its texture and its unique mouthfeel (Andrea-Nightingale et al., 2009). Chocolate has a melting temperature ranging between 29.0-37.5°C, varying between cocoa composition (Windhab, 2008). This results in a unique meltiness due to the temperature being close to body temperature. The higher the cocoa content in the chocolate, the higher the melting temperature. This can influence the expectations, as dark chocolate is believed to be harder and have a lower melting rate (Andrea-Nightingale et al., 2009). While in milk chocolate, the product is seen as creamier and more cohesive when melting. This coherence can also be associated with the attribute smoothness, which varies due to different cocoa concentrations (Qian et al., 2020). The meltiness and smoothness of chocolate is because of the presence of cocoa butter (Talbot, 2012). For carob chocolate shea oil is used instead of cocoa butter, which can have an influence on the final texture on snap, meltiness, and smoothness of the end product.

The perceived smoothness and meltiness of chocolate can be influenced by the product shape (Lenfant et al., 2013). For dark chocolate, texture attributes and in particular the hardness, snap, melting behaviour and graininess of the chocolate are crucial according to consumers (Thamke et al., 2009).

Appearance

When deciding on a food purchase, the first characteristics a consumer notices are on the appearance (Creusen & Schoormans, 2005). Multiple traits, that are important for the appearance of chocolate, are glossiness, shape, colour, and the level of blooming.

The glossiness of a chocolate product is dependent on the crystalline structure of cocoa butter. A study done by Krasnow & Migoya shows that the glossier the chocolate, the higher valued quality perception is by the consumer (2015). As carob chocolate does not contain cocoa butter, the difference in glossiness might present a barrier to consumer acceptance. Shape is another appearance attribute, that can be affiliated with an increased perception of other sensory cues, such as the taste, smoothness and melting (Lenfant et al., 2013).

Colour can also be seen as a quality characteristic by the consumer (Popov-Raljić & Laličić-Petronijević, 2009). Perceptions on colour variate between chocolate flavours but overall give a good indication to the consumer on its quality (Nyitrai et al., 2022). Colour can also condition the perceived quality on characteristics like taste, aroma and the level in intensity of those (Wadhera & Capaldi-Phillips, 2014). Nevertheless, the colour of chocolate can reduce the perceived quality if it does not match the consumers' preferences. When chocolate comes into contact with high temperatures and fluctuations, it can result in melting and re-crystallization of the chocolate. This phenomenon is called blooming. This blooming effect is also possible when a chocolate product is not tempered correctly, and thus not heat stable. As a result, the chocolate will lose its initial shininess and gain white coloured spots. This blooming effect has a negative impact on the quality perception of the consumer (Afoakwa, 2010).

Aroma

Aroma is an intrinsic cue that is not often the one to jump out compared to other cues, yet indirectly still has a major impact on the perception of quality. The level of intensity can differentiate, as well as the aroma notes when looking at various chocolate flavours (Toker et al., 2020). Even within the same categorization of flavours, the aroma perception can be distinct compared to others. Research has shown that milk chocolate has more milky, sweet/honey-like flavours (Liu et al., 2015). Whilst dark chocolate contains more nutty, malty and roasted aroma notes (Liu et al., 2015). Both of these chocolate flavours are associated with caramelised notes (Liu et al., 2015). Sweet and bitterness aroma notes differ between chocolate products, even within a population the same products can be perceived differently (Januszewska & Viaene, 2002).

Previous research showed that the aroma of carob is perceived as sweet, fruity and roasted (Ku & Liu, 2024). For this research, it will be interesting to investigate how this aligns with consumer preferences and expectations.

2.1.1.2 Extrinsic quality cues

Consumers mostly rely on food packaging cues and prices when observing extrinsic product perception. Packaging attributes including brand names, claims, and labels can have a positive and significant impact on perceived product quality (Javeed et al., 2022). Since the introduction of carob as a new cocoa alternative is relatively new, packaging and labelling will play a crucial role in communicating its origin, sustainability benefits, and distinctiveness from cocoa.

Packaging

Packaging is one of the first cues consumers notices during the decision process (Gunaratne et al., 2019). Shapes and colours can evoke various taste expectations for the consumer (Dolic et al., 2022). The colour brown is linked to bitterness and sweetness for chocolate, and circular shapes are more associated with sweetness and creaminess (Dolic et al., 2022; Wang et al., 2017). A black colour on the packaging implies a more bitter taste, whereas the colours pink and yellow induces both a sweet expectation as well as a higher meltability of chocolate (Baptista et al., 2021).

Brands and price

Another extrinsic cue in product perceptions is brand recognition. It has been shown that brands can play a crucial role surrounding the acceptability of different dark chocolates (Torres-Moreno et al., 2012). This factor can be especially beneficial for the quality perception for the premium brands before the tasting phase. The overall price of chocolate can be used as a quality indicator by the consumer, indicating a lower price with a lower perceived quality (Meyerding & Trinh, 2025). With that being said, consumer expectations and perception still are more dependent on sensory intrinsic quality attributes.

Labels

Certificated labels on product packaging are designed to encourage consumers in some way, most commonly in chocolate is for sustainability and ethical reasoning, yet other motivations may also be relevant. Sustainability claims are perceived in a more positive way towards the quality of chocolate, while consumers are more opposed to health claims as these are negatively associated with taste (Meyerding & Trinh, 2025). Certifications can help reduce any doubts that arises in the consumer behaviour process when evaluating quality (Kaczorowska et al., 2021).

As carob chocolate is a vegan alternative, that also focuses on a more sustainable product, labels and certifications on the packaging might help introducing carob on the Dutch market.

2.1.2 Expected quality

Consumers form expectations of product quality mainly based on intrinsic and extrinsic quality cues. In the case of chocolate, which is widely recognised as a product for pleasure, taste will be considered a key quality dimension in TFQM, with expectations on quality varying in between various types of chocolate (Pelsmaeker, 2016).

Regarding dark chocolate, attributes like the glossiness, snap, hardness and aftertaste are distinguished as key drivers in expected quality (Pelsmaeker, 2016). Whereas, for milk chocolate creaminess is considered to be more strongly associated to quality. Among that, a dry mouth feeling is still more pronounced for dark chocolate compared to other types of chocolate (Pelsmaeker, 2016).

2.1.3 Expected purchase motive fulfilment

Other than the intrinsic and extrinsic product cues, expected quality is also shaped by the consumers' values and beliefs, and to which these align with expected purchase motives. Hence quality is not an aim by itself, it rather helps satisfying consumer values. These values are personal for everyone, and multidimensional. In this research, the sustainability values are specifically important (Tanrikulu, 2021).

Although consumer often express sustainable and ethical intentions, their actual purchase behaviour are inconsistent with this intentions (Vermeir & Verbeke, 2006). This value-action gap is critical for this research on carob chocolate; whilst sustainability can be a motivator consumers still are unlikely to compromise on taste and other beliefs (Camargo et al., 2019).

Ethical concerns

Nowadays, chocolate production remains linked to several ethical concerns, including child labour and modern slavery (Zbucka Gargas et al., 2023). Although numerous promises are aimed to bring these problems towards an end, child labour continues to exist in this sector (Deam, 2020). Organisations like Fair Trade and Rainforest Alliance addressed standards to ensure equal income and improved working conditions among farmers (FairTrade, 2025; Rainforest Alliance, 2025). However, these standards remain far from the norm across the whole industry.

Environmental impact

Cocoa production faces serious environmental challenges including the application of fertilisers (Hosseinzadeh-Bandbafha & Kiehbadroudinezhad, 2022), excessive water use (Awafo & Owusu, 2022), cocoa being highly vulnerable to diseases (Matissek et al., 2012) and deforestation (Kalischek et al., 2023). These environmental pressures underline the urgency of exploring alternatives to cocoa, like carob as this grows in drier climates and are more prone to diseases (El Deen et al., 2014).

Water

The water footprint along the cocoa chain is estimated at 565 litres of water for 1 kilogram of cocoa product (Awafo & Owusu, 2022). Most of this is classified as green water (432 litres) used during the cultivation of cocoa. This is a concern, given that cocoa essentially grows in areas surrounding the equator, that are widely affected by climate change. Climate change results in unpredictable water patterns and water scarcity (Kosoe & Ahmed, 2022). According to the available water remaining (AWARE) methodology, that quantifies the environmental impact of the water consumption, cocoa chocolate ranks among the highest impact of food, with a water consumption of 77.12 m^3 eq per kilogram of product (García-Herrero et al., 2023).

Deforestation

Research discovered that cocoa plantations and production accounted for over 37% of the loss in forest in Côte d'Ivoire and over 13% in Ghana (Kalischek et al., 2023). The main driver for deforestation is likely the high demand from the Western countries for cocoa (Ruf et al., 2015).

2.1.4 Experienced quality

The experienced quality is formed after the consumption of chocolate and refers to the consumer's actual perception. This is shaped by the interaction of the expected quality and the sensory experience, as can be seen in Figure 1. In this stage, expectations are either confirmed or adjusted, which influenced the final purchase behaviour and acceptability.

For chocolate, sensory attributes such as taste, texture, and mouthfeel are combined with the overall enjoyment during consumption (Andersen et al., 2019). Positive alignment between expected and experienced quality ensures consumer satisfaction.

In the context of this research, experienced quality refers to the consumer perception of carob chocolate following consumption. In this study, experienced quality specifically concerns how consumers perceive carob chocolate after tasting, and whether its sensory profile aligns with expectations shaped by traditional cocoa chocolate. This directly addresses the third and fourth research sub questions.

2.2 Conceptual framework

Based on previous mentioned information, a conceptual framework has been developed to explain the consumer perception on the carob alternative to cocoa chocolate (Figure 2). This framework was used together with the research questions as a guideline for setting up the research.

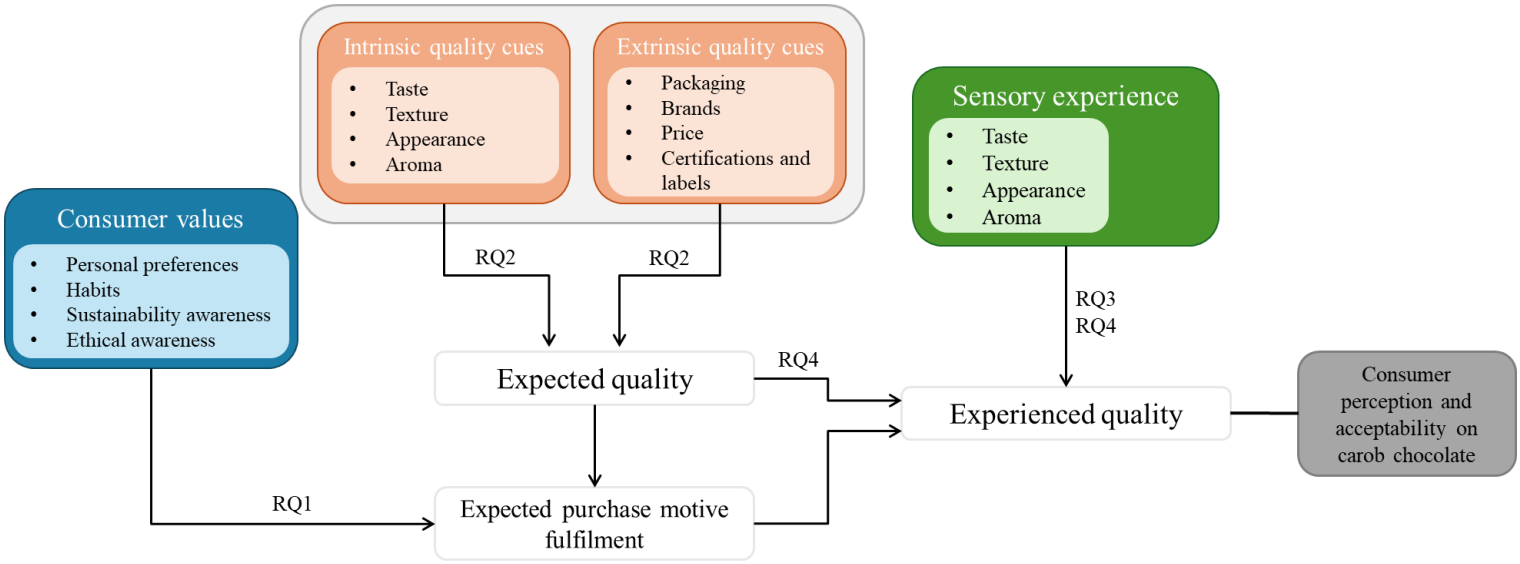

Figure 2. Conceptual framework on the perception of carob chocolate

3. Methodology

3.1 Methods

3.1.1 Focus groups

Focus groups were used for the qualitative research part on the topic of cocoa free chocolate. Since focus groups were proven to be valuable for gathering consumer information, beliefs, needs, motivation and values (Morgan, 1996). Focus groups had been proven to be especially useful to examine unknown phenomena, like the consumer perception of carob chocolate. Moreover, the focus group was an interactive way for participants to engage with each other's views and built on each other's opinions, which could lead to new insights (Acocella, 2012).

