A consumer *pear*spective

A literature review for the development of an overview of attributes for pears and their importance in the evaluation process

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Abstract

This research was conducted as a supporting study in the development of new pear varieties at Wageningen Plant Research in Randwijk. The purpose of this research was to develop an overview of attributes for pears and their importance in the evaluation process. With this a recommendation, from a consumer behavioural perspective, was given to Wageningen Plant Research for the development and marketing of new pear varieties based on attributes that were important for the evaluation of pears by consumers or consumer segments. The main research question was as follows; *What attributes that consumers use for the evaluation of pears need to be considered for the development of new pear varieties at Wageningen Plant Research in Randwijk?*

The research methodology of this research was a systematic literature review. For this review a final selection of 21 articles were used from the initial 83 articles found in two search engines. The selection of these articles was based on specific search queries and rejection rules, that included researches with pears only from the *Pyrus communis* family and fresh cut pears during the evaluation and rejected articles that were too instrumental. This research consisted of three parts that together provided answers to the main research questions; (1) attributes used for consumer evaluation of pears, (2) their importance dimension and influence in the evaluation process, and (3) consumer segments.

In total around 80 attributes were found. These attributes were allocated into four groups; physicochemical measures, appearance attributes, texture attributes and flavour attributes. Moreover, from the literature several items were also described that were deemed important and were grouped as overall evaluative judgements. Most of these attributes were measured on the relevance importance dimension followed by the determinance importance dimension. Only one attributes was measured on the salience dimension. From the literature not much information was found on consumer segments or the identification of consumer groups based on specific attributes.

Main conclusion and recommendations of this research included that for the development of new pear varieties at Wageningen Plat Research attributes should be researched in relation to each other and not just individually. For the development of an ideal pear for a specific consumer segments a unique combination of attributes should be used to target such a consumer segment. Lastly, identifying consumer segments should be a main topic of a future research and should use a different methodology than this research, since based on the literature not much information was found on consumer segments.

Although this research was not able to provide much information on consumer segments, it did provide further researches with an overview of attributes that can be used to measure consumer evaluation of pear and their influence in the evaluation process. Therefore, this research can be very helpful for various future researches into consumer evaluation of pear and the development of new pear varieties.

KEYWORDS: pear, *Pyrus communis*, European pear, consumer evaluation, preferences, attributes, importance dimension, consumer segments, evaluation process, sensory perception.

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1. Introduction

In 2013 the European Union (EU) produced about 66.8 million tons of fresh fruit, of which most fruit is produced in southern countries, such as Spain, Italy or Greece (CBI, 2015; Verdouw et al., 2010). In these countries also the highest consumption rates of fruits are seen (Freshel, 2008; Verdouw et al., 2010). Most of the fruits produced in the EU are apples, pears, citrus fruits and stone fruits (Freshel, 2008; Verdouw et al., 2010). Although the Netherlands are not in the top 10 producing countries, they are seen as an important fruit trader or trading hubs for fresh produces from developing countries for other European markets, re-exporting imported fruits (Verdouw et al., 2010; CBI, 2015). In the Netherlands mainly apples and pears are produced (CBI, 2015).

Changes in the market condition in recent years have led to a more consumer-oriented vision in agricultural- and food production (Bijman &Hendrikse, 2003). Due to increasing competition, more variety in products, and increasing average incomes, consumers began to demand better quality, variety and more convenience products (Bijman & Hendriks, 2003; Meulenberg, 2000). Consumers also became more involved in the fruit market in relation to food safety and environmental impact, which became determinants for their purchase decisions (Bijman & Hendrikse, 2003).

The need to be more consumer- or market orientated is seen in multiple parts of the fruit industry, since fierce competition learns the need to focus beyond mere quality (Jaeger et al., 2003b). This makes it important for companies to continuously try to develop new or innovative fruit varieties (Laurenson et al., 1994; Weil, 1998; Jaeger et al., 2003b). The development of a new kind of fruit is a time consuming endeavour and can take up many years, e.g. 15 years for kiwifruit with traditional breeding techniques (Patterson et al., 2003; Jaeger et al., 2011).

After the development of a new variety it remains uncertain whether or not it will be successful on the market. For industries, among which agricultural industries, more or better information is needed to link consumer behaviour to product quality (Mowat & Collins, 2000). Quality can mean different things to a growers than to a consumer. For a grower the quality of a fruit is possibly more related to the physicochemical attributes (e.g. growing conditions or mealiness after certain storage periods), while for consumers quality is more an individual perception based on personal needs, goals or experience (Steenkamp, 1989). Because of this difference, gaining more insights into how consumers perceive the quality of a pear could be of value for growers who develop pears. It is also important to note that consumer preference for certain attributes can also differ per consumer segment. Taste can change over a lifespan, e.g. research showed a preference for strong sweet tastes in young children, yet when growing older, this preference was found to continuously decline (Cowart, 1981; Beauchamp & Moran, 1982). This indicates that it can be very challenging to develop just one 'ideal' pear, since 'ideal' will probably differ consumer segment.

When tasting a product, people use all senses and multiple attributes at once to form an evaluation, e.g. apples are evaluated based on a combination of their sweetness, hardness, acidity and juiciness (Krishna, 2012; Harket et al., 2003). The evaluation of a product and it's attributes leading to consumer preference is a complex process (Espejel et al., 2007). Attributes that are used by consumers to evaluate the quality of a product, can be divided into intrinsic and extrinsic product attributes (Espejel et al., 2007). Intrinsic attributes are the physical aspects of a product (e.g. flavour, form, or colour), whereas extrinsic attributes are related to the product, but not physically part of the product (e.g. brand, certificates, price, or origin) (Espejel et al., 2007). Moreover, a distinction can be made between search, experience and credence attributes (Steenkamp, 1989). Experience attributes can be ascertained based on actual experiences with a product (e.g. tasting it), while credence attributes are related to the beliefs associated with a product (e.g. health benefits of sustainability claims) and are hard to assess during or

after consumption (Steenkamp, 1989). As can be imagined, consumers can evaluate products based on numerous attributes, e.g. the attribute of freshness was found to be a decisive attribute for the choice of fruits and vegetables, or more specifically sweetness and hardness were decisive attributes for consumers for apples (Visser et al., 2013; Harker et al., 2003). Even for specific fruits, different attributes can be more or less important for the evaluation of preference.

This research will be conducted as a supporting study in the development of new pear varieties at Wageningen Plant Research in Randwijk. Wageningen Plant Research at Randwijk is a research facility connected to Wageningen University and Research (WUR). In this research facility there is a substantial testing ground for research into various types of plants, of which pear trees are just one section. One of the topics of research is developing varieties of fruit that will do well on the market based on consumer insights. At the research facility they are experts in the agricultural research field and for a consumer behavioural perspective they work together with the consumer behaviour department of WUR. A previous study has focused on the preference attributes for apples, yet for pears it is expected that other attributes might also be important. Therefore this research builds upon, and expands, previous research with a focus on identifying important product attributes for consumer evaluation of preference for pears.

The purpose of this research is to develop an overview of attributes for pears and their importance in the evaluation process. With this a recommendation, from a consumer behavioural perspective, can be given to Wageningen Plant Research for the development and marketing of new pear varieties based on attributes that are important for the evaluation of pears by consumers or consumer segments. To be able to do so, the following research questions were developed;

Main research question: *What attributes that consumers use for the evaluation of pears need to be considered for the development of new pear varieties at Wageningen Plant Research in Randwijk?*

Sub-question 1: *What attributes drive consumer preferences for pears?*

Sub-question 2: *What is the influence of these attributes on consumer preferences?*

Sub-question 3: *What attributes are used to identify consumer segments?*

By conducting a systematic literature review on what attributes drive consumer preference for pears, an overview of existing literature on this topic is created. This overview will include lists of attributes mentioned in the articles, as well as their importance. Also information on consumer segments if given in found in the literature. Based on the results recommendations will be given to Wageningen Plant Research in Randwijk.

2. Theoretical framework

This chapter starts with a short description of the fruit pear and continues with a discussion of relevant theories. The first theory will include the process of sensory perception and evaluation. Second, when research looks in to the evaluation of consumers and the important attributes they use, different research methods can measure different dimension of attribute importance. Third, it is explained that inferences of quality are part of the evaluation of a product, along with multiple categorization methods for attributes that are used in the evaluation process. Fourth, it is addressed that quality evaluations can differ per consumer or consumer segment. The final section of this chapter includes the theoretical framework used for the systematic literature review.

2.1 The pear (*Pyrus)*

Pears are among of the oldest fruit varieties cultivated by humans and are eaten in many parts of the world (Bell, 1991; O'Callaghan, 2015). The word 'pear' is a collective name for approximately 20 species of trees in the genus *Pyrus* in the rose family (*Roscaceae)*, yet only some species are used for growing fruit such as the *Pyrus bretschneideri, Pyrus pyrifolia,* and the *Pyrus communis* (O'Callaghan, 2015; Taiti et al., 2017). Native to Europe is the European pear or *Pyrus communis*, with multiple varieties (O'Callaghan, 2015). Most important countries in Europe for the production of these pears are France, Germany and Belgium (O'Callaghan, 2015).

Pears grow on medium high trees and consist of a peel and flesh, yet the colour and shape can vary among varieties. For example in Europe a pear is pear-shaped with a mostly green skin, while an Asian pear is more apple-shaped with a yellow skin. On average a pear weighs approximately 150 grams, of which 130 gram is edible (when the core is not considered edible) (O'Callaghan, 2015; NHMRC, 2013). Consumers eat pears mostly as a fresh fruit, but they can also be used for other purposes such as cooking, canning, making juices, drying or for making pear cider (O'Callaghan, 2015).

At the Wageningen Plant Research facility of the WUR at Randwijk, they mostly work with varieties of the *Pyrus communis*, e.g. conference or doyenne du comice cultivars. At the site, there are some plots where several varieties of the Nashi pears are grown (Asian pears). Yet, it is expected that these pears will not be pursued in any further research since taste qualities are lacking in relation to taste preferences of the Dutch consumers. Since outcomes of this research could be of support to future research at the Randwijk facility, this research will focus on varieties of the *Pyrus communis.*

2.2 Sensory perception process

Organisms, including humans, face evaluative tasks throughout their life, ranging from trivial issues to life or death, fight or flight situations (Winkielman et al., 2003). Extensive experience in making evaluative judgements have given humans a wide toolbox to make evaluations based on different sources of information (Winkielman et al., 2003). For this evaluation people use their senses to form perceptions that, in turn, will lead to a certain evaluation. The sensation, or the stimulus of a receptor cells of a sensory organ, lead to perception, which is the awareness or understanding of this sensory information (Krishna, 2012).