3.1.2 Sensory analysis

After qualitative data was collected from the focus groups, the next step was to get a better insight of the consumers' perception was sensory research. Sensory research was performed to acquire a deeper understanding of the importance of several sensory attributes. This research was executed to determine which alternative cocoa chocolate products were appreciated most by the consumer. Due to time limitations, yet still aiming for significance, a sample size of 45 participants was determined, to reach data saturation while still including room for sampling errors (Jr & Rutenbeck, 2006). Affective testing was the chosen method to be applied during this part of the research (Gillette, 1990).

3.2 Participants

3.2.1 Target group

For this research several socioeconomics were outlined on which the participants had to comply with. These socioeconomics included several characteristics of participants such as their gender and age. Studies have shown that men and women showed similar willingness-to-pay (WTP) regarding sustainability purchases such as Fairtrade (Mai, 2014). Furthermore, research showed that there was no significant differences in the individuals' gender on the preferences towards different attributes regarding chocolate (Stefano et al., 2023). Because of those reasons it was decided to not to exclude a gender in this research.

For age restrictions it was chosen to investigate the perception on cocoa free chocolate on two different generations, the Generation Y, also referred to as Millennials, (1981-1996) and Generation Z (1997-2012) (Bullock et al., 2017; Casalegno et al., 2022). Studies have proven that both these generations showed responsible pro-environmental behaviour (Dwidienawati et al., 2021). Millennials were the first generation to have witnessed changing environmental conditions, and they actively tried to limit the effects of these changing conditions (Woosnam et al., 2019). Generation Z was the generation where social media started to become a major influence, which was able to affect their beliefs (Confetto et al., 2023; Sun & Xing, 2022). The difference between the generations was considered to be interesting to examine, as the beliefs of Generation Z were expected to be stronger than those of Generation Y, yet the actual buying potential of Generation Z was lower (Casalegno et al., 2022).

Participants in the focus groups were required to have no dietary restrictions related to allergies or intolerances for peanuts, nuts, milk, soya, or gluten-containing grains. This requirement was set for health reasons, as traces of these ingredients could be present in one of the products that were tasted during the sessions. For the sensory studies, any participant with a dietary restriction involving allergies or intolerances were prohibited to participate, since cross-contamination during the preparation of the pralines samples could not be ruled out.

3.3 Data collection

3.3.1 Focus groups

During consumer focus groups participants were asked to elaborate on their preferences for chocolates. In groups of 4/5 participants discussed the topic of alternative chocolate. The aim was to have a homogeneous division regarding both gender and age in every focus group. A scheme of the division of participants was made as an overview, which can be found in Table 1. Participants were reached through posters and social media (Appendix 9.1.1).

Table 1. Focus group division based on age and gender

Focus group number	Generation, gender
Focus group 1	Generation Y, female
Focus group 2	Generation Y, male
Focus group 3	Generation Z, female
Focus group 4	Generation Z, male

All the focus groups were conducted in a reserved room at one of the buildings of Wageningen University & Research. A discussion guide, consisting of eight main sections, was developed to ensure a structured flow for conversation (Appendix 9.2). In the beginning of this guide, general questions were asked, after which participants could discuss answers and voice their opinions. The spoken language of the focus group was Dutch, the native language of the participants, the moderator and the note takers. At the start of each focus group session, every participant signed a consent form which gave permission for the discussions to be recorded for review and further analysis.

3.3.2 Sensory analysis

Several affective testing techniques were used to examine the sensory attributes. Methods like hedonic testing and Check-All-That-Apply (CATA) were performed to better understand the preferences and perception of the consumer (Gillette, 1990). The sensory testing was conducted at the Wageningen University & Research in various buildings. Participants were once again recruited by posters and social media (Appendix 9.1.2).

Participants had to complete an online questionnaire combined with the tasting process. This questionnaire was made via Qualtrics and can be found in Appendix 9.39.2. Samples were marked with random numbers and participants had to fill in those sample numbers before every tasting part (Delwiche, 2023). The language of the questionnaire was again Dutch, to decrease the limitations of the descriptive vocabulary of the consumers (Thamke et al., 2009).

3.3.2.1 Hedonic testing

Hedonic testing was deployed to examine the degree of overall liking, and several sensory attributes in the categories of appearance, aroma, taste and texture (Torrico et al., 2023). Hedonic testing used a 9-point scale. This scale ranges from 1-9 or “extremely dislike” to “extremely like”.

3.3.2.2 Check-All-That-Apply (CATA)

CATA was believed to be a reliable method for characterizing sensory aspects that were associated to the product according to the participant (Amorim et al., 2023). Every sensory attribute description that the participant associated with a product had to be selected. The more frequent an attribute was selected, the more important that attribute was for the consumers’ perception. During the questionnaire the CATA was divided into four categories, each containing in between 13-18 attributes that could be selected by the participant. To minimise potential biases introduced by attribute ordering, it was chosen to randomise the order of attributes automatically with the tools of Qualtrics (Ares & Jaeger, 2013). These attributes

can be seen in the questionnaire in Appendix 9.3. Attributes were chosen based on previous literature (An & Lee, 2024; Jaeger et al., 2015; Jaeger et al., 2013; Schouteten et al., 2018; Vidal et al., 2019).

3.4 Product samples

The type of chocolate selected for these experiments consisted of milk and dark carob chocolate produced by the company Choruba. Dark chocolate was included in this research due to its growing popularity and increase of consumption over the recent years (Hulpe et al., 2013). Meanwhile, milk chocolate was selected as it remains the most widely recognised type of chocolate (Kozelová et al., 2014).

During both the focus groups and the sensory testing, the same kinds of samples provided by Choruba were tested. In total, four carob chocolate products were tested: two chocolate drops, milk (MCD) and dark (DCD), and two types of praline, milk (MCP) and dark (DCP), which can be found in Figure 3.

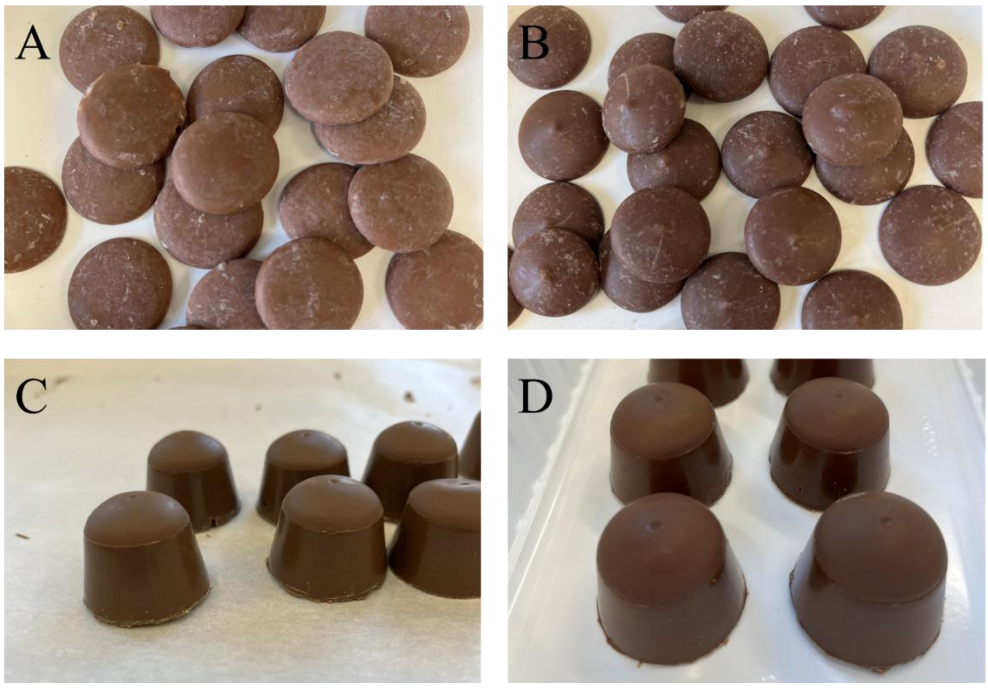

Figure 3. Samples; a. Milk chocolate drop, b. Dark chocolate drop, c. Milk chocolate praline, d. Dark chocolate praline

Both these pralines were filled with a hazelnut paste. During the focus groups the milk and dark chocolate drops were evaluated, as well as an additional product that is already available in Dutch supermarkets. This product replicated peanut M&M's by a brand named 'Treets'. In the sensory research participants had to assess four different products, the milk and dark chocolate drops as well as the milk and dark chocolate pralines. These products were randomly distributed throughout the sessions to minimise bias.

3.5 Data analysis

Within both research methods, tables and figures used for this research were made in the Microsoft program Excel.

3.5.1 Focus groups

To gather information on the availability of the participants as well as their demographics, an online questionnaire was sent out before the focus groups took place. This was done in order to get an overview

of general chocolate consumption. During the focus groups the discussions were recorded by the voice recorder of the researcher and by a backup from the note taker. The focus group discussions were later all transcribed through word-for-word transcription and uploaded to Word. Names and identity characteristics were removed to ensure anonymity. After each focus group was transcribed, it was qualitatively analysed with the help of the software program ATLAS.ti, organizing the data and coding. This coding was translated to English, without altering statements and quotes. A code book was developed both inductively as deductively, which was categorised on themes and can be seen in Appendix 9.4 (Brown et al., 2020; Camargo et al., 2019; Prokofeva, 2023). When using quotes of the transcript for further explanation in this research, the quotations were directly translated to English.

3.5.2 Sensory research

Participants had to fill in their availability through Excel, after which they were invited to the tasting. The following codes represented the carob samples.

- 187 → DCD
- 304 → MCD
- 792 → DCP
- 561 → MCP

All data was imported to the Excel, this program also was used for further in-depth analysis. Significance was proven when the null-hypothesis was rejected, which was set at $p<0.05$. The analytical testing that was used for this was one way ANOVA combined with Tukey's HSD as a post-hoc test to investigate which specific groups were proven to be significantly different from each other.

3.6 Pilot study

3.6.1 Focus group

A pilot study was conducted with the help of two participants. At the start of the focus group, a stopwatch was used to record the duration of the session. The moderator communicated in native language to ensure full understanding of the questions and to facilitate the start of an open discussion with the participants.

Following the pilot study, some adjustments were made on the order and wording of the questions to improve flow and clarity. Additional questions concerning product packaging, carob knowledge and labels and certifications were included near the end of the focus group guide. The duration of the pilot lasted approximately 55 minutes, which was considered appropriate given the number of participants.

3.6.2 Sensory research

A pilot sensory study was held with four participants, all of whom had a personal connection to the researcher. The purpose of this pilot was mostly to test the overall setup, evaluated the flowability of the tasting experience, and to gain feedback regarding the quality of the questionnaire. Based on feedback, minor adjustments were made regarding the questionnaire. These primarily involved revisions to the hedonic scale and the addition of additional attributes to the CATA questions.

4 Results focus groups

4.1 Participant information

4.1.1 Participant demographics

The online registration form was finalised by 57 persons. After reviewing the availability and inviting the participants, three focus groups of 3-4 participants were organized (n=11), see Table 2.

Table 2. Participant information of the focus groups

Focus group	Generation	Gender	Participants	Participant number
1	Generation X	Female	4	P1.1-P1.4
2	Generation X	Male	3	P2.1-P2.3
3	Generation Y	Female	4	P3.1-P3.4

4.1.2 Current consumer habits and preferences

During the focus groups the participants explained their chocolate consumption habits and preferences. All participants mentioned consuming chocolate several times per week, with the female participants of generation X (n=4) consuming chocolate products on a daily basis. The reported chocolate consumption ranged from categories like chocolate bars (n=11), ice cream (n=2), cookies (n=2), and chocolate incorporated into breakfast (n=2), lunch (n=2) and dessert (n=2). The average consumption was mentioned to expand during several holidays, like Easter, Sinterklaas and Christmas, with typical seasonal treats including chocolate letters (n=4) and chocolate eggs (n=5).

All eleven participants described chocolate as a treat or luxury, sometimes enjoyed with a cup of coffee (n=3). Convenience was also a factor for the male participants (n=3) to consume chocolate products, as chocolate provided a sugar boost alongside a source of motivation to continue their goals.

4.2 Knowledge on carob

During the focus groups the participants were asked about their knowledge regarding carob, the bean that is used as the cocoa alternative. Only three participants were aware of its existence prior the focus group session, yet only one linked their knowledge to the opportunity of it being an alternative for cocoa.

P2.2: "It is too unfamiliar for me. But it's good that it grows in Europe, at least I know it was growing in Greece, I reckon those trees were growing there too. So then you can have a more local chain, perhaps even closer to home."

From the majority participants (n=9) that were unaware of the existence, two stated similarities with cocoa, associating with it with aroma and colour attributes, linking it to the samples and picture provided.

4.3 Sustainability and ethical awareness

All the participants during the focus groups were aware of the presence in sustainability problems in the chocolate industry. Ethical concerns on the other hand, were mentioned less frequently by the participants, and even when asked about it a few (n=4) mentioned only having no knowledge about it apart from the presence of the concern. The sustainability and ethical concerns that were discussed by every participant during the sessions, are shown in Table 3. Moreover, reasoning on whether or not these concerns impacted the participants' chocolate consumption is also included in Table 3.

Table 3. Sustainability and ethical awareness and concerns of the focus groups

	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	Total
Awareness on												
Sustainability problems	x	x	x	x	x	x	x	x	x	x	x	11
Ethical concerns	x	x			x	x	x	x	x	x	x	9
Knowledge on problems												
CO2 emission					x	x	x					3
Not locally produced			x		x		x			x		4
Deforestation	x								x		x	3
Uncertain long supply chain		x					x	x	x	x	x	6
Unequal income distribution	x	x	x	x	x		x		x		x	8
Impact on consumer behaviour												
Scepticism			x		x	x		x	x	x	x	7
Brand avoidance	x	x										2
Social pressure		x			x	x	x			x		5
Taste above sustainability			x	x		x					x	4

Scepticism primarily arose from the understanding that participants (n=7) knew so little about the process chain on chocolate, nor the legislation on sustainability claims (n=2). They questioned the need on cocoa alternatives in the chocolate industry. Along with that, some participants (n=4) were doubting if their consumption patterns would change in order to be more sustainable when it would be at the expense of the taste and overall quality.

P1.2: "But that might be I think the core of the problem, because we are so far removed from the source, we have absolutely no insight into what's going on behind the production scenes. The only thing we do have some awareness of is that there is indeed a lot of dishonesty, but what it exactly might be? Yeah, companies are pretty good at keeping that a secret."

Social pressure mainly arose with the male participants (n=3) whenever something is offered or on specialty occasions like dining out with friends. Participant 1.2 shared her experiences whenever she went grocery shopping with someone else. Often she would declare actively avoiding certain brands and explaining her reasoning to her friends.

P1.2: "... I notice that I actively buy certain brands and avoid others, and I even try to tell friends sometimes like when you're looking at the shelves together and deciding what to get, I try to actively steer it a bit by saying okay maybe we should avoid those brands..."

4.4 Intrinsic factors

4.4.1 Appearance

Before the tasting session, participants scrutinised the MCD and DCD samples on their appearance. These results are found respectively in Table 4 and Table 5.

Table 4. Appearance attributes of sample MCD of the focus groups

Attributes	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	Total
Blooming effect						x		x		x	x	4
Comparable colour to chocolate		x			x	x		x				4
Dull	x		x	x		x		x			x	6
Satisfying shape		x	x		x		x	x	x	x		7
Unevenly coloured											x	1

Table 5. Appearance attributes of sample DCD of the focus groups

Attributes	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	Total
Blooming effect						x		x				2
Comparable colour to chocolate			x			x		x	x		x	5
Dull		x						x	x			3
Satisfying shape	x	x	x	x		x			x		x	7
Smooth											x	1
Glossiness	x		x	x		x	x					5

The general appearance of DCD was perceived better according to the participants, mainly due to the presence of a gloss (n=7) and the absence of blooming (n=2), compared to the MCD blooming (n=4) and dullness (n=6).

4.4.2 Aroma

Aroma attributes were perceived less often and also were ranked less important compared to other attribute categories as stated by the participants (n=7).

P2.2: "To me, chocolate does not have a very strong aroma or anything."

Nevertheless, some aroma notes were still perceived before the tastings of carob chocolate. These perceptions can be found back in Figure 4. Apart from the aroma perception of the samples MCD and DCD, aroma preferences are visible as well. These preferences were stated by the participants in the beginning of the session. The axis illustrates how many times an attribute is mentioned by one of the participants.

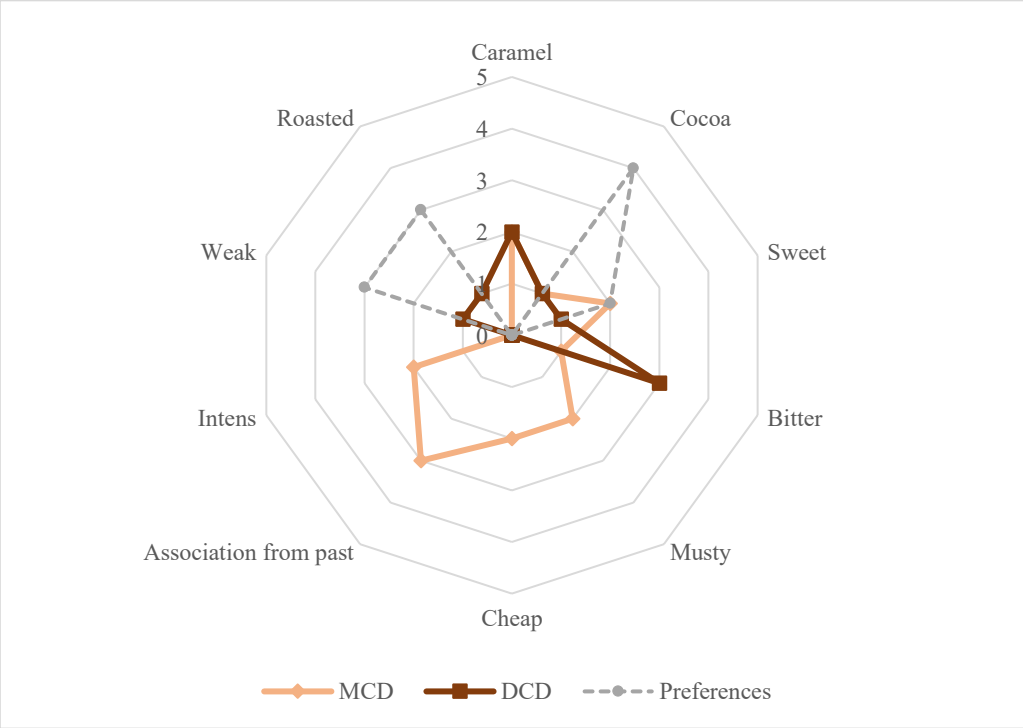

Figure 4. Aroma perception on (carob) chocolate of the focus groups (n=11)

In the beginning participants declared that on traditional chocolate products they preferred an aroma of "Cocoa" (n=4), "Roasted" (n=3), and "Weak" (n=3). With a weak aroma they meant it more as an example that there should not be an overpowering smell, as not to distract from the experience of

chocolate. Comparing the carob samples to the preferences it can be seen that the MCD sample had a distinct aroma perception compared to the preferred attributes, with associations from the past. These associations were linked to chocolate candies like “Smurfen chocolate” and “Koetjesrepen”. DCD was more reminiscent of traditional chocolate according to the participants, because of its bitterness (n=3).

4.4.3 Taste

Taste was by far the most highlighted attribute category according to the participants (n=10) for the formation of quality perception on chocolate. Whenever a new product, in this case an alternative to chocolate, would be introduced, participants believed that the taste should be equally as good, or even better. Apart from that, participants (n=9) assumed that the taste of alternative chocolate would be less enjoyable compared to traditional chocolate. They declared it being hard to replace traditional chocolate and were sceptic on a positive outcome after reviewing the samples appearance and aroma. During the tasting of both MCD and DCD several attributes were addressed that can be found back in Table 6 *and*

Table 7.

Table 6. Taste attributes of sample MCD of the focus groups

Attributes	**1.1**	**1.2**	**1.3**	**1.4**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**3.4**	**Total**
Caramel	x	x	x								x	4
Sweet			x			x	x				x	4
Sour							x					1
Lingering aftertaste (negative)	x	x	x	x	x	x	x			x	x	9
Earthy										x		1
Low quality	x		x		x	x		x	x	x	x	8
Weak			x		x			x	x			4
Intense	x	x										2
Satisfied?				**x**	**x**	**x**		**x**				**4**

Table 7. Taste attributes of sample DCD of the focus groups

Attributes	**1.1**	**1.2**	**1.3**	**1.4**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**3.4**	**Total**
Caramel	x	x									x	3
Sweet			x								x	2
Sour		x			x		x	x				4
Lingering aftertaste (negative)	x				x	x						3
Cocoa							x			x	x	3
Bitter	x	x	x	x				x	x		x	7
Coffee							x	x		x		3
Roasted/Burned							x					1
Hazelnut					x							1
Satisfied?	**x**	**x**	**x**				**x**		**x**			**5**

In the end, consumers were asked on their satisfaction of the product, in which DCD was seen as the more satisfied perceived option, especially according to the female participants of generation Z (n=3). The fourth generation Z female participant mentioned not liking bitterness of dark chocolate at all, hence she favoured the milk variant more.

P1.2: "Yes, I would think so, I am really pleased by this chocolate. Because it definitely tastes more like chocolate than, it is silly to keep comparing them, but I think it tastes more like chocolate than the one we had before. And even though that might not be like a real dark chocolate as we know it, I would indeed buy it sooner than a chocolate than the one before.

4.4.4 Texture

During the beginning of the focus groups, participants mentioned attributes like creaminess (n=7), meltiness (n=6), having a "snap" (n=6), and smoothness (n=5) to be noteworthy for a positive perception on the texture of chocolate. Within chocolate flavours preferred texture attributes also varied, as for dark chocolate participants expected a less creamy and more firm texture (n=2).

Different texture attributes were also discussed during the tasting part by the participants. These outcomes are shown in Table 8 for MCD, and Table 9 for DCD.

Table 8. Texture attributes of sample MCD of the focus groups

Attributes	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	Total
Soft/Fudge-like				x	x	x		x			x	5
"Snap"	x											1
Sticky		x	x		x					x	x	5
Meltiness						x	x		x			3
Uneven solidified								x	x	x	x	4
Grainy			x					x				2
Coating feeling		x										1
Comparable to traditional					x		x					2

Table 9. Texture attributes of sample DCD in focus groups

Attributes	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	3.4	Total
Soft			x									1
"Snap"	x	x		x	x	x				x	x	7
Sticky						x				x	x	3
Meltiness						x						1
Firm					x	x	x					3
Creaminess	x		x									2

4.5 Extrinsic factors

4.5.1 Packaging

At the beginning of the focus group, participants discussed important factors when deciding their chocolate choices. The females of generation Z (n=4) mentioned being attracted towards colourful packaging and as well as general marketing.

After the tasting part of the session, participants in pairs were tasked to make their ideal packaging of the carob free chocolate, results can be found the Appendix 9.5. Some participants (n=5) suggested placing the carob bean on the packaging to illustrate the difference between cocoa and carob.

P2.1: "It would seem to me that it shows that it is made of something other than (cocoa) chocolate. Everyone knows what a cocoa bean looks like, I reckon. It is just never visible on it, still people do know it. But in carob I would have no idea. And now you would still see that it is made of something else, which is also a bean."

Other participants (n=2) suggested putting a plastic wrapper on it, revealing a piece of the end product. Yet this was criticised as the packaging would be made of plastic (n=3). This could counteract the aim of carob chocolate being a sustainable product.

All participants proposed that the origin of carob should be highlighted on the packaging, along with claims displaying its vegan (n=11) and sustainable (n=11) properties. Six participants added "allergen-friendly/allergen free" to the packaging, though expressed doubts about the credibility of this claim. According to two female participants of generation Y, certifications and labels should be common to the consumer.

P3.3: "... Fairtrade everyone knows, you know what it entails. When you have to come up with a new logo for all the alternatives. I am already looking at things and thinking yes sure it will."

Lastly, five participants suggested including information on the environmental benefits of carob chocolate, along with a short narrative describing its product process, from bean to chocolate.

4.5.2 Brands

The brand 'Tony Chocolonely" was associated most with sustainability (n=8). Out of those participants, six reported buying Tony's products for its mission against unequal income and rights, and its goal towards sustainable chocolate.

Moreover, it was noted that certain brands were avoided as participants (n=2) were sure that they failed to meet sustainability claims.

4.5.3 Price

During the session participants (n=4) revealed that the price of chocolate did not influence their decision on what to buy, while being aware of the increased prices. However, the increased pricing of chocolate products played a role in the quantity of their chocolate purchase. Participants mentioned purchasing more chocolate in the past, as it was less expensive, and now limiting their purchase to one chocolate product (n=3).

P2.1: "... I think that its less about the price, but more on the quantity of it."

Another factor that was important was the overall perceived quality by the participants (n=6). It was mentioned that when the quality of the product is higher, the price can be raised higher and the product still will be bought. This perception was mainly influenced by sustainability and taste.

P1.2: "... I would be willing to invest my money in it. Because you just know that it is delicious, and high quality with a good background."

P1.3: "... I do not mind sometimes spending more money if it is actually much tastier. Yeah, then it is truly a treat."

Whenever something is in discount, participants (n=2) tend to be more adventurous and try new things.

Carob chocolate price

When discussion alternative chocolate prices, participants had distinct different views on it. On one side one participant mentioned that carob chocolate is expected to be more expensive, as it would be hard to beat the price of traditional chocolate products. Yet on the other side, participants were aware of the raised cocoa prices (n=2), which could raise the price point for traditional chocolate. When cheaper raw materials would be used instead of cocoa, the end product could be comparable, or even lower compared to regular chocolate products. Participants (n=7) figured purchasing alternative chocolate sooner when it was lower or comparable in prices or at least marketed really well with the sustainability benefits (n=2). Two participants mentioned when the alternative option would be more expensive, to turn it into a trend, as people would be praising the product regardless of the prices.