Extensive research covers the workings and effects of these senses in various situations, yet this research will focus on the workings of theses senses in relation to product evaluation and more specifically the evaluation of pears. When it comes to consumption and taste, we need all senses to be able to perceive subtle differences in taste, e.g. to differentiate between wine and coffee (Krishna, 2012; Herz, 2007). When tasting a fruit, consumers often use multiple attributes at once to form an evaluation, e.g. apples are evaluated based on a combination of their sweetness, hardness or acidity or juiciness (Harker et al., 2003). It is important to realize that consumer preference is based on an interaction of

multiple senses at the same time. From a targeted object (pear) senses receive stimuli, of which the stimuli for ears is different than the stimuli for touch. Based on the perception of this stimuli a person eventually form an evaluation. Figure 1. gives an overview of the workings of sensory perception based on the conceptual framework for sensory marketing from Krishna (2012).

The evaluation of a product and it's attributes leading to consumer preference is a complex process (Espejel et al., 2007). Some attributes can be perceived from just seeing the product and possible relevant information (e.g. shape, colour, price, or origin), others can only be perceived when actually consuming the product (e.g. taste, crunchiness, or juiciness). For example for actually tasting a food product, the eyes are needed to see the colour of a product, the hands and mouth to determine the texture, weight, temperature or mouthfeel, the mouth is also needed for tasting and determining flavour using the basic 5 tastes, this is done in combination with the nose to smell the food and also the ears to experience the sounds of textures such as crunchiness. This shows that all the senses work together in determining the taste of a product and with an exclusion of one or more senses this process changes. This general ambiguity of product experience leads to susceptibility to external factors or influences, such as physical attributes, nutritional information, brand names, packaging, and so on.
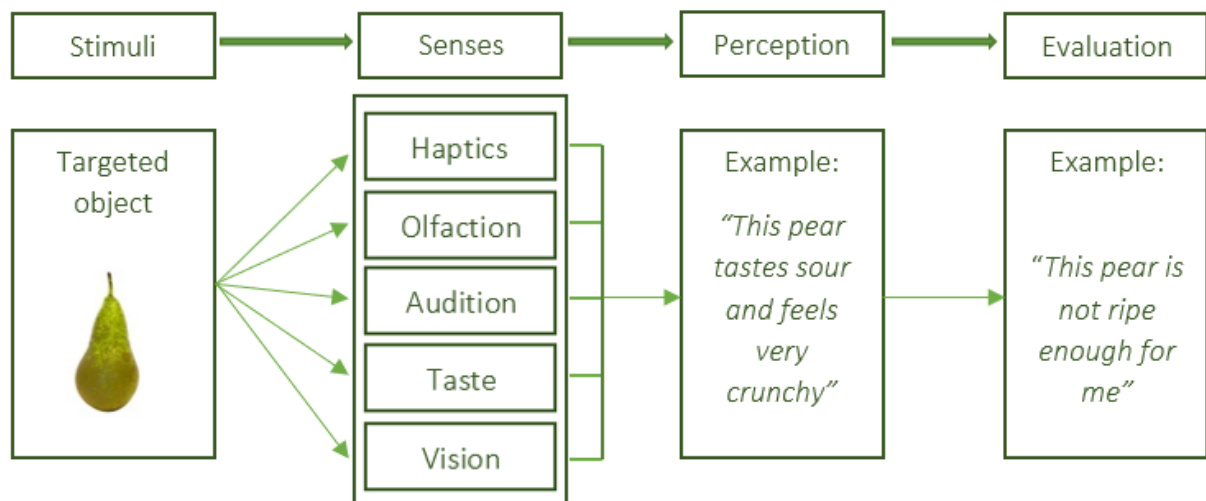

Figure 1 Process of sensory perception and evaluation

This can also be used for the marketing of a product to subconsciously trigger consumer perceptions of abstract notions (product attributes) of the product, e.g. these shiny cherries must be very sweet (Krishna, 2012). Sensory marketing can be defined as; "*marketing that engages the consumers' senses and affects their perception, judgement, and behaviour*" (Krishna, 2012). From a more research perspective, as is the case in this research, sensory marketing reflects more the understanding of sensation and perception as it applies to consumer evaluation of a product (Krishna, 2012). This can be interesting for Wageningen Plant Research for when a new variety is developed en needs to be positioned in the Dutch consumer market. By knowing which attributes and how they lead to favourable evaluations of certain consumers, specific marketing tools can be developed.

2.3 Attribute importance
For the development of new varieties it is important to determine which attributes are important for consumers when evaluating pears and what weights are attached to these attributes in the evaluation process. The importance of an attribute can be expressed and understood in multiple ways. In existing literature, there are many possible research methods to uncover product attributes that are important,

yet not all measure the same dimension of attribute importance (van Ittersum et al., 2007). This proposition of multi-dimensionality of attribute importance includes three dimensions; salience, relevance and determinance (Myers & Alpert, 1968;1977; van Ittersum et al., 2007). Table 1 gives an explanation of the dimensions including often used research methods.

Table 1. Attribute importance dimensions (van Ittersum et al., 2007)

Dimension	Explanation	Research method
Salience	Reflects the degree of ease with which attributes comes to mind or are recognized when seeing a targeted product. It is also dependable on the quality and quantity of accessible attribute information (Alba et al., 1991).	Free-elicitation
Relevance	Reflects the individual variation in personal values and desires, resulting in different attribute relevance.	Direct-rating, direct-ranking, point-allocation, analytical hierarchy process, information-display-board,
Determinance	Reflects the importance of an attribute in judgement and choice (Myers & Alpert, 1977) and is generally calculated based on the difference in valuation of different attributes.	Multi-attribute attitude model, trade-off, swing-weight, conjoint method.

The three attribute dimensions have certain influences on each other, as shown in Figure 2. Attributes that are relevant are in most cases also seen as more salient, since the salience of an attribute is often used as heuristic for inferencing relevance (Fishbein & Ajzen, 1975; van Ittersum et al., 2007). In turn, the determinance of an attribute is influenced by the relevance a consumer attaches to an attribute (Alpert, 1971; van Ittersum et al., 2007). Here it must be noted that although an attribute is seen as relevant, it might not be determinant in the evaluation process, while irrelevant attributes in some cases are determinant in evaluation (van Ittersum et al., 2007; Carpenter et al., 1994). For example when making a comparison between two fruits, land of origin might be a relevant attribute, yet when the land origin is similar for both fruits, it may not be seen as a determinant attribute. The salience of an attribute is influenced by both the relevance and determinance of the attribute, which entails that when an attribute is relevant or determinant for evaluation, it will be more salient in de mind of the consumer (van Ittersum et al., 2007).
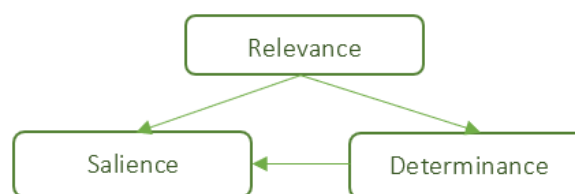
Figure 2 Framework for attribute dimensions (van Ittersum et al., 2007)

For the remainder of this paper the term 'importance' will be used as umbrella term for the three dimensions of attribute importance. During the systematic literature review the distinction between salience, relevance, and determinance of attribute importance is used to categorize the discussed attributes. Moreover, using the results and the research methods used in current literature it might be possible to create a ranking of the discussed attributes.

Lastly, attribute importance is influenced by the number and range of attribute levels included in the selected research method (van Ittersum et al., 2007; Wittink et al., 1989; Verlegh et al., 2002). For example for pears, the attribute of colour could have several levels such as: green, yellow, red, or brown.

To account for the influence of such levels, the levels (if included) for the attributes mentioned in the articles of the literature review will be documented. This will give more information on what levels are currently used for what kind of attributes.

2.4 Evaluation of quality

Quality of a product is a frequently discussed term in the field of consumer behaviour and the meaning can differ per research perspective. Quality can be described as a subjective concept, dependent on consumer or individuals perception of it based on personal needs, goals or experience (Steenkamp, 1989). Using the behavioural (or perceived quality approach), this research used the broad definition; "*Perceived quality is fitness for use*" (Steenkamp, 1989). There are multiple variation of 'fitness for use' in this definition, yet 'fitness for use' includes how based on consumer perception, in relation to consumer goals and/or needs, a product fulfils or performs its function (Kotler, 1984; Kawlath, 1969; Steenkamp, 1989). This also emphasizes the subjectiveness of perceived quality. Consumers use their individual experience, knowledge, goals and needs to recognize and perceive quality, therefore quality can differ because consumers are different (Steenkamp, 1989). To form quality perceptions using the process of sensory perception, people use internal knowledge and experience in combination with information they receive from the stimuli of a targeted object (Steenkamp, 1989).

Based on stimuli, or cues, from a targeted object, consumers perceive the attributes of an object and can infer or perceive the quality of an object. Attributes for inference making of quality, quality attributes, are the benefit-generating aspects of a product (Steenkamp, 1989). Since knowledge, experience and individual goals and needs of consumers differ, consumers may use different cues and quality attributes to form evaluative quality judgements (Steenkamp, 1989). This evaluative process includes that consumer can infer beliefs of quality, while using and categorizing cues from the targeted object and quality attributes (Steenkamp, 1989). Quality attributes can function as mediating variable between the cues from the targeted object and consumers' quality evaluation (Steenkamp, 1989).

Quality attributes can be categorized as intrinsic or extrinsic quality attributes (Steenkamp, 1989). The qualityattributes that are actually part of the physical product are seen as the intrinsic quality attributes, e.g. flavour, form or colour (Steenkamp, 1989.; Espejel et al., 2007) The extrinsic quality attributes are related to the product but not physically part of it, examples are; brand, price, or land of origin (Steenkamp, 1989;Espejel et al., 2007).

Quality attributes can also be categorized as search, experience or credence attributes based on information and the different points in the consumer decision-making process (Steenkamp, 1989; Maute & Forrester, 1991). Before actual consumption, search attributes can be evaluated using knowledge, inspection, reasonable effort and normal channels for retrieving product information (Maute & Forrester, 1991). Whereas experience attributes can be ascertained and evaluated based on actual experiences with a product and credence attributes cannot be ascertained even after consumption (Steenkamp, 1989; Maute & Forrester, 1991). Credence attributes include attributes related to the beliefs associated with a product (e.g. health benefits of sustainability claims) and are hard to assess during or after consumption because of the expertise of consumers or lack of accurate information (Steenkamp, 1989; Maute & Forrester, 1991).