After tasting the carob samples, participants were more critical and indicated there was only little interest in purchasing the product. The female participants of generation Z were more positive towards the dark variant of the drops yet remained sceptical towards the form of the product. On the other hand, generation Y women saw more opportunities with the milk variant. The male participants recognised as well the opportunities in melting the milk variant nevertheless were not open to purchase the product in this format. One male participant was indifferent about the idea of purchasing the dark carob chocolate.

4.5.4 Certification and labels

During the beginning phase of the focus group session, participants expressed their thoughts and awareness on different certifications and claims of chocolate labels. Figure 5 shows the number of times participants mentioned observing a certain claim by themselves. This was regardless of the influence from the claims on the consumption behaviour of the participant.

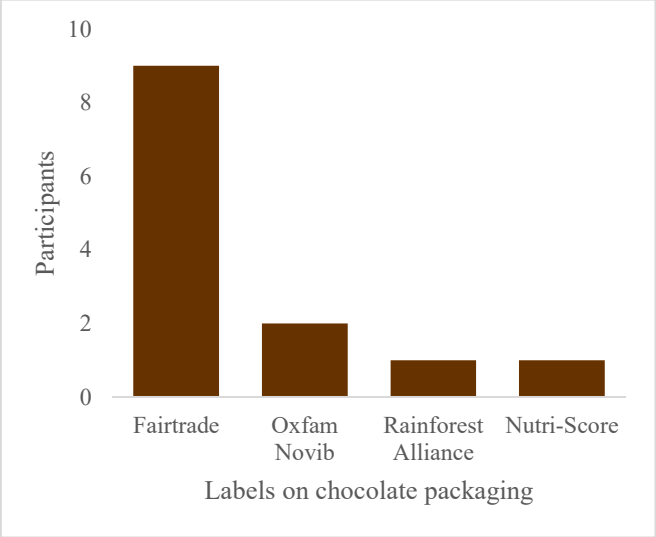

Figure 5. Described certifications and claims by the focus group participants (n=11)

The most mentioned certification that participants looked at while deciding on a chocolate product was Fairtrade. Nonetheless, of those participants, three participants expressed dubious feelings about the claim.

P3.4: "But I also find it difficult, because I did some research, and some packaging mentions it is Fairtrade or sustainably sourced. But then it also says that it is made of 40% sustainable cocoa, I think, well, what is the point? More than half of it is still a meagre bar… They clearly state "Fairtrade" and on the back, in very small print, it says at least 20%. How is this even allowed to use a logo like that?"

On top of that, the label "On the way to PlanetProof" was a meaningless goal according by females of generation Y (n=3). As this claim was, according to them, made by western privileged countries, of which the actual countries where the produce is harvested does not see any benefits of.

During the packaging assignment for carob chocolate, participants described the importance of several claims for the packaging. These can be found back in section *4.5.1 Packaging*.

4.6 Future possibilities

During the final part of the focus groups, all participants tasted the M&M's by Treets and were questioned regarding future possibilities of cocoa free chocolate. All participants were intrigued by the product and saw opportunities in consuming and even purchasing the product. Other future possibilities recommended by the participants were: cookies (n=5), snack products (n=4), including trail mixes and sweets, breakfast products (n=3), baking products (n=2), Easter eggs (n=2), and coffee products (n=1).

P2.2: "Just like how you would introduce children to consuming vegetables, you hide it."

The primary reason for the participants' enthusiasm was because of combining the cocoa free chocolate with other flavours. This would mask unpalatable attributes, while still aiming for a more sustainable product. This was why the Treets M&M's were perceived so well, because of the combined peanut and sugar with cocoa free chocolate.

Whenever a product would enter the market, two varieties of strategies were suggested by the participants. One would be to advertise it as a cocoa alternative chocolate, which would mimic traditional chocolate product. Whereas the other would be to introduce a new novel food category that focuses on sustainability.

5 Results sensory analysis

5.1 Participant demographics

In total 39 participants completed the sensory questionnaire, only one participant did not follow the criteria and had to be removed for further data analysis. The general characteristics of the participants can be seen in Table 10.

Table 10. Participant information of the sensory analysis

Variable	**Total (n=38) (%)**
Gender	
Female	65.8
Male	34.2
Other	0
Generation	
Generation Y	10.5
Generation Z	89.5
Chocolate consumption	
Multiple times a day	5.3
Once a day	18.4
Multiple times a week	47.4
Once a week	21.1
Multiple times a month	7.9
Once a month	0
Rarely/Never	0

5.2 Intrinsic factors

The presence of intrinsic factors were questioned by CATA-questions as well as hedonic questions for more in dept information. The average of the hedonic questions ranged from 1-9 (extremely dislike-extremely like), which can be seen in Appendix 9.7. The intrinsic factors were divided by four categories: Appearance, Aroma, Taste and Texture.

5.2.1 Appearance

On the frequent mentioned attributes from the CATA method, four word clouds were made, which can be seen in Appendix 9.6.19.6.1. Some interesting results came from the hedonic questions, where participants rated their thoughts on the absence/presence of shininess. The presence of shininess of both pralines samples were chosen more often as well as rated higher, with MCP (6.481±1.528) (n=27), DCP

(6.207±1.497) (n=29), compared to the respected drop samples MCD (6.200±1.304) (n=5) and DCD (5.667±1.589) (n=15), yet no significant results could be proven.

There was a statistically significant difference between MCD and MCP in regard to the suitability on the presence of a smooth and even surface of the samples (F=6.941, p=0.0109). The averages showed that MCD (6.733±1.413) (n=30) was significantly higher rated than MCP (5.893±0.956) (n=28).

5.2.2 Aroma

Aroma attributes that were most commonly mentioned for both MCD and MCP were "Sweet" (n=25, n=24) and "Milk" (n=17, n=15). Additionally, for MCD the aroma flavour compound "Vanille" (n=18) was mentioned regularly as well. At the same time, with the dark samples, DCD and DCP, attributes like "Weak" (n=19, n=17), "Roasted" (n=14, n=20) and "Sweet" (n=18, n=14) were addressed most often. These findings can be seen in the word clouds in Appendix 9.6.2.

When asked about the pleasantry of the presence of roasted aroma notes, participants had significant different opinions on it for DCD and DCP (F=4.809, p=0.0342). The presence of a roasted aroma in the case of DCD (4.842±1.834) (n=19) was significantly less likable according to the participants compared to the roasted aroma in DCP (5.957±1.461) (n=23).

5.2.3 Taste

In Figure 6, word clouds of all the sample is shown. As can be seen, the attribute "Sweet" was regularly selected for all samples, with high scores on MCD (n=21), MCP (n=31) and DCP (n=28). The most elected attribute for DCD was "Bitter", which was chosen 17 times. The taste attribute "Milk" was frequently chosen with MCD (n=18), and MCP (n=24). While in contrast this attribute was barely chosen with its dark flavour opponents DCD (n=5) and DCP (n=11).

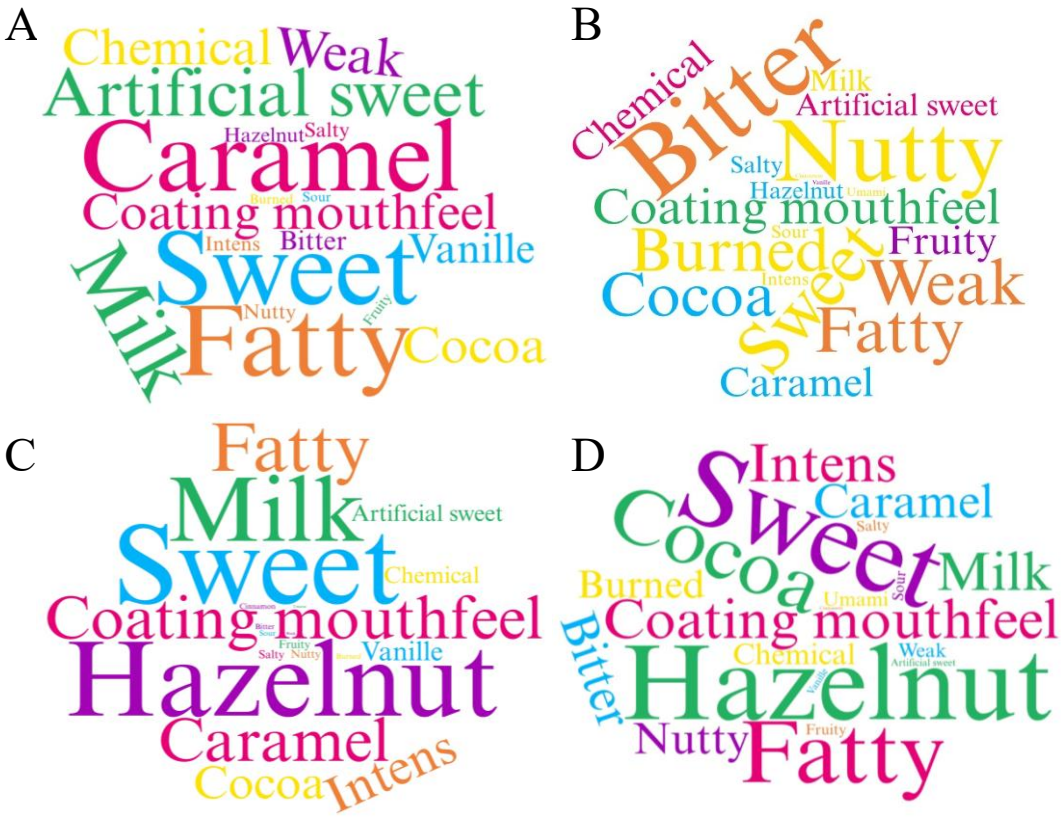

Figure 6. Word clouds on taste from sensory analysis: a. Milk chocolate drop, b. Dark chocolate drop, c. Milk chocolate praline, d. Dark chocolate praline

During the hedonic testing, the absence of bitterness in taste was evaluated by the participants, in which significant differences were proven between DCD and DCP (F=4.278, p=0.0451). Overall DCD (6.500±2.121) (n=18) was rated higher in regard to the pleasantness of the absence of bitterness in taste compared to DCP (5.208±1.911) (n=24). For MCD and MCP no significant results were found, yet all participants mentioned on MCP that in the sample a sweet taste was present (n=38), which was also rated relatively high on the hedonic scale (6.711±1.523).

5.2.4 Texture

For the final category, many texture attributes were chosen repeatedly. These attributes are presented in word clouds in Figure 7.

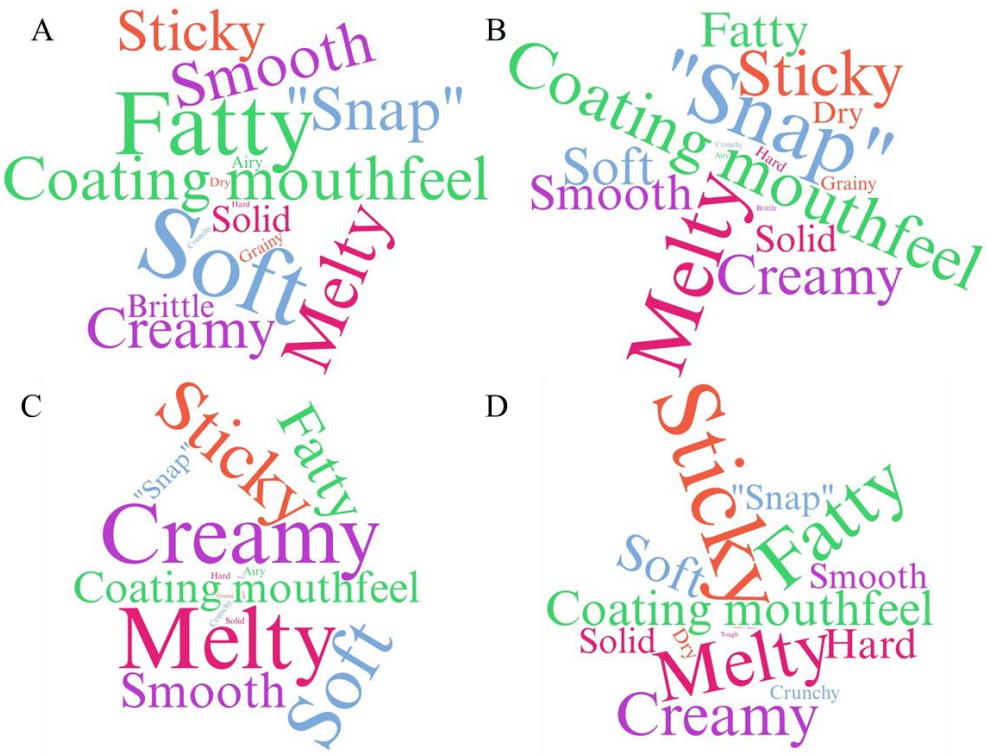

Figure 7. Word clouds on texture from sensory analysis: a. Milk chocolate drop, b. Dark chocolate drop, c. Milk chocolate praline, d. Dark chocolate praline

The main outcomes on texture for MCD were “Soft” (n=24), “Fatty” (n=22), and “Melty” (n=17). MCP was often linked to “Melty” (n=30), and “Soft” (n=26), as well as “Creamy” (n=29), “Sticky” (n=20) and “Coating mouthfeel” (n=20). Regular selected texture attributes of DCD included “Coating mouthfeel” (n=23), “Snap” (n=22), “Melty” (=22) and “Sticky” (n=17). Finally, DCP entailed five attributes that were selected frequently: “Sticky” (n=28), “Coating mouthfeel” (n=26), “Fatty” (n=23), “Melty” (n=22), and “Creamy” (n=19).

From the hedonic testing, only one statistically significant value could be proven. This was the case for the absence of the “Snap” within products DCD and DCP (F=6.210, p=0.0191). The attribute was significantly ranked lower for DCP (4.050±1.468) (n=20), in contrast to DCD (5.556±1.590) (n=9). With that being said, participants were more deceived by the lack of snap on the praline than on the drop variant.

5.3 Overall liking

The overall liking score was calculated and compared across all four samples, which can be seen back in Table 11. Significant differences were proven ($F=7.091$, $P<0.001$), thus rejecting the null hypothesis. This indicates that there were samples that were perceived differently in the overall liking.

Table 11. Results on the overall liking of all four samples from sensory analysis

Sample	Mean	Standard dev.
MCD	5.395	1.925
DCD	4.030	2.103
MCP	6.711	1.609
DCP	5.763	1.684

Tukey's HSD revealed that MCD-MCP and DCD-MCP both had significant differences in the overall liking scores. In both cases MCP was rated significantly higher than its opponent sample. Besides that, although it not being significant a clear trend could be observed between DCD and DCP, with DCP scoring relatively high compared to its drop variant.

6 Discussion

This study focussed on gathering insight into consumers' perception of carob chocolate potentially being a cocoa alternative. During both focus groups as sensory studies, participants expressed their opinion and perceptions, through various elicitation methods. Data was gathered by transcription and coding with focus groups, and for the sensory part a questionnaire was held, of which the data was proceeded into (statistical) data analysis. Having both qualitative and quantitative research methods helped contributing to this research value and insights.

6.1 Overall perception

The result for overall liking shows that the MCP was the most preferred option. However, it achieved only a moderate score, averaging 6.711 out of 9, which corresponded to a hedonic rating between "slightly like" and "like". That the carob chocolates received a moderate score was not surprising and even could be perceived as promising. Consumers experienced uncertainty with novel foods, which ensured a harder time estimating its final quality (Cardello, 2003; Hoeffler, 2003). Another research implied that having repeated exposure of an unfamiliar food product, would enhance the overall acceptance (Hong, 2025). Repeated exposure could help decreasing uncertainty while increasing the familiarity with carob, which could be promising for future development.

When comparing sample types, a clear preference for the milk products emerged, alongside a relative increase in liking for pralines in contrast with the drops. The higher acceptance of pralines could be attributed to processing factors, as the pralines were tempered, while the original drops were not. Moreover, pralines could be seen as a luxury food product, which could be a reason for the possible success of carob chocolate (Januszewska, 2021). Additionally, insights from the focus group revealed that participants were more inclined to accept carob chocolate when used as an ingredient rather than as a pure product. Thus the addition of the filling in the pralines likely contributed to their higher level of acceptance. Looking at new product development on carob chocolate, participants saw possibilities for carob being represented in other composite chocolate products, increasing the overall acceptance.

6.2 Intrinsic factors

6.2.1 Appearance

The glossiness of the pralines was perceived more occurring than on the chocolate drops. During the focus groups, the drops were often described as dull looking, which negatively impacted the quality perception. This was proven as well by the MCD and MCP in regard to the appropriateness of the presence of the gloss on the sample. That the evident presence of glossiness slightly improved the perceived quality of the chocolate, was already proven by Krasnow (2015). A reliable reason for the improvement of glossiness on the pralines samples could be due to retempering of the carob chocolate, during the praline making. Tempering chocolate has proven to be the reason for a glossy finish, as it stabilises the fat crystals into a uniform β-crystalline (Afoakwa et al., 2007). Tempering also helped preventing the formation of blooming, white surfaces will appear (Hodge & Rousseau, 2002). During the focus group discussions participants mentioned their dislike towards bloom formation, especially for MCD, as it decreased the quality of the chocolate.

Overall, appearance was seen as an important critical cue, which either can enhance the overall perception, with the presence of attributes like shininess, or lower the overall quality with dullness and blooming.

6.2.2 Aroma

The category aroma was the least essential category for consumer perception on chocolate. This mostly came forward in the focus groups, where participants were not sure on their preferences on the aroma of chocolate. Yet, an off flavour aroma profile was an indicator of poor quality. However, aroma could be linked to taste and together form the total flavour profile of a product (Toker et al., 2020). So albeit the least important quality cue, it still was considered to be valuable when looking at the total flavour perception, and moreover several aroma notes were mentioned in the sensory study.

Aroma notes that were mentioned for MCD and MCP were mostly sweet and caramel-like aromas, while a roasted, bitter, cocoa-like aromas were more linked to DCD and DCP. “Vanilla” was frequently associated with sample MCD, and for MCP still relatively high. This aroma flavour in chocolate was because of to several components, like vanillin or dimethyl pyrazines (Toker et al., 2020). 3-ethyl-2,5-dimethylpyrazine present in small proportions in carob, contributed to a cocoa-like aroma (Choo-Yong Ku et al., 2025). A high concentration of carob indicated a higher concentration of 3-ethyl-2,5-dimethylpyrazine, which could justify the increased frequency of the attribute “Cocoa” in DCD and DCP. In traditional chocolate, vanillin was an important aroma that provides a vanilla flavour (Toker et al., 2020), yet in carob only negligible traces were found so far (Hanousek Čiča et al., 2020). This provides limiting evidence that the vanilla perception was due to those compounds. Another reasoning for the vanilla perception could be due to cross-modal perception as sweetness and vanilla are often associated with each other (Bertelsen et al., 2021). This however remained a speculation, as it had not been proven to be true for carob specifically.

6.2.3 Taste

Out of both research methods, taste was considered to be the primary attribute category for the perception of carob chocolate. The quality perceptions varied between the flavours of carob chocolate; where dark chocolate was often associated with bitterness, milk chocolate was more compared to a sweet, caramel and fudge-like flavour. These findings were consistent with previous research on traditional chocolate (Fernandes et al., 2017; Gámbaro & Ellis, 2012; Lybeck et al., 2006; Thaichon et al., 2018). With carob chocolate having a similar taste profile as traditional chocolate, these results seemed to be looking promising for the product development on carob chocolate. Especially the focus group participants were satisfied with the bitterness as it provided a similar flavour profile to original chocolate. That the lack of bitterness during the sensory studies were appreciated could be explained due to the sweetness of carob chocolate mitigating the perception of the bitterness, and vice versa (Palma-Morales et al., 2024). This would indicate that sweeter perceived samples, were also perceived as less bitter, which was the case for the drop sample in both research parts of this study. Preferring sweet over bitter or vice versa is a personal preference which could influence the final results on the perception of the carob chocolate. It could act as a barrier for the consumer to turn from traditional chocolate to carob chocolate when it does not align with personal preferences.

The sensory attributes “Sour” and “ (negative) lingering after taste” perceived during the studies were not seen positively, as these attributes were not associated with traditional chocolate. These attributes could be linked back to the most present compound groups in carob for taste; the acids, followed by esters (Krokou et al., 2019).

Lastly, during the sensory research and especially MCD and MCP were associated with a milky taste. This was surprising as the product was mentioned to be plant-based. Reasoning for this could be that the products were received to be fattier and sweeter, as this increases a higher milk/dairy intensity (Guinard & Mazzucchelli, 1999). Milk chocolate products are also perceived to be creamier, which also results in a more milk based taste perception (Kilcast & Clegg, 2002). This could be an optimistic

opportunity for the development of carob chocolate, as consumers already tend associate traditional chocolate with milky attributes (Code et al., 2025).

6.2.4 Texture

More bitter products, in this case DCD and DCP, consist of a higher carob content, equalling a higher carob fat content, which increases the hardness and could negatively correlate to the smoothness of the product (T. M. Gunaratne et al., 2019). This was also noticed by the participants, especially the milk variants MCD and MCP were perceived to be softer. Results of this research conflicts with existing research on the fact that dark flavoured carob chocolate was believed to be creamier compared to the milk variant. Moreover, this was observed once more as an equal amount participants selected during the sensory testing that the creaminess was pleasantly present in all the four samples (Appendix 0).

The perceived softness of milk variants implied that product form (praline vs drop) strongly influenced the consumer texture acceptance and overall quality perception. Moreover, all samples were round in shape, the pralines samples were substantially larger, resulting in an increased surface area. Existing research have shown that an increased surface area could enhance the perception of desirable texture attributes like meltiness and smoothness (Lenfant et al., 2013).

6.3 Extrinsic factors

6.3.1 Packaging

One of the key points from the packaging assignment was the importance of including the country of origin, on the product label, in this case Italy. Existing research has highlighted the influence of origin information on consumer perceptions and final purchase intentions (Bryła, 2021). A study by Camgoz & Ertem revealed that providing country of origin cues can shift purchasing preferences, often favouring foreign chocolate products (Camgöz & Ertem, 2007). Applied to this current research, such findings suggested that carob chocolate could gain an advantage in overall quality perception, through its Italian origin.

Another crucial factor identified was the inclusion of an explanation on the story of carob chocolate production, as participants indicated that nowadays chocolate lacks transparency. These statements were in accordance with earlier studies, which emphasised the urgency of communication for the consumer (García-Herrero et al., 2019). Particularly, as consumers often lacked or possessed insufficient knowledge on environmental and socio-economic impacts of chocolate production (García-Herrero et al., 2019). In light of this, providing such information could enhance the trust of the consumer, which then could improve the overall perception.

The visual representation of a carob bean was also proposed as a means to introduce the consumer to the product. Highlighting the carob bean would not only serve to familiarise consumers with carob in general, but also presented its similarity to cocoa, reducing discrepancies in expectations. Prior research, by Jensen & Froberg (2022), alongside Machiels & Karnal (2016), showed that depicting an ingredient rather than the final product on the packaging increases perceptions on naturalness and healthiness, which in turn increases the likeliness-to-buy. Furthermore, illustrating the main ingredient on the packaging, may suggest an increase of the quantity of that ingredient in the end product, strengthening perceptions of the quality and naturalness (Gil-Pérez et al., 2020).

6.3.2 Price

Participants expressed divided opinions regarding the price of carob chocolate. While some believed that cheaper raw materials should be translated into cheaper end products, others argued that sustainable product usually equals a higher price point. The latter was consistent with prior literature, which had illustrated that consumers' willingness to pay increases when products were accompanied by

sustainability labels, and in particular the Fairtrade certification (Rousseau, 2015; Vecchio & Annunziata, 2015).

In addition to that, another study suggested that social settings and self-imagery influenced the willingness-to-pay on sustainable and fairtrade products (Teyssier et al., 2014). Consumers tended be more inclined to purchase sustainable labelled products, as it reinforces a positive self-identity (Teyssier et al., 2014).

6.3.3 Certification and labels

During the focus group discussions, doubts emerged regarding the credibility of claims surrounding sustainability. This reflected a common challenge in consumer behaviour. A prior study had shown that consumers exhibit some sort of scepticism towards sustainability certifications (Baldelli, 2024). Hoek et al, suggested that general claims were often more trusted by the consumer than specific ethical claiming (2013).

Moreover, the consumers' decision making was often influenced by self-centred motives, like taste. As revealed during the focus group sessions, participants mentioned refraining from opting for a more sustainable product if this came at the expense of taste and thus quality (Aschemann-Witzel, 2015). This division had been highlighted as a key barrier towards sustainable food consumption.

Other literature argued that higher investments were needed on the transparency of the chocolate production, rather than having to rely on certifications by itself (Toussaint et al., 2021). This went in hand with the suggestions made by the participants during the sessions, who emphasised the importance of providing clear information on the production processes. Nevertheless, labelling still retained potential value with claims such as Fairtrade have been found to positively influence consumer perceptions and enhanced product quality (Rousseau, 2015). Introducing carob chocolate with well known certifications, like Fairtrade, and transparency could positively enhance the perception of the products.

6.4 Updated conceptual framework

An updated conceptual framework was made to summarize the importance of several attributes in the development of quality perception. These results can be found in Figure 8.