In general experience attributes are seen as more important than credence attributes in the evaluation of a product or the formation of quality judgements of a product, yet some credence attributes can be of such value to consumers they overrule experience attributes (Steenkamp, 1989). Moreover, research showed that consumers are more able to use quality cues in the inference process in relation to experience attributes than in relation to credence attributes (Steenkamp, 1989). Since credence attributes are assessed mostly after consumption, consumers have less opportunity to learn or change

their inferential beliefs based on quality cues (Steenkamp, 1989). The quality evaluations of consumers appears to be mostly based on quality attributes, whereas quality cues are valued for their predictive validity of quality attributes and not for their value on their own (Steenkamp, 1989).

The distinction between intrinsic and extrinsic and search, experience and credence attributes will be used to further categorize product attributes during the systematic literature review. Moreover, attention is paid to objective and subjective quality attributes. Objective quality includes the technical, measurable and verifiable nature of a pear and its related production processes and quality controls (Espejel et al., 2007). On the other hand, the subjective quality refers to the perceptions or value judgements of quality of consumers (Espejel et al., 2007). To avoid a mixture of objective and subjective quality attributes, these two types of quality attributes are separated during the documentation of quality attributes form the literature. For the research facility in Randwijk the objective quality attributes can be used for the cultivation of new pear variaties. During the literature review an attempt will be made to find relations between these subjective and objective quality attributes.

2.5 Differences in quality evaluation

As described in section 2.4, consumers base their quality evaluation on their individual experience, knowledge, goals, and needs (Steenkamp, 1989). Their perception of quality can therefore differ, since people's internal structures that include personal knowledge and experience differ. This indicates that it might be impossible to develop the 'ideal' pear variety, since 'ideal' can differ per consumer or consumer segment. Wageningen Plant Research is therefore also interested in the possibility of identifying attributes of importance for specific consumer segments.

Taste can change over a lifespan, e.g. research showed a preference for strong sweet tastes in young children, yet when growing older, this preference was found to continuously decline (Cowart, 1981; Beauchamp & Moran, 1982). Conversely, babies prefer low salt concentrations while older people prefer higher salt concentrations in food (Beauchamp & Cowart, 1990). Next to taste, other senses are also active when consuming pear and even less is known about changes of the olfactory sense in relation to food consumption (Cowart, 1981).

Changing consumer preference for pear could indicate that instead of developing an 'ideal' pear for a certain cohort of consumers and expecting that consumer preference within this cohort will remain stable, it might be interesting to develop varieties for specific segments, based on difference in preference attribute. During the literature review an attempt will be made to find what attribute are definitive for differences in preferences.

2.6 Conceptual framework

Based on the discussed literature a conceptual framework (Figure 3.) is created to give an overview of the related aspects that will be considered during the systematic literature review. It uses the model of sensory perception and evaluation as a basis and indicates the position of quality cues, quality attributes, attribute importance, and consumer segments in this relation to this process.
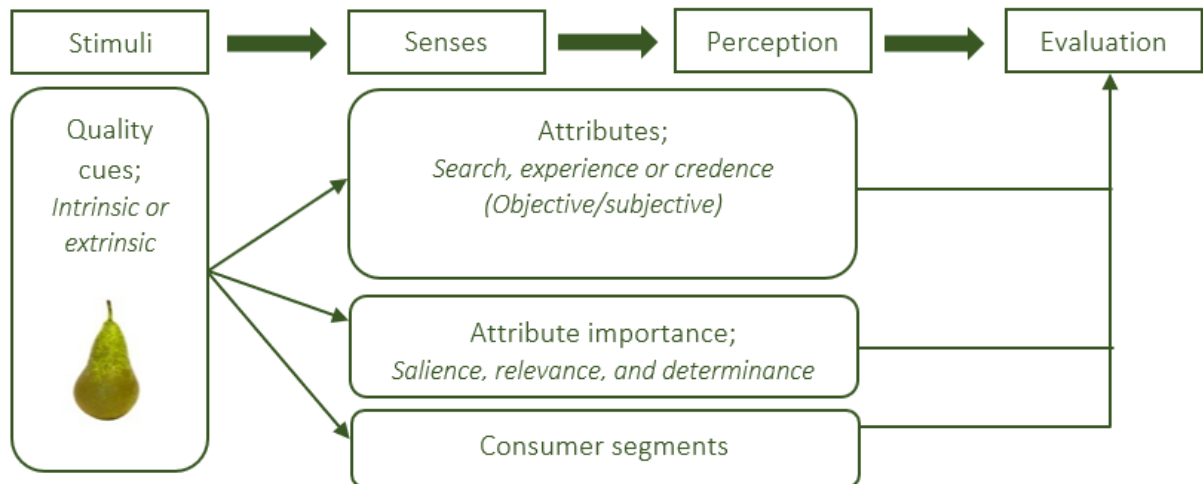

Figure 3 Conceptual framework

3. Methodology literature review

In this chapter the methodology of this systematic literature review is explained. First, the database search strategy is described, including the development of the search query. Then the inclusion criteria are explained and a flow diagram of the selection process was developed. Lastly, based on the research questions a strategy is developed for the analysis of the literature.

3.1 Database search strategy

For this study, two databases have been used for the literature search: CAB Abstracts and Scopus. The database of CAB Abstract was selected on the basis of its coverage of literature in the field of life science and agriculture. Scopus was chosen since it includes peer-reviewed literature in the field of social science, which is very useful for the consumer behavioural approach of this research.

To develop a useful search query for this study, first the concepts to be used were identified. The first concept is the pear, the central fruit variety in this research. Second and third concepts are the attributes and the consumers. The fourth concept includes limitation to the search query such as language, document type or specific fields of interest. For each of these concepts synonyms or relevant terms were tested in each of the two databases. Next to the Boolean operator "OR" and "AND", wild card characteristics were used to optimize the search terms, such as "?", "*", and "adj.". The Boolean "AND" was used to add terms to the search query and "OR" was used to include synonyms. A "*" was used for the terms quality and property capture both words ending with '-y' and '-ies'. The wildcard "adj6" was used to find adjacent terms that would be at maximum six words apart from each other. The search was conducted on September 6th 2019.

In table 2, the final search terms per concept used for each of the databases is given. For the database of CAB Abstract limitations were that the publication was written in English or Dutch and that it did not include any articles related to Food Storage and Preservation (QQ110) or Micriobial Technology in Food Processing (QQ120). Inclusion of articles from these fields would lead to added hits that would not be relevant for further analysis. Limitations for Scopus included also a limitation to English or Dutch articles and to documents in the form of articles or peer-reviewed articles, indicated by "AND DOCTYPE (ar OR re)" in the search strategy. No limitations were included for publication year.

Concept	Search strategy	Hits
CAB Abstract		
#1 Pear	Pear OR pyrus communis	42.112
#2 Attributes	AND (sensory qualit* OR sensory attribute OR sensory propert* OR sensory characteristic OR sensory evaluation OR quality attribute)	335
#3 Consumers	AND (consumer adj6 preference) OR (consumer adj6 acceptance) OR (consumer adj6 choice) OR (consumer adj6 segments)	18
#4 Other	NOT QQ110 NOT QQ120	18
Scopus		
#1 Pear	"Pear" OR "pyrus communis"	15.209
#2 Attributes	AND "sensory qualit*" OR "sensory attribute" OR "sensory propert*" OR "sensory characteristic" OR "sensory evaluation" OR "quality attribute"	331
#3 Consumers	AND "consumer" OR "perception" OR "preference" OR "segments" OR "consumer preference" OR "consumer acceptance" OR "consumer choice"	93
#4 Other	AND DOCTYPE (ar OR re)	71

Table 1 Search strategy

3.2 Inclusion criteria

Multiple inclusion criteria were established in order to reach a final selection of articles to include in this literature review. Firstly (i), the article should give information about pears and not just other kinds of fruit. A specific focus is on pears from the *Pyrus communis* family and therefore articles including other varieties were excluded. During the scanning of the titles and abstracts it became clear that multiple articles used the word 'pear' as an example of a fruit variety, while the actual research involved another type of fruit. Secondly (ii), articles that mostly covered instrumental measures or agricultural techniques were excluded. Except when these agricultural measures would be judged as relevant for Wageningen Plant Research, e.g. for physicochemical measures. Lastly (iii) selected articles included fresh pears in their research. Articles that used processed pears, pear extracts, syrups, dried pears or other forms of pears were excluded.

Further in the selection process when reading the full articles, some articles were excluded on the basis of content or because they were not retrievable. Exclusion based on content mostly happened due to a different focus of the research than was expected based on the title and abstract. Not retrievable articles were articles that could not be acquired via the WUR library and institutional access on other platforms, and that were not in the possession of anyone in the network of the researcher.

3.3 Selection process

Using a PRISMA diagram based on work of Fischer et al. a flow diagram was created of the selection process (Figure 4) (2011). This figure shows the number of articles selected or excluded in each step of the selection process.
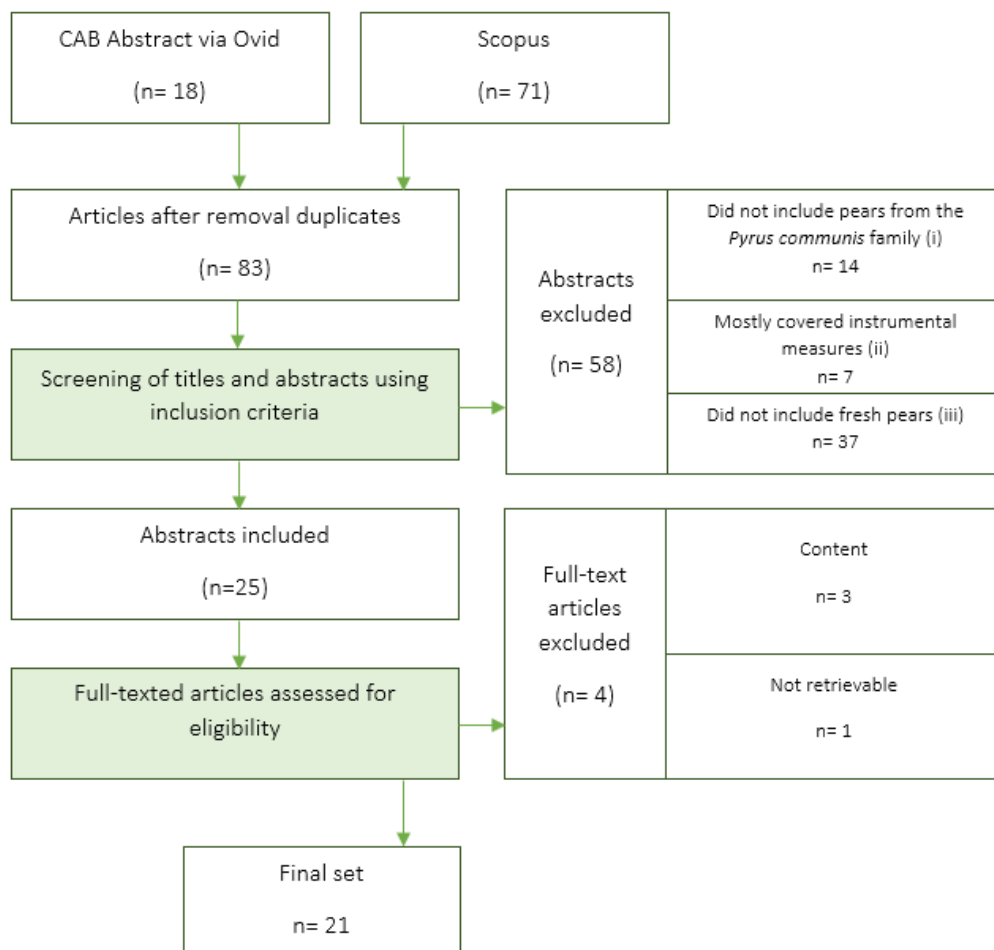