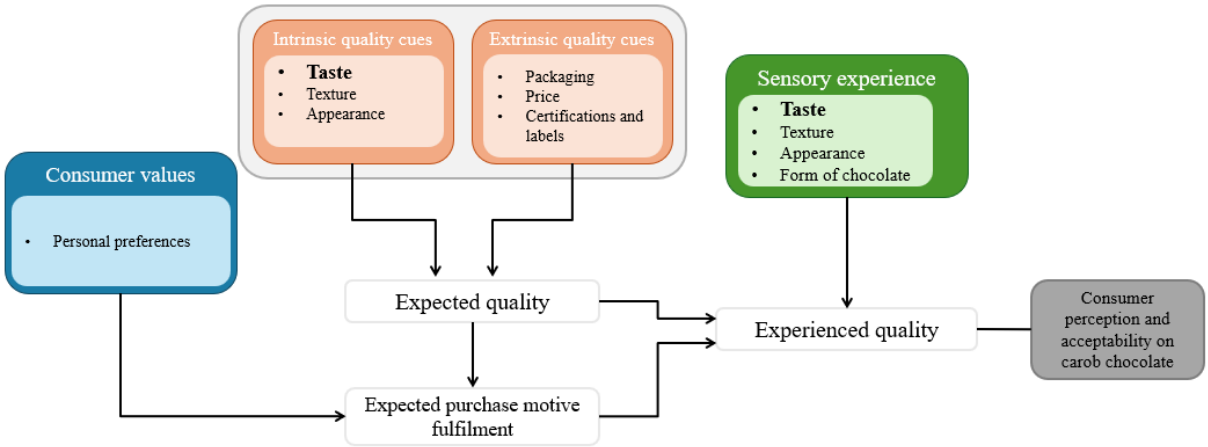

Figure 8. Updated conceptual framework

6.5 Limitations

Several limitations occurred in this study that should be acknowledged. A primary limitation in this research concerns the sample sizes, particularly in the qualitative focus groups. Due to a lack of availability and interest, no generation Y male participants were recruited, which entailed an adjustment of the research design to three focus groups. Social desirability biases were limited as participants had to write down their thoughts for several questions before discussing, yet biases still cannot be fully ruled out.

The quantitative sensory research was also affected by an unequal demographic distribution, in terms of gender and age. This unequal distribution is most likely a consequence from the snowball-sampling. Moreover, only in the focus groups participants were asked beforehand on their flavour preference, a factor that could really have an influence on the overall perception of chocolate.

Another limitation was the fact that the whole research has been restricted to Dutch-speaking consumers, as both the focus groups as the sensory research were conducted in the Dutch language. While, this choice made it easier for consumers to explain their thoughts, it also restricted the generalisability of the findings beyond the non-Dutch speaking consumer based in the Netherlands.

Finally, in terms of product limitations, the variance of storage conditions of the pralines, used in the sensory part, could have affected product quality overtime. The testing sessions were conducted over a two-month period, during which the pralines were refrigerated for extended duration for stability. This might have had an influence on textural properties and appearance, although taste remained unaffected. Condensation on the pralines could have been a cause for the increased shininess appearance of the pralines. With the formed condensation, the pralines experienced a change in texture, especially in regards of the increased softness and stickiness. A credible reason for the formation of condensation and softening of the chocolate was oil migration from the hazelnut filling (Lidgard, 2025). As the filling itself hardened overtime, this seemed to be a very plausible scenario for the texture changes.

With that being said, no major changes were observed in the data over the different testing days. Nonetheless, the possibility of variation in perceived quality across the sessions cannot be excluded.

6.6 Future research

This research provides a useful foundation for further and broader research on consumer perception and acceptability of carob chocolate. As these results suggest that carob chocolate tends to be more accepted as an ingredient rather than as the final product, future studies could explore how carob chocolate would be implemented into several formats and inclusions in order to identify the most promising product application on the market.

As uncertainty remained around how carob chocolate should be positioned in the market, with it either embracing as a direct cocoa alternative or as a novel product. It would be interesting for future research to gain more insights on the consumer preferences on this.

As mentioned in the limitations, a broad consumer validation, using larger samples across different age groups, nationalities, cultural backgrounds and genders, could strengthen the generalisability of these results and might reveal new interesting differences in perception. For instance, in Mediterranean countries, where carob is more familiar, may view carob chocolate differently compared to the Dutch consumers (Pedret-Massanet et al., 2023).

Lastly, during the focus group discussions, and participant raised the idea of a hybrid carob-cocoa chocolate as a potential introduction to the Dutch market. For future research, it could be interesting to

investigate consumer perceptions on this hybrid product, alongside an examination on their sensory attributes.

6.7 Implications

Insights from this current study can be used as a basis for further development of the carob chocolate. This research suggests changes in the taste and texture should be made to carob chocolate to improve the overall perception. This could be done by improving the tempering of carob to optimise several texture attributes.

To increase consumer interest in carob chocolate, more awareness to sustainability in chocolate needs to be raised. Moreover, to promote carob chocolate, it could take in two distinct directions. It should represent itself as similar to traditional chocolate, or it needs to be positioned as something completely novel. To facilitate a successful market entry, it will be important to investigate whether consumers resonate more with it being a cost-competitive alternative to cocoa, or if it will be seen as a premium and more sustainable product.

With respect to extrinsic cues, packaging that features the carob bean was seen as an appropriate way to introduce consumers to carob. Besides that, providing transparent information about the carob chocolate supply chain, from country of origin to the production processes, can be seen as a positive way to increase awareness.

Finally, insights from both the focus groups as the sensory study indicated that participants preferred carob chocolate when used as an ingredient in an end product. This suggest strong potential for future possibilities within line extensions, which could support the introduction of carob chocolate.

7 Conclusion

To successfully introduce alternative chocolate, it is essential to understand consumer perceptions and preferences. This research provides new insights into the acceptability and perception of carob-based chocolate among Dutch consumers.

The integration of quality and quantitative research enabled the identification of the most influential sensory attributes for carob chocolate. It became evident that although participants value sustainability, it cannot be at the expense of taste. This category proceeded to be the most important factor in shaping the consumers' perception on carob chocolate, followed by texture and appearance. Aroma was recognised as the least important category for the carob chocolate.

Extrinsic cues were found to be less relevant on overall perception, yet packaging cues such as the country of origin and imagery of the carob bean were recommended. Only clear and recognisable certifications, like "Fairtrade" and "vegan", were considered to be suitable, provided that they are not misleading. Including a brief narrative on the packaging might raise awareness of sustainability issues within the chocolate sector, whilst informing of the purpose of carob chocolate.

To situate the best launch of the carob chocolate with consumer expectations and preferences, introducing carob chocolate initially as an ingredient appeared to be the most promising approach. As pralines, especially the milk sample, were addressed to on a more positive note compared to the drop alternatives.

Ultimately, this research provided valuable insights and deeper understandings into the perception of chocolate alternatives. Although consumers expressed openness towards more sustainable chocolate, their unwillingness to compromise on taste and texture remained. To achieve success in the Dutch market, these attributes categories require further optimisation.

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9 Appendix

9.1 Posters

9.1.1 Poster focus group recruitment

Figure 9. Poster for participant recruitment focus groups

9.1.2 Poster Sensory tasting recruitment

This poster was used and changed according to the date and location of the tasting.

Figure 10. Poster for participant recruitment sensory study

9.2 Focus group guide

Dutch version

Duratie (min)	Introductie stappen	Commentaar en materiaal
8	1. Verwelkom de deelnemers in de ruimte waar de focus groep plaats zal vinden.	
	2. Er zal een fijne en warme sfeer zijn, terwijl er gewacht wordt op iedere deelnemer. “Smalltalk” wordt aangemoedigd.	Echter zullen de onderwerpen niet over chocolade of duurzaamheid mogen gaan. Verspreid alle naamplaatjes.
	3. Nadat alle deelnemers gearriveerd zijn, bedank hen voor hun tijd en deelname. Stel jezelf voor als moderator en notetaker. Geef ook een kleine introductie van het onderwerp en wat er verwacht wordt van de deelnemers tijdens dit onderzoek.	Voorbeeld: “ten eerste, allemaal heel erg bedankt dat jullie hier zijn. Mijn naam is Ymke van Roosmalen, en voor mijn thesis onderzoek ik de perceptie van verschillende soorten chocolade. Vandaag gaan we het hebben over jullie ervaringen met chocolade en de

	Geef de dieetrestricties nog een keer aan, om problemen te voorkomen.	verwachtingen voor de toekomst. Later in de sessie zal ook een proeverij plaatsvinden. Als laatste ontvangen jullie nog allemaal papier en een pen, aangezien bij sommige vragen je eerst iets op zal schrijven voordat er een discussie plaats vindt.
	4. Informeer over de duur van de focus groep (~60-90 minuten).	
	5. Laat de deelnemers weten dat alle resultaten anoniem blijven. Verder zijn er geen goed en fout antwoorden op de vragen. Deze discussie zal opgenomen worden. Verspreid de consentformulieren die getekend moeten worden, die getekend moeten worden als ze akkoord gaan met de condities. 6. De antwoorden op vragen mogen in het Nederlands gegeven worden, zodat de deelnemer meer vertrouwen heeft voor het antwoorden van vragen.	Verspreid de consentformulieren, pennen, en het papier. Controleer de consentformulieren
	7. Begin met opnemen zodra alle consentformulieren gecontroleerd zijn.	Zorg er voordat je reserveapparatuur hebt om op te nemen. Voor dat je begint met vragen, zorg ervoor dat je opname apparatuur is gestart.
	8. Een kleine ronde van introducties van de groep	Vraag om naam, leeftijd, en bezigheid in het dagelijks leven, e.g. beroep, werkloos, student.

RQ	Duratie (min)	Vragen voor de focus groep	Aandachtspunten voor moderator en notetaker
Opwarm vragen en herkenning			
RQ1	10	1. Wat komt in je op als je denkt aan chocolade? Waarom? 2. Waarom consumeer je chocolade?	Vertel dat de deelnemers eerst hun gedachtes moeten opschrijven voordat ze beginnen met discussiëren.
RQ1		3. Welke smaak van chocolade vind je het lekkerst? a. Waarom vind je dit zo lekker? 4. Welke vorm van chocolade vind je het lekkerst? Waarom?	Als “vorm van chocolade” onduidelijk is geef vage voorbeelden zoals koekjes, repen, ijs, snoep en Nutella
RQ1		5. Hoe vaak eet je chocolade? 6. Op welke gelegenheden eet je of wil je chocolade eten? Waarom dan? a. En op welke tijden van de dag? Waarom?	Wanneer niet beantwoord in vraag 6, stel deelvraag a.
Motieven en barrières			
RQ3	8	7. Welke kenmerken vind je belangrijk wanneer je aan chocolade denkt? a. Wat voor aroma zou je idealiter verwachten bij chocolade? Waarom? b. Wat voor textuur zou je idealiter verwachten bij chocolade? Waarom? c. Wat zou je van de romigheid van chocolade idealiter verwachten? Waarom?	Wanneer niet beantwoord in vraag 7, stel deelvragen a-e.

		d. Wat voor kleur zou je idealiter verwachten bij chocolade? Waarom e. Wat voor smaak zou je idealiter verwachten bij chocolade?	
RQ2		8. Stel je staat voor een schap in de supermarkt, wat zijn belangrijke factoren die beslissen welke keuze rondom chocolade jij uiteindelijk maakt? Waarom? a. Wat vindt je belangrijk over de verpakking van het product? Waarom? b. En wat vind je van labels en certificaten? Waarom? c. En wat vind je van de prijzen? Waarom? d. Zijn er nog andere factoren die jouw keuze beïnvloed, die je nog wil toevoegen?	Wanneer niet beantwoord in vraag 8, stel deelvragen a-d.
Perceptie op duurzaamheid & ethiek			
RQ2	8	9. Wat komt in je gedachten op zodra je denkt aan chocolade en duurzaamheid?	Vertel dat de deelnemers eerst hun gedachtes moeten opschrijven voordat ze beginnen met discussiëren.
RQ2		10. Wat weet je van de ethiek over de productie van chocolade?	
RQ2		11. Denk je dat er actief tegen deze problemen gevochten wordt? Hoe dan?	Vraag alleen als de problemen benoemd zijn in vraag 9 of 10.
RQ2		12. Hoe beïnvloedt duurzaamheid en ethiek jouw chocolade consumptie? Waarom?	
Perceptie op alternatieve chocolade			
RQ1	10	13. Wat komt in je op als je denkt aan alternatieve chocolade? a. Als niks tot je gedachten komt, waarom denk je dat dat zo is? b. Wat zou je ervan verwachten? Waarom?	Vertel dat de deelnemers eerst hun gedachtes moeten opschrijven voordat ze beginnen met discussiëren.
RQ1		14. Heb je ooit alternatieve chocolade geconsumeerd? 15. Waarom heb je dit gegeten? a. En in welke vorm heb je dit gegeten? 16. Wanneer dit nog niet gebeurd is, zou je open staan om alternatieve chocolade te consumeren? Waarom (niet)?	Wanneer de deelnemers niet weten wat ze moeten verwachten van alternatieve chocolade, zeg dat ze het moeten vergelijken zoals vlees-, melk-, en koffievervangers.
RQ3		17. Welke kenmerken van alternatieve chocolade zouden belangrijk voor je zijn om het te overwegen te consumeren? Waarom? a. Wat voor aroma verwacht je van alternatieve chocolade? Waarom? b. Wat voor textuur verwacht je van alternatieve chocolade? Waarom? c. Wat voor romigheid verwacht je van alternatieve chocolade? Waarom? d. Wat voor kleur verwacht je van alternatieve chocolade? Waarom?	Leg voordat je deze vraag stelt uit dat alternatieve chocolade, chocolade is die gemaakt is zonder cacao. Wanneer niet beantwoord in vraag 17, stel deelvragen a-e.