Figure 4 PRISMA Flow Diagram selection process

3.4 Methodology per research question

For a systematic approach to find the information needed to be able to answer the main research question (MRQ) and the sub-questions (SQ's) of this research, an overview was created of the needed information, concepts, and expected output per research question. The column 'needed information from the articles' includes what information is expected from the articles to answer a specific research question. The 'concepts' include the terms that could help identify the sections in the articles where information can be found to answer a research question. Using these concepts the results of the articles can be analysed, compared and categorized. The expected output per research question can differ, as can be seen in the 'output' column. Using the structure of the output per research question, information from the articles can be systematically collected and analysed.

Table 2 Needed information and output per research question

Needed information from the articles:	Concepts:	Output:
MRQ: *What attributes that consumers use for the evaluation of pears need to be considered for the development of new pear varieties at Wageningen Plant Research in Randwijk?*		
To answer this research question the results for the three sub-questions are combined and analysed.	n.a.	Recommendation for Plant Research Wageningen for the development and marketing of new pear varieties, including attributes and attribute importance, and the possible differences therein per consumer segment.
SQ 1: *What attributes drive consumer preferences for pears?*		
Attributes that are used in previous research to evaluate pears. Both the attributes that are used by panels or consumers to evaluate pears, as well as the attributes used to measure the physicochemical characteristics of pears.	Attributes, consumers/respondents, panels/ panellists/ experts, quality/ preferences attributes, physicochemical measurements.	Overview of attributes, using the categorization for quality attributes (search/experience/credence). Categories will also include the attributes and the measurements levels used in the literature, e.g. attribute = colour, level = green, yellow or red.
SQ 2: *What is the influence of these attributes on consumer preferences?*		
Information on the evaluation process, consumer preference and the importance of the attributes.	Measurements, research techniques, methodology, attribute importance, consumer preference/ evaluation, results/ analysis of attributes/ evaluation.	Overview of attributes, using the categorization the importance of attributes (salience, relevance, determinance).
SQ 3: *What attributes are used to identify consumer segments?*		
Information on the consumer segments that were included in the research. Differences in preferences per segment, or information on changes in taste preferences per segment.	Consumers, respondents, preferences, backgrounds, demographics, nationalities, age, socio-demographics, consumption of pear, preferences.	Information on possible differences in preference for pears per consumer segment. Information on possible distinctions that can be made to create segments.

4. Results and analysis

In this chapter the results and analysis of the systematic literature review is given. Firstly, the attributes that were used in the literature to measure physicochemical characteristics and, more importantly, consumer preference for pears is given. Secondly, the attribute importance is discussed. Lastly, consumer preference per segment is described.

4.1 Attributes

This section gives an overview of all attributes mentioned in the articles that were included into the systematic literature review. Many different varieties of the European pear were used by the researchers in their researches. This diversity in pear varieties make it impossible to directly compare the results with each other. Section 4.1.1 will provide further information on all the varieties included.

The attributes mentioned in the following parts are all intrinsic attributes, if not mentioned otherwise. As for objective and subjective measurements, the physicochemical attributes are seen as the objective measurements and the consumer or panellist evaluations as subjective measurements. Most literature used physicochemical measures simultaneous, or prior to, consumer or panellist evaluations. Attributes used for these physicochemical measurements were different than the attributes used for consumer or panellist evaluation or held different meanings. Section 4.1.2 gives an overview of all physicochemical measures used in the researches. Lastly, but the main topic of this research, many attributes were used to measure consumer and or panellists evaluations of pear. These attributes are described in section 4.1.3.

4.1.1 Pear varieties

The *Pyrus communis* family, consists of various varieties of pear cultivars. In the studied literature multiple varieties of European pears were used for research purposes. Table 3 gives an overview of the pears that were used in the literature that was studied in this literature review. Where some researchers focused on one specific variety, other researchers included a substantial numbers of pear varieties, for the specific pear varieties references are made to the concerning articles. For comparison with European pear varieties, some researches also included some varieties of Asian pears such as Hosui or Ya Li pears. The research of Steyn et al. (2010), also included two varieties that were still in de developmental phase and are referred to using codes.

Table 3 Pear varieties

Author(s)	Pear varieties
Abolhassani et al., 2013	Bartlett
Alihadzic et al., 2018	29 pear cultivars
Blanckenberg et al., 2016	Forelle, Packham's Triumph, Abate Fetel
Chauvin et al., 2010	Anjou, Bartlett, Bosc
Combris et al., 2009	Rocha
Cronje et al., 2015	Forelle
Crouch & Bergman, 2013	Forelle
Gallardo, 2011	Anjou
Gallardo et al., 2011	Anjou
Gamble et al., 2006	Several varieties with a focus on Maxie
Gittens et al., 2011	Bartlett and 25 genotypes
Harker et al., 2003	8 pear varieties (undefined)
Jaeger et al., 2003a	Buerre Bosc, Packham's Triumph, Doyenn du Comice, a hybrud and an Asian pear
Konopacka et al., 2014	Alfa, Radana, Conference, Hortensia, Dicolor, Uta, Concorde, Xenia, Verdi, Erika, Clapp's F.
Oliveira et al., 2015	Rocha
Prediere & Gatti, 2008	Abate Fetel
Salvador et al., 2006	Flor de Invierno
Steyn et al., 2010	Rosemarie, Cheeky, Packham's Triumph, Concord, 4A-88-18, 3D-44-3, Golden Russet Bosc, Hosui (Asian), Abate Fetel, Red d'Anjou, bon Chrétien.
Taiti et al., 2017	Hosui and Ya Li (both Asian) and Willims (EU)
Varela et al., 2006	Flor de Invierno
Zhang et al., 2010	Anjou

4.1.2 Physicochemical measures

Before letting participants evaluate the pear varieties, most researchers used physicochemical measurements to evaluate the objective quality of the pear, since such measurements reflect the measurable and verifiable nature of a pear and its related production processes and quality controls (Espejel et al., 2007). For the measurement of most attributes specific tools were used such as spectrometers, pressures, juice extractors, scales or digital refractometers. Table 4 gives an overview of the physicochemical attributes that were used in the literature. The attributes in the table are divided into appearance, texture, flavour, and 'other' attributes. Moreover, the attributes were allocated to one of three attribute categories (search, experience, or credence).

Starting with the appearance attributes, the **colour of the peel** was measured based on a colour scale using a hue spectrometer or with the levels yellow or green. More specifically, Crouch and Bergman (2013) used **'red skin colour'** of a pear as an attribute to evaluate the colour of the peel. The **shape** (form of the pear) was measured by looking at the shape/length relative to the maximum diameter and the position of the maximum diameter. **Weight** was used to measure the amount of kilograms of a single pear measured on a digital scale. And **diameter** was used as measurement of the width of the fruit using a digital calliper. The **size** was measured based on a scale from extremely small to very large using

exemplar varieties. All appearance attribute were seen as search attributes, since they can be evaluated prior to actual consumption.

Secondly the texture attributes, the **firmness** of the pear reflects the consistency or solidity of the flesh of a pear and can be measured using a fruit pressure tester. Similarly, the **hardness** of a pear reflects the massiveness or solidity of the texture of the flesh and can be measured using a fruit texture analyser. The **tensile properties** of a pear include the ability to be stretched and are related to tension. The **mealiness** of a pear describes the granular characteristics of the flesh of the pear. The **dry matter concentration** reflects the part of the flesh after removal of the water content (Blanckenberg et al., 2006). The **starch breakdown** is related to the starch content in the flesh of the pear. The **juiciness** reflects the percentage of juice when the fruit is squeezed and tasted (Cronje et al., 2015). For consumers, these attributes can only be tested when consuming the pear and therefore they are classified as experience attributes.

Thirdly the flavour attributes. The **titratable acidity** (TA) of the pear describes the degree of sourness/ acidity of a pear and can be measured using a juice extractor. The **brix** content of a pear is an reflection of the sugar content of the flesh. The **soluble solid** (TSS) content measures the sugar content using a digital refractometer and can be expressed as degree of brix (Blanckenberg et al., 2016). Similar to the texture attributes, these attributes are also classified as experience attributes since the sweetness or sourness is a feature of a pear that can only be experienced during consumption.

Lastly the 'other 'attributes, starting with **ethylene production rates** which reflect the production of a certain hormone in the plant with an effect on the ripening of a fruit. **Species** was used to describe whether the pear is from the *Pyrus communis, Pyrus hybrid,* or the *Pyrus pyrifolia* (Jaeger et al., 2003a). **Availability** was classified into cultivar or seedling (Jaeger et al., 2003a). **Pectin methylesterase** measured a certain enzyme related to the cell-wall and breakdown of the flesh. **Endo-polygalacturonase** is also a certain enzyme related to the cell-wall and works to soften en sweeten the fruit during the ripening process. The **microstructure** of the flesh is a very small scale structure of the pear and can be used for looking at various aspects. Unfortunately, none of these aspects were further described. All 'other' attributes were classified as credence attributes since they are hard to asses during consumption and consumers might lack information or simply need to trust which species it is for example.

Table 4 Physicochemical measures

	Attribute	Attribute levels	Search	Experience	Credence	Author(s)
				Attribute category		
Appearance	Colour (peel)	Yellow and green (Jaeger et al., 2003a)	X			Abolhassani et al., 2013, Crouch & Bergman, 2013, Jaeger et al., 2003a, Oliveira et al., 2015, Taiti et al., 2017
	Red skin colour		X			Crouch & Bergman, 2013
	Shape		X			Jaeger et al., 2003a, Taiti et al., 2017
	Weight		X			Jaeger et al., 2003a, Oliveira et al., 2015
	Diameter		X			Oliveira et al., 2015
	Size		X			Taiti et al., 2017
				Table continues on next page.		