		e. Wat voor smaken zou je lekker vinden van alternatieve chocolade?	
RQ2		18. Welke factoren zouden belangrijk zijn voor jou om te overwegen of je alternatieve chocolade wil kopen/consumeren? a. Wat zou belangrijk zijn qua verpakking van het alternatieve chocoladeproduct? Waarom? b. En wat over de labels en certificaten? Waarom? c. En wat zou je vinden over de hoogte van de prijs van het product? Waarom? d. Zijn er nog andere factoren die jouw keuze zou kunnen beïnvloeden, die je nog wil toevoegen?	Wanneer niet beantwoord in vraag 18, stel deelvragen a-d.
RQ1		Wanneer iemand niet open is om alternatieve chocolade te consumeren, vraag: 19. Op welke manier zou je overwegen wel alternatieve chocoladeproducten te proberen? Waarom	
Voor de proeverij			
"Nu is het tijd om te beginnen met de proeverij van verschillende producten. De producten zijn een alternatief op traditionele chocoladeproducten, wat betekent dat er geen cacao inzit. Iedereen krijgt hetzelfde product tegelijkertijd. Voordat er geproefd kan worden, zullen er een paar vragen vooraf zijn, waarna je een teken krijgt zodra je mag beginnen met proeven. Je mag je gedachtes over het product opschrijven, maar probeer stil te blijven tot iedereen klaar is. Hierna zullen er nog wat vragen komen over je ervaring met het product voordat we naar het tweede product gaan.			
RQ3	10	20. Welke kenmerken verwacht je terug te vinden in het cacao vrije chocoladeproduct?	
RQ3		21. Wat vind je wel leuk over het uiterlijk van het product? Waarom? 22. En wat vind je niet leuk over het uiterlijk? Waarom? 23. Wat vind je van het aroma van het product? 24. Zijn er nog andere dingen die je opvallen aan het product voordat je het product gaat proeven?	
Na de proeverij – perceptie			
MRQ	20	25. Wat waren je eerste gedachtes na het proeven van de chocolade? a. Wat vond je van de smaak? Waarom? b. Wat vond je van de textuur? Waarom? c. Wat vond je van de romigheid? Waarom?	Wanneer niet beantwoord in vraag 25, stel deelvragen a-c.
		26. Voldoet dit product aan je verwachtingen? Waarom wel (of niet)?	
RQ4		27. Voldoet deze vorm van het product aan je verwachtingen? Waarom wel (of niet)?	
RQ3		28. Zijn er dingen die dit product mist, die je wel verwacht/gewild had? Waarom wel (of niet)?	
RQ4		29. Zou je open staan dit product vaker te consumeren? a. Waarom wel (of niet)? b. Op welke gelegenheden zou je open staan om dit product vaker te consumeren?	Wanneer niet beantwoord in vraag 29, stel deelvragen a-b.
RQ4		30. Zou je open staan dit product te kopen in de supermarkt? a. Waarom wel (of niet)?	

Carob vragen			
MR Q	5	31. Wat komt er in je op als je denkt aan johannesbrood (carob)?	Zorg voor foto's van het johannesbrood, en laat het de zaal rondgaan.
MR Q		32. Wat zou je verwachten van de boon in vergelijking tot de cacao boon?	
		33. Zou je van mening veranderen, mocht je geinformeerd worden over de duurzame impact van het gebruik van de Johannesbrood? Waarom wel (of niet)?	Leg uit dat de bonen in Italië groeien. De productie van carob chocolade heeft minder water nodig en stoot minder CO2 uit.
Packaging design			
"Als volgende opdracht, vraag ik of jullie de voorkant van een verpakking van carob chocolade zou willen tekenen in duo's/trio's. Denk hierbij aan de naam, de kleuren, labels en certificaten, maar ook al de andere informatie die je op de verpakking kwijt zou willen. Het product is geheel veganistisch en allergeen vrij en zou in de Nederlandse supermarkt terecht komen. Na een paar minuten zullen we kort iedereens verpakking bespreken."			
	10	34. Waarom heb je voor deze naam gekozen? 35. Welke kenmerken vond je belangrijk om op de verpakking te zetten? Waarom? 36. Welke labels en certificaten moeten er volgens jullie op de verpakking? Waarom 37. Zijn er nog andere factoren die belangrijk waren om op de verpakking gezet te worden? Waarom 38. Wat vindt je sterke punten van andere schetsen? 39. Op wat voor soort consument heb je je gefocust terwijl je de verpakking tekende?	Deel het papier uit, waarop getekend kan worden.
Introduceer het Treets alternatief op m&m's: "Dit is op het moment de enige optie van alternatieve chocolade die te vinden is in de Nederlandse supermarkt. Het omhulsel van de pinda is gemaakt van een alternatief op cacao. Iedereen mag het product proberen voordat er paar vragen over gesteld worden."			
RQ4	5	40. Wat is je algemene mening van dit product? a. Wat vind je er positief aan? Waarom? b. Wat vind je er negatief aan? Waarom?	
RQ4		41. Zou je open staan dit product te kopen? Waarom wel (of niet)?	
RQ4		42. Denk je dat deze vorm van chocolade een optie is om alternatieve chocolade te introduceren op de Nederlandse supermarkt? Waarom wel (of niet)?	

Duratie (min)	Conclusie stappen	Commentaar en material
5	1. Bedank de deelnemers voor het deelnemen aan dit onderzoek.	
	2. Vraag of er nog opmerkingen zijn over het onderwerp.	
	3. Stop de opnames.	Controleer of alles is opgeslagen.
	4. Laat de deelnemers weten dat ze toegang hebben tot de uitslag van de focus groep mochten ze dat willen.	Wissel contact informatie uit.

	5. Laat de deelnemers uitpraten voordat ze de ruimte weer verlaten.	Mocht het over het product nog gaan, maak notities.

9.3 Sensory questionnaire

The sensory questionnaire consisted of five blocks, with the first one containing demographic questions. The others were all the same only divided among the four samples, in this Appendix only one block of a sample is shown.

Msc Thesis Cocoa free chocolate - Dutch - Final

Start of Block: Default Question Block

Ten eerste bedankt voor het helpen voor mijn master onderzoek, zowel je tijd als moeite worden erg gewaardeerd! Je zal beginnen met wat algemene vragen, waarna je gedurende deze sessie vier verschillende alternatieve chocoladeproducten gaat proeven. Deze producten zijn van carob (johannesbrood) bonen gemaakt in plaats van cacao. Bij ieder product zullen er twee onderdelen zijn met vragen. Het invullen van de vragenlijst duurt ongeveer 20 minuten! Mocht je vragen voor of gedurende de sessie hebben, mag je ten alle tijden je handopsteken.

Veel succes!

Nogmaals kan je alleen met dit onderzoek meedoen mits je niet allergisch bent voor **(hazel)noten**, en de crackers bevatten **gluten,** ook verdere **crosscontaminatie** kan **niet** uitgesloten worden!

End of Block: Default Question Block

Start of Block: Personal

Q1. Wat is je geslacht?

- ○ Vrouw
- ○ Man
- ○ Zeg ik liever niet
- ○ Anders: _____

Q2. In welk jaar ben je geboren?

Q3. Hoe vaak eet je chocolade producten (denk aan: repen, koekjes, snoep, ijs, bonbons, m&m's, etc..)?

- Elke dag meerdere keren
- Elke dag eenmaals
- Meerdere keren in de week
- Een keer in de week
- Meerdere keren in de maand
- Een keer per maand
- Zelden/nooit

End of Block: Personal

Start of Block: Participant number

Q4. Wat is je deelnemers nummer?

_____

End of Block: Participant number

Start of Block: First introduction

Je mag nu beginnen met het proeven van het eerste product. Zorg dat minimaal de helft van het product geconsumeerd wordt voor een goede interpretatie van de sensorische kenmerken. Als je er klaar voor bent mag je je handopsteken om het eerste product te ontvangen!

Pak een stukje cracker en een slok water voor dat je begint.

End of Block: First introduction

Start of Block: Product

Q6. Wat is het nummer op het product?

- 187
- 304
- 792
- 561

Page Break

Q7. Selecteer de termen die volgens jou passend zijn voor dit product, je mag er zo veel kiezen als je passend vindt: **Uiterlijk**

- [ ] Wit
- [ ] Licht bruin
- [ ] Bruin
- [ ] Donker bruin
- [ ] Zwart
- [ ] Glanzend
- [ ] Dof
- [ ] Oneffen in glans
- [ ] Gelijkmatig gekleurd
- [ ] Ongelijkmatig gekleurd
- [ ] Korrelig
- [ ] Glad

Q8. Selecteer de termen die volgens jou passend zijn voor dit product, je mag er zo veel kiezen als je passend vindt: **Geur**

- [ ] Cacao
- [ ] Caramel
- [ ] Vanille
- [ ] Melk
- [ ] Geroosterd
- [ ] Intens
- [ ] Zwak
- [ ] Fruitachtig
- [ ] Zoet
- [ ] Zoutig
- [ ] Verbrand
- [ ] Notig
- [ ] Aarde

Q9. Selecteer de termen die volgens jou passend zijn voor dit product, je mag er zo veel kiezen als je passend vindt: **Smaak**

- [ ] Zoet
- [ ] Zoutig
- [ ] Umami
- [ ] Zuur
- [ ] Bitter
- [ ] Cacao
- [ ] Vanille
- [ ] Caramel
- [ ] Fruitig
- [ ] Vettig
- [ ] Kaneel
- [ ] Melk
- [ ] Chemisch
- [ ] Kunstmatige zoetstof
- [ ] Intens
- [ ] Zwak
- [ ] Verbrand
- [ ] Notig (anders dan hazelnoot)
- [ ] Filmend (smaak blijft lang in je mond hangen)
- [ ] Hazelnoot

Q10. Selecteer de termen die volgens jou passend zijn voor dit product, je mag er zo veel kiezen als je passend vindt: **Textuur en mondgevoel**

- [ ] "Snap" (breekt makkelijk en mooi)
- [ ] Hard
- [ ] Zacht
- [ ] Korrelig
- [ ] Bros
- [ ] Taai
- [ ] Romig
- [ ] Smeltbaar
- [ ] Vast
- [ ] Vettig
- [ ] Droog
- [ ] Plakt aan je tanden/kleverig
- [ ] Glad
- [ ] Crunchy/knapperig
- [ ] Filmend (er blijft een laagje achter in je mond)
- [ ] Luchtig

Page Break

Q11. Vind je van de volgende kenmerken dat ze aanwezig zijn?

	Ja	Nee
Zoet (geur)	○	○
Geroosterd (geur)	○	○
Zoet (smaak)	○	○
Bitter (smaak)	○	○
Glans	○	○
Romigheid	○	○
Smeltbaarheid	○	○
Glad en gelijk	○	○
Snap (breekt makkelijk en mooi)	○	○

Q12. In hoeverre vind je de volgende eigenschappen van het product aangenaam? (als het niet aanwezig is, vind je dat dan juist fijn of niet)

	Extreem onaan-genaam				Neutraal				Extreem aan-genaam
Zoet (geur)	○	○	○	○	○	○	○	○	○
Geroosterd (geur)	○	○	○	○	○	○	○	○	○
Zoet (smaak)	○	○	○	○	○	○	○	○	○
Bitter (smaak)	○	○	○	○	○	○	○	○	○
Glans	○	○	○	○	○	○	○	○	○
Romigheid	○	○	○	○	○	○	○	○	○
Smeltbaarheid	○	○	○	○	○	○	○	○	○
Glad en gelijk	○	○	○	○	○	○	○	○	○
Snap (breekt makkelijk en mooi)	○	○	○	○	○	○	○	○	○

Q13. Hoe lekker vond je het product in totaliteit?

	Helemaal niet lekker (1)	Echt niet lekker (2)	Niet lekker (3)	Een beetje niet lekker (4)	Neutraal (5)	Een beetje lekker (6)	Lekker (7)	Echt lekker (8)	Extreem lekker (9)
Ik vond het...	○	○	○	○	○	○	○	○	○

End of Block: Product

Start of Block: Tussendoor

Drink nu een slok water en eet een stukje cracker voordat je doorgaat naar het volgende product. Steek hierna je hand op voor het volgende product. Zorg voor het volgende product weer dat je minimaal de helft van het product consumeert voor een goede interpretatie!

End of Block: Tussendoor

Note: the block "Product" and the block "Tussendoor" was repeated in total 3 times after this yet remained the same in the questioning and structure. Hence it is not included in the appendix.

9.4 Codebook focus group

Abbreviations are only given when specifically combined with a section of the focus group to differentiate answers during discussions.

Table 12. Codebook for data analysis of the focus group discussions

Category	Code Name	Abbreviation
Consumer behaviour and habits		
	Self control	
	Uncertainty	
	Mood	
	Negative association	
	Motivation and Triggers	Exp_Motivation_and_Triggers
	Curiosity and Openness	Exp_Curiosity_and_Openness
	Sceptical	Exp_Sceptical
	Purchasing decisions	Rea_Purchasing_decisions
Market and Consumption contexts		
	Brands	
	Holidays	
	Marketing	
	Timing	

Health	Exp_Health
Quantity	Exp_Quantity
Frequency	Exp_Frequency
Type of chocolate	
Sustainability and ethical awareness	
Awareness	
Ethical reasoning	
Claims and Certifications	Exp_Claims_and_Certifications
Sustainability	
Previous experiences and preferences	
Previous experiences	Exp_Previous_Experiences
Liking preferences	Exp_Liking_Preferences
Disliking preferences	Exp_Disliking_Preferences
Expectations	Exp_Expectations
Blooming effects	
Expectations traditional chocolate	
Snap	Exp_Snap
Aroma	Exp_Aroma
Colour	Exp_Colour
Convenience	Exp_Convenience
Creaminess	Exp_Creaminess
External factors	Exp_External_Factors
Fillings	Exp_Fillings
Formats of chocolate	Exp_Formats of chocolate
Grainy	Exp_Grainy
Hardness	Exp_Hardness
Quality_Perception	Exp_Quality_Perception
Meltiness	Exp_Meltiness
Price	Exp_Price
Richness	Exp_Richness
Smoothness	Exp_Smoothness
Softness	Exp_Softness
Taste	Exp_Taste
Temperature	Exp_Temperature
Texture	Exp_Texture
Expectations and knowledge alternative (carob) chocolate	
Overal expectation alternative chocolate	
"Snap"	Alt_"Snap"
Appearance	Alt_Appearance
Aroma	Alt_Aroma
Association	Alt_Association
Colour	Alt_Colour
Dull	Alt_Dull
Glossiness	Alt_Glossiness
Meltiness	Alt_Meltiness
Taste	Alt_Taste
Texture	Alt_Texture

Alternative Chocolate Consumption	Exp_Alt_Choc_Consumption
Overall expectation and knowledge carob chocolate	
Appearance	Car_Appearance
Awareness	Car_Awareness
Knowledge	Car_Knowledge
Labelling	Car_Labelling
Packaging	Car_Packaging
Possibilities	Car_Possibilities
Sceptical	Car_Sceptical
Sustainability	Car_Sustainability
Target group	Car_Target_group
Taste	Car_Taste
Actual perception carob chocolate	
"Snap"	Rea_"Snap"
Aroma	Rea_Aroma
Association	Rea_Association
Colour	Rea_Colour
Creaminess	Rea_Creaminess
Flavour	Rea_Flavour
Grainy	Rea_Grainy
M&M_Treets	Rea_M&M_Treets
Meltiness	Rea_Meltiness
Mouthfeel	Rea_Mouthfeel
Possibilities	Rea_Possibilities
Price	Rea_Price
Quality	Rea_Quality
Satisfaction	Rea_Satisfaction
Taste	Rea_Taste
Texture	Rea_Texture

9.5 Packaging designs from focus groups

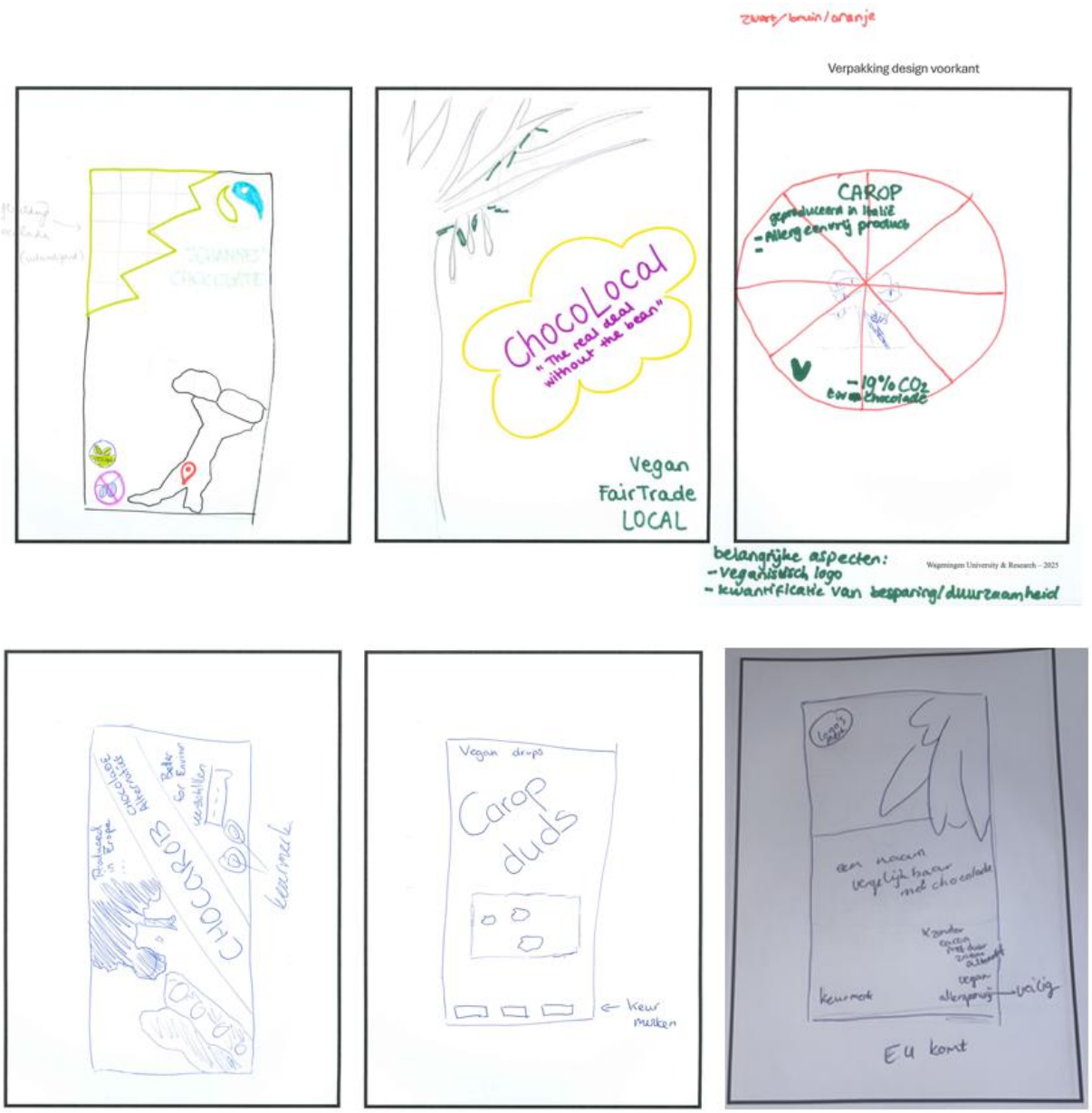

Figure 11. Packaging designs made by the focus group participants

9.6 Word clouds

9.6.1 Word clouds: Appearance

Figure 12. Word clouds on appearance from sensory analysis: a. Milk chocolate drop, b. Dark chocolate drop, c. Milk chocolate praline, d. Dark chocolate praline

9.6.2 Word clouds: Aroma

Figure 13. Word clouds on aroma from sensory analysis: a. Milk chocolate drop, b. Dark chocolate drop, c. Milk chocolate praline, d. Dark chocolate praline

9.7 Hedonic testing results

9.7.1 Hedonic results for MCD

Asterisk (*) indicate statistically significant differences (P<0.05) in Table 13. The hedonic results of sample “Milk chocolate drop” in sensory analysisTable 13 with another sample.

Table 13. The hedonic results of sample “Milk chocolate drop” in sensory analysis

Attribute Sample MCD	Mean	St dev	N	N (%)
Sweet (Aroma) - Present	6,121	2,012	32	84,21
Sweet (Aroma) - Absence	4,600	0,548	6	15,79
Roasted (Aroma) - Presence	5,333	2,309	3	7,89
Roasted (Aroma) - Absence	5,314	1,623	35	92,11
Sweet (Taste) - Presence	6,222	1,884	36	94,74
Sweet (Taste) - Absence	4,000	0,000	2	5,26
Bitter (Taste) - Presence	4,400	1,817	5	13,16
Bitter (Taste) - Absence	5,364	2,089	33	86,84
Shine - Presence	6,200	1,304	5	13,16
Shine - Absence	4,667	1,534	33	86,84
Creaminess - Presence	6,111	1,783	27	71,05
Creaminess - Absence	4,636	1,567	11	28,95
Meltiness - Presence	6,379	1,265	29	76,32
Meltiness - Absence	4,778	2,108	9	23,68
Smooth and even - Presence*	6,733	1,413	30	78,95

Smooth and even - Absence	4,500	1,069	8	21,05
Snap - Presence	6,833	1,523	24	63,16
Snap - Absence	4,214	1,847	14	36,84
Overall liking*	***5,395***	***1,925***	***38***	***100,00***

9.7.2 Hedonic results for DCD

Asterisk (*) indicate statistically significant differences (P<0.05) in Table 14, with another sample.

Table 14. The hedonic results of sample "Dark chocolate drop" in sensory analysis

Attribute Sample DCD	**Mean**	**St dev**	**N**	**% N**
Sweet (Aroma) - Present	6,091	1,716	22	57,89
Sweet (Aroma) - Absence	4,125	1,163	16	42,11
Roasted (Aroma) - Presence*	4,842	1,834	19	50,00
Roasted (Aroma) - Absence	5,684	1,416	19	50,00
Sweet (Taste) - Presence	6,148	1,916	27	71,05
Sweet (Taste) - Absence	3,727	1,954	11	28,95
Bitter (Taste) - Presence	3,800	2,118	20	52,63
Bitter (Taste) - Absence*	6,500	2,121	18	47,37
Shine - Presence	5,667	1,589	15	39,47
Shine - Absence	5,087	1,203	23	60,53
Creaminess - Presence	6,417	1,442	24	63,16
Creaminess - Absence	4,786	1,672	14	36,84
Meltiness - Presence	6,167	1,487	30	78,95
Meltiness - Absence	5,000	2,268	8	21,05
Smooth and even - Presence	6,818	1,380	33	86,84
Smooth and even - Absence	5,400	1,517	5	13,16
Snap - Presence	7,172	1,416	29	76,32
Snap - Absence*	5,556	1,590	9	23,68
Overall liking*	***6,711***	***1,609***	***38***	***100,00***

9.7.3 Hedonic results for MCP

Asterisk (*) indicate statistically significant differences (P<0.05) in Table 15, with another sample.

Table 15. The hedonic results of sample "Milk chocolate praline" in sensory analysis

Attribute Sample MCP	**Mean**	**St dev**	**N**	**N (%)**
Sweet (Aroma) - Present	6,250	1,391	32	84,21
Sweet (Aroma) - Absence	4,833	2,401	6	15,79
Roasted (Aroma) - Presence	5,900	1,197	10	26,32
Roasted (Aroma) - Absence	5,107	1,571	28	73,68
Sweet (Taste) - Presence	6,711	1,523	38	100
Sweet (Taste) - Absence			0	0
Bitter (Taste) - Presence	5,000	2,646	3	7,89
Bitter (Taste) - Absence	5,486	1,755	35	92,11
Shine - Presence	6,481	1,528	27	71,05
Shine - Absence	4,273	1,104	11	28,95
Creaminess - Presence	6,387	1,453	31	81,58
Creaminess - Absence	5,857	1,574	7	18,42
Meltiness - Presence	5,969	1,356	32	84,21

Meltiness - Absence	4,833	0,753	6	15,79
Smooth and even - Presence	5,893	0,956	28	73,68
Smooth and even - Absence	4,500	1,080	10	26,32
Snap - Presence	6,231	1,013	13	34,21
Snap - Absence	4,120	1,301	25	65,79
Overall liking*	***4,816***	***2,103***	***38***	***100,00***

9.7.4 Hedonic results for DCP

Asterisk (*) indicate statistically significant differences (P<0.05) in Table 16, with another sample.

Table 16. The hedonic results of sample "Dark chocolate praline" in sensory analysis

Attribute Sample DCP	**Mean**	**St dev**	**N**	**N (%)**
Sweet (Aroma) - Present	6,529	2,065	17	44,74
Sweet (Aroma) - Absence	4,524	1,914	21	55,26
Roasted (Aroma) - Presence*	5,957	1,461	23	60,53
Roasted (Aroma) - Absence	5,067	1,624	15	39,47
Sweet (Taste) - Presence	6,686	1,711	35	92,11
Sweet (Taste) - Absence	3,667	3,055	3	7,89
Bitter (Taste) - Presence	5,000	2,000	14	36,84
Bitter (Taste) - Absence*	5,208	1,911	24	63,16
Shine - Presence	6,207	1,497	29	76,32
Shine - Absence	5,000	1,000	9	23,68
Creaminess - Presence	6,643	1,521	28	73,68
Creaminess - Absence	4,600	1,776	10	26,32
Meltiness - Presence	6,100	1,768	30	78,95
Meltiness - Absence	5,250	1,982	8	21,05
Smooth and even - Presence	6,500	1,414	32	84,21
Smooth and even - Absence	4,333	1,506	6	15,79
Snap - Presence	6,667	1,328	18	47,37
Snap - Absence*	4,050	1,468	20	52,63
Overall liking	***5,763***	***1,684***	***38***	***100,00***

9.8 Use of Artificial Intelligence (AI)

For this thesis report the use of Artificial Intelligence (AI) was minimal. The only tool used was ChatGPT, which was used at the early stages as starting point to generate ideas in the developmental phase of this research. Moreover, it provided guidance on methodological approaches and analytic procedures, without incorporating actual data. Additionally, AI contributed with the development of the title of this research, which was later revised by the researcher.

Overall, AI was mainly used as a starting supportive tool for idea generation. It was not utilised for making fundamental decision or, conducting data analysis, or influencing outcomes.