	Attribute	Attribute level	Attribute category			Author(s)
			Search	Experience	Credence	
Texture	Firmness			X		Abolhassani et al., 2013, Cronje et al., 2015, Crouch & Bergman, 2013, Jaeger et al., 2003a, Gallardo et al., 2011, Konopacka et al., 2014, Oliveira et al., 2015, Prediere & Gatti, 2008, Steyn et al., 2010, Taiti et al., 2017
	Hardness			X		Chauvin et al., 2010, Cronje et al., 2015
	Tensile properties			X		Chauvin et al., 2010
	Mealiness			X		Blanckenberg et al., 2016., Cronje et al.., 2015
	Dry matter concentration (DMC)			X		Blanckenberg et al., 2016
	Starch breakdown			X		Crouch & Bergman, 2013
	Juiciness			X		Cronje et al., 2015
Flavour	Titratable acidity (TA)			X		Abolhassani et al., 2013, Blanckenberg et al., 2016, Cronje et al., 2015, Crouch & Bergman, 2013, Konopacka et al., 2014, Oliveira et al., 2015, Prediere & Gatti, 2008, Salvador et al., 2006, Steyn et al., 2010, Taiti et al., 2017, Varela et al., 2006
	Brix (Soluble solid, SS)			X		Jaeger et al., 2003a, Gallardo et al., 2011, Konopacka et al., 2014, Varela et al., 2006
	Total soluble solid (TSS) content			X		Abolhassani et al., 2013, Blanckenberg et al., 2016, Cronje et al., 2015, Crouch & Bergman, 2013, Oliveira et al., 2015, Prediere & Gatti, 2008, Steyn et al., 2010, Taiti et al., 2017
Other	Ethylene production rates				X	Cronje et al., 2015
	Species	Pyrus communis, Pyrus hybrid, or the Pyrus pyrifolia			X	Jaeger et al., 2003a
	Availability	Cultivar/ seedling			X	Jaeger et al., 2003a
	Pectin methyl-esterase				X	Varela et al., 2006
	Endo-polygalacturonase				X	Varela et al., 2006
	Microstructure				X	Varela et al., 2006

4.1.3 Attributes

Next to the attributes measured with physicochemical measures for the evaluation of the objective quality of a pear, multiple attributes were used to investigate consumers' evaluation of pear. These attributes are related to subjective quality judgements, since it will include perception or value judgements of consumers (Espejel et al., 2007). Multiple researchers used a combination of (expert) panels and consumer groups to research their evaluations of a pear. To create a comprehensive overview of the attributes used for the evaluation of pears, the attributes used for panels and consumers research were combined. To be able to still make a distinction between the attributes used for both groups, the 'P' indicates that the attribute is used for (expert) panels and the 'C' is used for consumer groups. Similar to the attributes in table 4, the attributes used for panel and consumer research are divided into appearance, texture, and flavour attributes. In some articles items were mentioned that might also be of influence in the evaluation process besides attributes. These items are bundled under overall evaluative judgements. Moreover, if mentioned in the literature, the attribute levels are described. Lastly, the attributes are allocated to one of the three attribute categories; search, experience or credence. The results in this section provide an answer to the first sub-question: *What attributes drive consumer preferences for pears?*

4.1.3.1 Appearance attributes

Visual appearance of a pear is a term that generally describes how a pear looks. Only Cronje et al. included peel colour as a level to this attribute others did not include any levels (2015). The **shape** of the pear was used to describe to form of the pear and was measured with the levels round-, elongate-concave-, or intermediate straight shape (Gamble et al., 2006). **Skin colour** was used to evaluate the colour of the peel, for which some researchers use an intensity scale, while another used the levels yellow and red. **Flesh colour** is an attribute used for the evaluation of the colour of the flesh, and was measured using an intensity scale. The **blush** reflects the intensity of deeper colours on the peel of the pear. Blush was measured using three attribute levels, namely none, slight, and full coverage (Gamble et al., 2006). The **scarring** of the pear describes the cuts into the peel and flesh of the pear and was measured on an intensity scale. **Bruising** referred to the dents or soft spots on the pear and was also measured using an intensity scale. **Internal browning** measured the coloration of the flesh of the pear to more brown colours and was measured on a preference scale. Except for flesh colour and internal browning, all appearance attribute were allocated the search attribute category, since they could be evaluated prior to consumption. Flesh colour and internal browning were allocated to the experience category, since these can be evaluated during the consumption phase.

Table 5 Appearance attributes

Attribute	Attribute levels	Attribute category			Author(s)
		Search	Experience	Credence	
Appearance (visual) (P+C)	Peel colour (Cronje et al. 2015)	X			Abolhassani et al., 2013, Taiti et al., 2017, Cronje et al., 2015, Crouch & Bergman, 2013, Steyn et al., 2010, Jaeger et al., 2003a
Shape (C)	Round, elongate-concave, and intermediate straight	X			Gamble et al., 2006
Skin colour (P+C)	Green, yellow and red (Gamble et al., 2006)	X			Abolhassani et al., 2013, Gamble et al., 2006, Oliveira et al., 2015
Flesh colour (P)			X		Abolhassani et al., 2013
Blush (C)	None, slight, full coverage	X			Gamble et al., 2006
Scarring (P)		X			Abolhassani et al., 2013
Bruising (P)		X			Abolhassani et al., 2013
Internal browning (C)			X		Cronje et al., 2015

4.1.3.2 Texture attributes

Texture is a general term that some researches did not further explain, while other gave levels to the attribute such as, among others, firmness or crunchiness (Gittens et al., 2011; Konopacka et al., 2014). **Flesh texture** is a more concrete term that describes the feeling of the flesh of the pear and was measured on an intensity scale. **Firmness** is also related to the flesh of the pear and its texture and how much force is needed to chew the sample, yet describes the consistency or solidity of the flesh. This attribute can be measured on an intensity scale, or with the levels firm, medium, or soft texture (Oliveira et al., 2015; Predieri & Gatti, 2008). Similar to firmness, **hardness** reflects the solidity of the flesh or the force needed to chew with your teeth and was measured on an intensity scale. **Skin toughness** describes the elasticity and or thickness of the skin. **Crispness** and **crunchiness** both refer to the noise of the pear when in the mouth of consumers (or panellists), yet crispness can better be ascribed to the noise made with the front teeth and crunchiness to the chewing with molars (Blanckenberg et al., 2016; Jaeger et al., 2003a). Some researchers saw crunchiness and crispiness as interchangeable terms or attributes. Both attributes can be measured on a intensity scale.

Then continuing with the attribute of **grittiness** which refers to the presence of tiny, hard particles in the flesh of a pear that are felt between the front teeth and was measured on an intensity scale (Blanckenberg et al., 2016). On the contrary, **graininess** refers to the soft particles in the flesh of a pear when broken down into a mass (Jaeger et al., 2003a). Graininess was also measured on an intensity scale. **Fibrouseness** is related to how much the texture of the pear feels like, or consists of, fibers. **Mealiness** is related to feeling of the flesh and how it breaks down into very fine, yet dry, particles. This attribute was measured on an intensity scale (Blanckenberg et al., 2016). The **melt character** refers to the feeling of the flesh melting in the mouth and was measured on an intensity scale (Blanckenberg et al., 2016). The **ease of breakdown** described the ease of which the flesh of the pear breaks down into sizes that can be swallowed (Jaeger et al., 2003a). **Fracturability** is related to the rupture of the flesh when being chewed in a fast rate (Chauvin et al., 2010).

Lastly, the description of the last three texture attributes. **Flesh moisture** is related to the juiciness of flesh of the pear and was measured on an intensity scale. **Juiciness** refers to the level of juice that comes out of the flesh of the pear when being chewed and was also measured on an intensity scale.

All texture attributes are seen as experience attributes since they can best be evaluated when tasting or experiencing a sample in the mouth.

Table 6 Texture attributes

Attribute	Attribute levels	Attribute category			Author(s)
		Search	Experience	Credence	
Texture (P+C)	Firmness, meltiness, coarseness, juiciness stone cells (Gittens et al., 2011). Crispness, hardness, crunchiness, flesh consistency, juiciness, stone cell sensation, overall texture quality (Konopacka et al., 2014).		X		Crouch & Bergman, 2013, Abolhassani et al., 2013, Gallardo, 2011, Gittens et al., 2011, Gallardo et al., 2011, Konopacka et al., 2014, Zhang et al., 2010
Flesh texture (P)			X		Abolhassani et al., 2013
Firmness (P+C)	Firm, medium, soft texture (Oliveira et al., 2015; Predieri & Gatti, 2008)		X		Abolhassani et al., 2013, Gallardo, 2011, Jaeger et al., 2003a, Gallardo et al., 2011, Oliveira et al., 2015, Prediere & Gatti, 2008, Taiti et al., 2017, Zhang et al., 2010
Hardness (P+C)			X		Blanckenberg et al., 2016, Chauvin et al., 2010, Cronje et al., 2015, Steyn et al., 2010
Skin toughness (P)			X		Jaeger et al., 2003a
Crispness (P+C)			X		Blanckenberg et al., 2016, Chauvin et al., 2010, Cronje et al., 2015, Crouch & Bergman, 2013, Jaeger et al., 2003a, Steyn et al., 2010
Crunchiness (P+C)			X		Blanckenberg et al., 2016, Jaeger et al., 2003a, Steyn et al., 2010, Taiti et al., 2017
Grittiness (P+C)			X		Blanckenberg et al., 2016, Cronje et al., 2015, Jaeger et al., 2003a, Steyn et al., 2010
Graininess (P)			X		Abolhassani et al., 2013, Jaeger et al., 2003a, Prediere & Gatti, 2008, Taiti et al., 2017
Fibrousness (P)			X		Taiti et al., 2017
Table continues on next page.					

Attribute	Attribute level	Attribute category			Author(s)
		Search	Experience	Credence	
Mealiness (P+C)			X		Blanckenberg et al., 2016, Cronje et al., 2015, Steyn et al., 2010
Melt character (P+C)			X		Blanckenberg et al., 2016, Cronje et al., 2015, Steyn et al., 2010
Ease of breakdown (P)			X		Jaeger et al., 2003a
Fracturability (P)			X		Chauvin et al., 2010
Flesh moisture (P)			X		Abolhassani et al., 2013
Juiciness (P+C)			X		Abolhassani et al., 2013, Blanckenberg et al., 2016, Chauvin et al., 2010, Cronje et al., 2015, Crouch & Bergman, 2013, Gallardo, 2011, Jaeger et al., 2003a, Gallardo et al., 2011, Prediere & Gatti, 2008, Steyn et al., 2010, Taiti et al., 2017, Zhang et al., 2010

4.1.3.3 Flavour attributes

Starting with the attribute of **flavour**, which entails a general description of the flavour of a pear. None of the researchers that used this attribute specified any levels, yet the attribute was measured on a preference or intensity scale. **Pear flavour** or **pear aroma** was used to measure whether or not the pear tasted as a pear. This attributes was measured on a 9-point hedonic scale and no further levels were given. The attribute **off flavour** describes the presence of negative or undesirable hints of flavour. This attribute was measured on an intensity scale. Similarly to off flavour, the attribute of **fermented flavour** was used to measure the intensity of aromatics and tastes of fermented fruit in the pear and was also measured on an intensity scale.

Then continuing to basic tastes or flavours in the mouth. **Sweetness** describes the basic taste of sweet on the tongue stimulated by sugar or high potency sweetener (Jaeger et al., 2003). **Sourness** was used to measure the basic taste on the tongue stimulated by acids (Jaeger et al., 2003). **Astringency** was used to describe the dry feeling in the mouth (Jaeger et al., 2003). **Acidity** represents the level of acidity in the fruit that can give the pear a sour taste. **Bitterness** is a basic taste on the tongue stimulated by substances such as quinine or certain alkaloids in the flesh of the pear (Jaeger et al., 2003). All these tastes were measured on intensity scales.

Moving to flavour attributes related to certain tones or hints of flavours. **Ripeness** was used for the evaluation of the ripening stage of the pear with the levels; unripe, ripe or overripe based on personal preference (Prediere & Gatti, 2008). **Ripeness** can also be described as days to wait until fully ripe (Gallardo, 2011). **Overripe pear** was used as an attribute to measure a pears sensory characteristics and describes whether the pear felt and/or tasted like being beyond the optimal ripening stage. This attribute was measured on a preference scale. **Green fruity flavour** was used to evaluate whether the pear had hints for fresh, sour, green fruits (Alihodzic et al., 2018). The attribute of **grassy green** was used to measure the smell of the pear and whether it smelled like unripe or green fruit, similar to fresh cut

grass and the likes (Jaeger et al., 2003a). Both attributes were measured on intensity scales. **Stemmy/woody** measures the taste and aromatics of the pear similar to the taste and smell of stalks or cores (Jaeger et al., 2003a). **Canned pear** was used to evaluate how the pear tasted and smelled similar to canned Bartlett pears (Jaeger et al., 2003a). The attribute of **apple** was used to evaluate whether the taste and aromatics of the pear were similar to those of apples (Jaeger et al., 2003a).

Lastly, the last few flavour attributes. **Typical flavour** was used to evaluate the intensity of how much the sample pear tasted like a typical pear and was measured on an intensity scale. **Blandness** refers to the lack of flavour or insipidness of the pear. **After taste** was used to measure the intensity of the taste that was left in the mouth after tasting and was measured on an intensity scale. **Aroma** is quite a general term for the (positive) smell that comes of the fruit that can be measured on an intensity scale. One researchers used the levels sour, pear, sweet, grass, and off aroma to measure the aroma (Konopacka et al., 2014). **Odour intensity** was used to measure the intensity of the smell or odour and can be measured on an intensity scale, although not specified, odour is often used to describe a negative or unpleasant smell. **Global intensity** was another attribute used to evaluate the smell. Gitten et al. used several levels to measure global intensity, such as; tropical fruit, herbaceous, citrus, floral, solvent, wet cardboard, and musty (2018). The attribute of **taste** was used as a general term for the taste of the pear, but also with levels such as; sweetness, acidity, astringency, bitterness, sweet, or pear flavour (Gittens et al., 2011; Konopacka et al., 2014). **Tasty** was used to measure whether or not the taste of the pear was experiences as pleasant. **Flavourful** was used to measure the degree of flavour of the pear. These last two attributes were both measured on an intensity scale.

All flavour attributes were categorized as experience attributes. All panellists or consumers had to actually experience (taste or smell) the pear for evaluation. Moreover, in a real situations these attributes are hard to asses prior to consumption.

Table 7 Flavour attributes

Attribute	Attribute levels	Attribute category			Author(s)
		Search	Experience	Credence	
Flavour (C+P)			X		Abolhassani et al., 2013, Crouch & Bergman, 2013, Taiti et al., 2017, Zhang et al., 2010
Pear flavour/ aroma (P+C)			X		Blanckenberg et al., 2016, Cronje et al., 2015, Gallardo et al., 2011, Prediere & Gatti, 2008, Steyn et al., 2010
Off flavour (P)			X		Abolhassani et al., 2013,
Fermented flavour (P+C)			X		Jaeger et al., 2003a
Sweetness (P+C)			X		Abolhassani et al., 2013, Alihodzic et al., 2018, Blanckenberg et al., 2016, Cronje et al., 2015, Crouch & Bergman, 2013, Gallardo, 2011, Jaeger et al., 2003a, Gallardo et al., 2011, Prediere & Gatti, 2008, Steyn et al., 2010, Taiti et al., 2017, Zhang et al., 2010
Table continues on the next page.					

Attribute	Attribute levels	Attribute category			Author(s)
		Search	Experienc	Credence	
Sourness (P+C)			X		Abolhassani et al., 2013, Alihodzic et al., 2018, Blanckenberg et al., 2016, Cronje et al., 2015, Crouch & Bergman, 2013, Jaeger et al., 2003a
Astringency (P+C)			X		Blanckenberg et al., 2016, Cronje et al., 2015, Jaeger et al., 2003a, Prediere & Gatti, 2008, Taiti et al., 2017
Acidity (P)			X		Prediere & Gatti, 2008, Taiti et al., 2017
Bitterness (P+C)			X		Blanckenberg et al., 2016, Cronje et al., 2015, Jaeger et al., 2003a
Ripeness (C)	Unripe, ripe or overripe (Prediere & Gatti, 2008)		X		Prediere & Gatti, 2008, Gallardo, 2011
Overripe pear (C)			X		Cronje et al., 2015
Green fruity flavour (P)			X		Alihodzic et al., 2018
Grassy green (odour) (P+C)					Jaeger et al., 2003a
Stemmy/ woody (P+C)			X		Jaeger et al., 2003a
Canned pear (P+C)			X		Jaeger et al., 2003a
Apple (P+C)			X		Jaeger et al., 2003a
Typical (flavour) (P)			X		Alihodzic et al., 2018
Blandness (P+C)			X		Cronje et al., 2015
After taste (P)			X		Abolhassani et al., 2013, Alihodzic et al., 2018
Aroma (P)	Sour, pear, sweet, grass, off aroma (Konopacka et al., 2014)		X		Abolhassani et al., 2013, Konopacka et al., 2014, Taiti et al., 2017
Odour intensity (P)			X		Alihodzic et al., 2018
Global intensity (P)	Tropical fruit, herbaceous, citrus, floral, solvent, alcohol, wet cardboard, musty		X		Gittens et al., 2011

Table continues on next page.

| Attribute | Attribute level | Attribute category | | | Author(s) |
		Search	Experienc	Credence	
Taste (P)	Sweetness, acidity, astringency, bitterness (Gittens et al., 2011) Sweet, sour, astringent, pear flavour (Konopacka et al., 2014)		X		Gittens et al., 2011, Konopacka et al., 2014, Salvador et al., 2006, Varela et al., 2006
Tasty			X		Jaeger et al., 2003a
Flavourful			X		Jaeger et al., 2003a

4.1.3.4 Overall evaluative judgements

With a similar structure of previous three sections, this last part will describe items concerning overall evaluative judgements of panellist and consumers. Th Although they are not attributes are seen as intrinsic to a pear, they were deemed important based on the discussed literature. Following items will mainly concern people's overall evaluative judgements.

Starting with **overall liking**, this item for liking is probably seen as descriptor of the overall liking for a pear. Unfortunately, none of the researches defined specific aspects of this attribute. This items can be measured on a five-point Likert scale. **Liking for eating quality** defines more closely the liking of the quality of the pear when being eaten. This items was measured on a preference scale. **Preference**, generally describes a preference in choice when choosing between one or more varieties of pear. **Preference for total eating experience** looks more specifically into the eating experience of one pear compared to another. Levels ascribed to this item are texture and flavour and this item can be measured on a preference scale (Blanckenberg et al., 2016). **Attitudes** generally include consumers' beliefs, feelings and behavioural intentions towards a pear. The research of Blanckenberg et al. asked consumer to choose one of the attributes used in their study to represent their liking best (2016). **Acceptance** was related to whether or not consumers deemed the pear acceptable for (hypothetical) purchase (Crouch & Bergman, 2013). **Overall quality** was used as an evaluative item for the balance and harmony of all attributes used to describe quality and possible interaction between them, unfortunately no levels were described (Konopacka, et al., 2014). The item of **ideal pear** was measured by Jaeger et al. (2003) using sentence completion exercise of how consumers would describe their ideal pear. Steyn et al. (2010) used the attributes that were included in their research for consumers to use to indicate which attribute would best describe their ideal pear. **Overall sensation** was a general term used to describe the general sense of stimuli of taste and smell of the pear.

Next to these items, also an extrinsic attribute/ item was mentioned. Price is an extrinsic attributes related to the amount of money asked for a certain amount of pears. Price was seen as belonging to the search category.

Accept for attitude, all other evaluative judgement attributes were allocated to the experience category since they can be determined during or directly after consumption. Attitude allocated to the credence category, because attitudes are hard to asses prior or during consumption and is sensitive to personal

experiences and external information. Moreover, an attitude is also partly based on inferences and beliefs and can change over time.

Table 8 Overall evaluative judgements

| Attribute | Attribute levels | Attribute category | | | Author(s) |
		Search	Experience	Credence	
Overall liking (C)			X		Abolhassani et al., 2013, Gallardo et al., 2011, Oliveira et al., 2015, Prediere & Gatti, 2008, Steyn et al., 2010
Liking for eating quality (C)			X		Blanckenberg et al., 2016
Preference (C)			X		Steyn et al., 2010
Preference for total eating experience (C)	Including texture and flavour		X		Blanckenberg et al., 2016
Attitude (C)				X	Blanckenberg et al., 2016
Acceptance (C)			X		Crouch & Bergman, 2013, Taiti et al., 2017
Overall quality (P)			X		Konopacka et al., 2014
Ideal pear (C)			X		Jaeger et al., 2003a, Steyn et al., 2010
Overall sensation (P)			X		Alihodzic et al., 2018
Price (C)		X			Gallardo, 2011

4.2 Attribute importance

This section of the results provides answers to the second sub-questions: *What is the influence of these attributes on consumer preferences?* As explained in the theoretical framework, there are many possible research methods to uncover product attributes that are important, yet not all measure the same dimension of attribute importance. There are three dimensions of attribute importance. Firstly, the salience dimension reflects the degree of ease with which attributes come to mind or are recognized when seeing a targeted product (Alba et al., 1991). For this dimension usually a free-elicitation method is used, which was used only a few times in the literature. Secondly, the relevance dimension reflects the individual variation in personal values and desires resulting in different attribute relevance (Alba et al., 1991). Usually for this dimension multiple attributes are evaluated on a scale. This was also a dimension commonly seen in the literature. Thirdly, the determinance dimension reflects the importance of an attribute in judgement and choice (Alba et al., 1991). Usually for this dimension attributes are compared and preference is indicated. Such research methods were sometimes used in the studied literature.

During the literature review, research methods for evaluation of the pears using the attributes were categorized into these dimensions of attribute importance. Following tables, tables 9 to 12, give an overview of the attributes and the attribute importance dimension per research. Similar to previous section, this section starts with the appearance attributes (table 9), followed by the experience

attributes (table 10) and then the flavour attributes (table 11). Lastly, there is a table with overall attributes (table 12). The attributes are divided over several tables to improve the readability. The attributes discussed here are the same as the attributes in section 4.1.3 and have the same meaning.

Table 9 Importance of appearance attributes

Attribute	Attribute category		
	Salience	Relevance	Determinance
Appearance (visual) (C+P)		Abolhassani et al., 2013, Taiti et al., 2017, Salvador et al., 2006, Crouch & Bergman, 2013, Steyn et al., 2010	Jaeger et al., 2003a
Shape (C)			Gamble et al., 2006
Skin colour (P+C)		Abolhassani et al., 2013	Gamble et al., 2006
Flesh colour (P)		Abolhassani et al., 2013	
Blush (C)			Gamble et al., 2006
Scarring (P)		Abolhassani et al., 2013	
Bruising (P)		Abolhassani et al., 2013	
Internal browning (C)		Cronje et al., 2015	

Table 10 Importance of experience attributes

Attribute	Attribute category		
	Salience	Relevance	Determinance
Texture (P+C)		Abolhassani et al., 2013, Gittens et al., 2011, Konopacka et al., 2014, Zhang et al., 2010, Crouch & Bergman, 2013	Gallardo, 2011, Gallardo et al., 2011
Flesh texture (P)		Abolhassani et al., 2013	
Firmness (P+C)		Abolhassani et al., 2013, Jaeger et al., 2003a, Oliveira et al., 2015, Prediere & Gatti, 2008, Taiti et al., 2017, Zhang et al., 2010	Gallardo, 2011, Gallardo et al., 2011
Hardness (P+C)		Blanckenberg et al., 2016, Chauvin et al., 2010, Cronje et al., 2015, Steyn et al., 2010	Steyn et al., 2010
Skin toughness (P)		Jaeger et al., 2003a	
Crispness (P+C)		Blanckenberg et al., 2016, Chauvin et al., 2010, Crouch & Bergman, 2013, Jaeger et al., 2003a, Steyn et al., 2010	Crouch & Bergman, 2013, Steyn et al., 2010
Crunchiness (P+C)		Blanckenberg et al., 2016, Jaeger et al., 2003a, Steyn et al., 2010, Taiti et al., 2017	Steyn et al., 2010
Grittiness (P+C)		Blanckenberg et al., 2016, Cronje et al., 2015, Jaeger et al., 2003a, Steyn et al., 2010	Steyn et al., 2010
Graininess (P)		Abolhassani et al., 2013, Jaeger et al., 2003a, Prediere & Gatti, 2008, Taiti et al., 2017	
Fibrousness (P)		Taiti et al., 2017	
Mealiness (P+C)		Blanckenberg et al., 2016, Cronje et al., 2015, Steyn et al., 2010	Steyn et al., 2010
Melt character (P+C)		Blanckenberg et al., 2016, Cronje et al., 2015, Steyn et al., 2010	Steyn et al., 2010
Ease of breakdown (P)		Jaeger et al., 2003a	
Fracturability (P)		Chauvin et al., 2010	
Flesh moisture (P)		Abolhassani et al., 2013	
Juiciness (P+C)		Abolhassani et al., 2013, Blanckenberg et al., 2016, Chauvin et al., 2010, Cronje et al., 2015, Crouch & Bergman, 2013, Prediere & Gatti, 2008, Steyn et al., 2010, Taiti et al., 2017, Zhang et al., 2010	Crouch & Bergman, 2013, Gallardo, 2011, Gallardo et al., 2011, Steyn et al., 2010

Table 11 Importance of flavour attributes

Attribute	Attribute category		
	Salience	Relevance	Determinance
Flavour (C+P)		Abolhassani et al., 2013, Taiti et al., 2017, Zhang et al., 2010, Crouch & Bergman, 2013	Gallardo et al., 2011
Pear flavour / aroma(P+C)		Abolhassani et al., 2013, Blanckenberg et al., 2016, Cronje et al., 2015, Jaeger et al., 2003a, Prediere & Gatti, 2008, Steyn et al., 2010	Steyn et al., 2010
Off flavour (P)		Abolhassani et al., 2013,	
Fermented flavour (P+C)		Jaeger et al., 2003a	
Sweetness (P+C)		Abolhassani et al., 2013, Alihodzic et al., 2018, Blanckenberg et al., 2016, Cronje et al., 2015, Crouch & Bergman, 2013, Jaeger et al., 2003a, Prediere & Gatti, 2008, Steyn et al., 2010, Taiti et al., 2017, Zhang et al., 2010	Crouch & Bergman, 2013, Gallardo et al., 2011, Steyn et al., 2010
Sourness (P+C)		Abolhassani et al., 2013, Alihodzic et al., 2018, Blanckenberg et al., 2016, Cronje et al., 2015, Crouch & Bergman, 2013, Jaeger et al., 2003a	Crouch & Bergman, 2013
Astringency (P+C)		Blanckenberg et al., 2016, Cronje et al., 2015, Jaeger et al., 2003a, Prediere & Gatti, 2008, Taiti et al., 2017	
Acidity (P)		Prediere & Gatti, 2008, Taiti et al., 2017	
Bitterness (P+C)		Blanckenberg et al., 2016, Cronje et al., 2015, Jaeger et al., 2003a	
Ripeness (C)		Prediere & Gatti, 2008	Gallardo, 2011
Overripe pears (C)		Cronje et al., 2015	
Green fruity flavour (P)		Alihodzic et al., 2018	
Grassy green (odour) (P+C)		Jaeger et al., 2003a	
Stemmy/ woody (P+C)		Jaeger et al., 2003a	
Canned pear (P+C)		Jaeger et al., 2003a	
Apple (P+C)		Jaeger et al., 2003a	
Typical (flavour) (P)		Alihodzic et al., 2018	
Blandness (P+C)		Cronje et al., 2015	
After taste (P)		Abolhassani et al., 2013, Alihodzic et al., 2018	
Aroma (P)		Abolhassani et al., 2013, Konopacka et al., 2014, Taiti et al., 2017	
Odour intensity (P)		Alihodzic et al., 2018	
Global intensity (P)		Gittens et al., 2011	

Table continues on next page			
	Attribute category		
Attribute	**Salience**	**Relevance**	**Determinance**
Taste (P)		Gittens et al., 2011, Konopacka et al., 2014, Salvador et al., 2006	
Tasty		Jaeger et al., 2003a	
Flavourful		Jaeger et al., 2003a	

Table 12 Importance of overall evaluative judgements

	Attribute category		
Attribute	**Salience**	**Relevance**	**Determinance**
Overall liking (C)		Abolhassani et al., 2013, Cronje et al., 2015, Oliveira et al., 2015, Prediere & Gatti, 2008, Steyn et al., 2010	Cronje et al., 2015, Gallardo et al., 2011
Liking for eating quality (C)		Blanckenberg et al., 2016	
Preference (C)		Steyn et al., 2010	
Preference for total eating experience (C)			Blanckenberg et al., 2016, Cronje et al., 2015
Attitude (C)			Blanckenberg et al., 2016
Acceptance (C)		Crouch & Bergman, 2013, Taiti et al., 2017	
Overall quality (P)		Konopacka et al., 2014	
Ideal pear (C)	Jaeger et al., 2003a		Steyn et al., 2010
Overall sensation (P)		Alihodzic et al., 2018	
Price (C)			Gallardo, 2011

4.3 Consumer segments

This last section of the results helps to answer the last sub-question: *What attributes are used to identify consumer segments?* Results of this literature review showed sometimes similar and sometimes different results for consumer preference or evaluation of pear. Although not statistically measured, an attempt was made to order some of the attributes as most important for consumer evaluation of pear. Table 13 gives an overview of the most mentioned or significant attributes for consumer evaluation of pear. It must be noted that different researches showed different results and the overview in table 13 is based on a combination of the attributes discussed in the literature, but was not significantly proven as this was not the purpose of the research.

Most of the information on consumers described in the articles were related to behavioural variables. These are variables that can be used to distinguish consumer groups based on certain behaviour they show, e.g. eating soft or hard pears. On the other hand, not many descriptive variables were mentioned, except for nationality and having kids under the age of 18. In some researches participants were asked to give their age, or other descriptive variables, but no significant effects were found.

1	Taste (flavour)	8	Size (appearance)
2	Texture (texture)	9	Crispness (texture)
3	Firmness (texture)	10	Colour and blush (appearance)
4	Juiciness (texture)	11	Pear flavour (flavour)
5	Sweetness (flavour)	12	Mealiness (texture)
6	Appearance (appearance)	13	Sourness (flavour)
7	Shape (appearance)	14	Astringency (flavour)

For consumers, the **appearance** of a pear is a determining factor in choice (Gamble et al., 2006). In their research, consumers generally preferred green and yellow colours with intermediate-straight or elongated-concave shapes (Gamble et al., 2006). Research by Cronje et al. found that their African consumers slightly preferred pears with a light blush, yet no significant difference in appearance was found (2015). That consumer preference can differ was also found in research of Jaeger et al. where the appearance evaluation was expressed as "a complex segmentation pattern among consumers" (2003). In their research they found that some consumers preferred big and elongated/ pyriform shape, others preferred a round shape and warm golden colours, and again others rejected dark green and brown colours (Jaeger et al., 2003a). According to research of Steyn et al. an ideal pear should be pear shaped and be yellow or green and/or with a bright red or pink blush (2010). In a sentence completion exercise "ideal" colours for pears included green, yellow and golden brown (Jaeger et al., 2003a).

When it comes to size of a pear, a similar exercise showed a preference for medium to large pears, yet results also showed that shape rather than size was of importance in the evaluation of appearance (Jaeger et al., 2003a). Their data also indicated that appearance of a pear is a critical aspect of acceptance, with 36% respondents mentioning this attribute which is just below juicy (43%) and sweet (38%) (Jaeger et al., 2003a).

Chauvin et al. found that **texture attributes** provide consumers with an indication of maturity and acceptability (2010). There is some discussion on whether consumers prefer softer or harder pears, yet research from Blanckenberg et al. found a ratio between consumers preferring softer to harder pears of 2:1 (2016). Participants in their study were a mix of black, coloured and white consumers from a city in South Africa and they generally preferred a softer European pear. In another study it was found that German consumers (in contrary to UK consumers) preferred a firmer to a softer pear (Crouch & Bergman, 2013). Moreover, fruit firmness of a pear was considered a predictor for consumer appreciation, more than the other attributes included in the research (Konopacka et al., 2014). Texture attributes were also found to be determining in consumer appreciation for pears, with as main determinants for texture; firmness and juiciness (Prediere & Gatti, 2008).

Moreover, they mentioned that consumers are more sensitive to subtle differences in texture than flavour and therefore tend to use texture as factor for acceptability (Prediere & Gatti, 2008). Similarly, Steyn et al. Found that good texture and strong flavour of a pear was of greater importance than the attributes juiciness and sweetness.

Using willingness-to-pay estimations, Gallardo et al. found that consumers were willing to pay more for firmer pears (Anjou pears) (2011). Also Zhang et al. found firmness to have the largest effect on consumers' willingness-to-pay, even more so than sweetness and juiciness, which were also significant

factors (2010). Moreover, in the article of Harker et al. they found that firmness was of greater importance to consumers than crispness (2003).

When looking into **flavour attributes** that were preferred by consumers, research of Cronje et al. found that consumers prefer pears that are high in sweetness, juiciness and pear flavour (2015). While mealiness, blandness, astringency, and bitterness were attributes that were undesired (Cronje et al., 2015). Influencing acceptance, flavour attributes such as tasty, flavourful and not overripe had a positive impact, while odours such as fermented, bitter, stemmy/woody and artificial pear (off flavours) had a negative impact on acceptance (Jaeger et al., 2003a). Konopacka et al. Identified the flavour attributes sweetness, juiciness, and buttery flesh consistency as indicators of consumer appreciation of pear (2014).

Although the **physicochemical measures** were not mentioned often in the results, Prediere & Gatti mentioned no significant influence of sugar concentration or TSS on consumer evaluation (2008). On the other hand, Taiti et al. mentioned that consumer preferences could also be influence by higher sugar content in pears (2017). Also, Varela et al. mentioned that the acceptability of pears could be influenced by acid/sugar ratios of the pear (2006). More technical, they found that textural changed were possibly related to loss of cell wall integrity observed at microscopic level as a result of the activation of the PME and PG enzymes during ripening at 20°C (Varela et al., 2006).

Based on the articles it was hard to **identify possible consumer segments** based on attributes. In some articles demographics of the participants were given, yet not many findings were linked to these demographics. In their research Zhang et al. did link results to participants' demographic, with only 'having children under age 18' showing significant results (2010). In their research they found that participants with children under the age of 18 had a higher willingness to pay (Zhang et al., 2010). Moreover, the attributes of firmness, sweetness and juiciness were significant factors in explaining this willingness to pay (Zhang et al., 2010).

In their research Crouch & Bergman mentioned that firmness could possibly be an attribute that could be used to target certain consumer segments (2013). They mentioned the possibility of using in-store communication that uses the term "best enjoyed firm" to target the right consumer segment. Oliveira et al. found it could be interesting to further investigate the degree of ripeness as attribute for segmentation (2015). In their research they found that about half of their consumers preferred more green and crunchy pears, while another half preferred more mature and softer pears (Oliveira et al., 2015).

Jaeger et al. tried to find relations between attributes, such as a consumers with a preference for 'X' also have a preference for 'Y', yet these results were not significant (2003a). In their research they were able to allocate a consumer group that preferred a round shape with warm golden colours and a consumer group that preferred big and elongated/pyriform shaped pears, which indicates a combination of the appearance attributes shape and colour, and size and shape (Jaeger et al., 2003a). This was not further analysed in the research.

5. Discussion

5.1 Conclusion

The main question of this research was as follows: *What attributes that consumers use for the evaluation of pears need to be considered for the development of new pear varieties at Wageningen Plant Research in Randwijk?*

With the following sub-questions:

Sub-question 1: *What attributes drive consumer preferences for pears?*

Sub-question 2: *What is the influence of these attributes on consumer preferences?*

Sub-question 3: *What attributes are used to identify market segments?*

The results in previous chapter have helped answer the sub-questions by listing the attributes that were used in studies to measure consumer evaluation of pears, describing their importance dimensions and explaining whether in current literature consumer segments were identified based on the attributes or combinations of attributes. These results help to answer the main research question.

For the development of new pear varieties at Wageningen Plant Research the attributes shown in table 13 should be seen as most importance to consider. For more attributes, all attributes mentioned in the results could be used. In the discussed literature these were mentioned most or it was indicated that the results of these attributes had the most impact on consumer choice or evaluation. Therefore it seems that these attributes are most important to consider for the development on new varieties.

It is also interesting to not only consider these attributes individually, but also in relation to each other especially if a new variety is developed for a specific consumer segment. For example, the combination of the attributes soft and juicy could be interesting to consider together. Maybe even as opposed to hard and sweet for example. It can be imagined that these two examples could speak to different consumer groups. A soft and juicy pear might be preferred by older people, while younger people might prefer a harder and sweeter pear.

5.2 Academic relevance and recommendations for future research

The purpose of this research was to develop an overview of attributes for pears and their importance in the evaluation process of consumers. This was done based on 21 relevant articles in current literature. An overview was created with distinctions between physicochemical measures and appearance, texture and flavour attributes. Based on the articles about 80 attributes were discussed along with their importance dimensions to consumers. This research can be used for future research into consumer preference for pears. This overview provides researchers with a quick list of possible attributes that can be considered and their possible attributes levels. For such future research several recommendations for are given, especially for future research at Wageningen Plant Research.

Firstly, it is recommended to perform a follow-up research that tries to find attributes that make it possible to identify consumer or market segments. In current literature some attempts were made, but there is still room for further research. It would be especially interesting to see differences between age groups or whether preferences change over a life-span. Another interesting aspect would be to further investigate differences in the pear-shopper and the pear-end consumer. As one researcher found a significant effect for people with children under the age of 18, it might be interesting to also look in to why parents prefer to buy certain pears over other types of pears for their children. Moreover, it is also interesting to further investigate if the consumptions of the parent matches the preferences of the child.

Secondly, it is recommended to investigate the possible relationships between attributes and their effect on consumer preference. This can be used to develop new pear varieties based on unique combinations of attributes that could be considered the "ideal pear" for a specific consumer segment. As it turned out in the research, consumer preference for pears is divers and therefore it might be impossible to develop just one "ideal pear" for every consumer. Therefore it seems best to find a combination of specific attributes to develop an "ideal pear" for a specific consumer segment. An example can be a pear for young consumers that is bright green, fruity fragranced, with a hard and crunchy texture and a highly sweet flavour. For an older consumer segment an ideal combination of attributes might be elongated shape, thin peel, melt character and a soft texture that is very juicy.

Thirdly, it is recommended to look beyond the beaten path as it comes to attributes and attributes levels when wanting to develop an innovative new pear variety. Sticking to the levels related to existing pear varieties, innovation of new pear varieties may be limited. In the article of Gamble et al. it was mentioned that consumers respond to familiar attributes of pears, yet there is a danger in focussing on the familiar shapes and colours only (2006). Therefore it is recommended that if the goal of Wageningen Plant Research is to develop an innovative new variety of pear, attributes and attribute levele can also be expanded based on consumer trends or attributes of other fruit varieties.

Lastly, it is recommended that future research looks into the attribute importance dimensions of attributes used for consumer evaluation. In this research most attributes were measured on the relevance importance dimension. Although this can be informative, the importance dimensions of determinance and salience can should not be forgotten. For finding attributes that describe the way consumers look at pears using free-elicitation exercises (salience dimension) can be very useful. This gives an insight into consumers minds without the prejudice of existing attributes for evaluation. Also when there is some idea of what attributes are used by consumers, yet not about which ones are most important, an exercise in ordering or ranking attributes into most and least important (determinance dimensions), can give valuable information. Especially when this is done by a specific consumer group.

5.3 Limitations

This research, as with most researches, is subject to some limitations. Firstly, in the selection process of the literature, certain rejection and acceptance rules were used. The articles selected for this research had to cover research on pears from the *Pyrus communis* family, had to include consumer evaluation and not just instrumental measures, and had to included fresh pears in the tastings. Although this helped narrow down and specify this research, it also limited the amount of articles that could be used in this study. Especially when the goal is to develop a new and innovative pear variety, using inspiration from pears outside the *Pyrus communis* family might be helpful. Why are for example Hosui or Ya Li pears preferred by Asian consumer segments? And could this also be true for European, or more specifically certain Dutch, consumer segments?

Secondly, this research did not find many results on what attributes can be used for the segmentation of certain consumer segments. In hindsight, finding more information on consumer segments requires a different type of research, methodology and data that were beyond the scope of this research. For finding more information on consumer segments for pear consumption, a choice can be made for a-priori or post-hoc segmentation. When there is a segment of consumers in mind (e.g. kids under the age of 18), collecting attitudinal data for this specific segment can be useful. Based on this data using statistical analysis, more information can be gathered on a specific consumer segments and their pear consumption preferences (a priori). Another way to gather more information and to identify possible consumer segments is the collection of comprehensive data from a large population. Based on this data and statistical clustering techniques certain consumer segments can be identified based on shared preferences (post-hoc).

Although this research was not able to provide much information on consumer segments, it did provide further researches with an overview of attributes that can be used to measure consumer evaluation of pear. Moreover, this data was organized in such a way distinctions can be made for physicochemical measures, appearance, texture and flavour attributes. It also provides more information on the level of attributes importance of the attributes used for consumer evaluation. Therefore, this research can be very helpful for various future researches into consumer evaluation of pear and the development of new pear varieties.

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Appendices

I. Articles included for systematic literature review

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