MASTER THESIS

From waste to premium:

Consumers perception of value-added surplus products and their willingness to pay

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Acknowledgement

At this point, I would like to thank all those who contributed with their professional and personal support to the process of my master thesis.

First of all, I would like to thank my supervisors Dr. Devrim Yazan and Dr. Luca Fraccascia for supporting and guiding me throughout the whole process of writing this thesis during these unusual times of Covid-19. I especially appreciate their openness to realize a thesis for validating important parts of a business idea I proposed to them. This greatly underlines the entrepreneurial spirit of the University of Twente and its employees and students.

Furthermore, a big ‘Thank you’ goes out to my parents Joachim und Katrin for enabling me to graduate from a University and widely broaden the opportunities of my future life.

Finally, I want to thank all my friends for being so amazing and helping me to succeed, and from time to time also to escape from, my studies.

With this work I will finish my time as a student, in which I visited 4 Universities in 4 different cities in 3 countries. I am greatly thankful for this time and can just hope my professional life will be as awesome as my student life.

Jannes Köpcke
Berlin, November 2020

Abstract

Aim: Food waste has a critical impact on the environmental, economic, and social sustainability of the planet. Novel approaches are necessary to reduce the amount of food waste and increase the utilization rate of food in the food supply chain. This study examined how consumers perceive and assess value-added surplus products (VASP). VASP are a novel kind of food which can help to reduce the amount of food waste by making use of surplus or underutilized food which was formerly wasted.

Method: An online survey in Germany with 201 participants was carried out to examine the willingness to pay for VASP, and the factors influencing it. Furthermore, a two-step cluster analysis was conducted to identify promising consumer segments.

Results: The results showed that 78,5% of the participants were open to paying at least the same amount of money for VASP products as they would pay for comparable conventional products. Overall, consumers were willing to pay an additional price premium of 10%. Five customer segments were identified, and similarities to customers of organic and sustainable food were found.

Conclusion: The results indicate a promising market potential together with economic feasibility for the production of VASP for food supply chain actors. Furthermore, it was shown that VASP is not perceived as lower in quality and price discounts are not necessary. This study contributes to the theoretical understanding of the market for VASP and provides indications for future marketing and policy positioning strategies.

Keywords: Food waste, value-added surplus product, circular economy, willingness to pay

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1 Introduction

1.1 VASP – a potential solution to decrease food waste

In light of the need for sustainable development, the effects of food waste are gaining increased attention. The Food and Agricultural Organization (FAO) of the United Nations states that the percentage of food wasted corresponds to around 30% of global food production (Gustavsson, Cederberg, Sonesson, Van Otterdijk, & Meybeck, 2011). The impact of food waste on the planet, people and profits, also called triple bottom line (Elkington & Rowlands, 1999), thereby is immense and several negative externalities are known to be associated with it. To begin with, an increase in the level of greenhouse gases caused by the production and decomposition of wasted food (Bhatt et al., 2018), is leading to a catastrophic effect on climate change (Melikoglu, Lin, & Webb, 2013). Natural resources are increasingly strained, and planetary systems such as biodiversity, biochemical flows of phosphorus or nitrogen and land-use change are already overused or in the risk of it (Steffen et al., 2015). Next, impacting global food security, the amount of global food waste is more than enough to feed all the hungry people in the world (Melikoglu et al., 2013). Lastly, the economic cost of wasted food has been estimated to be US$ 680 billion in industrialized countries and US$ 310 billion in developing countries (FAO, 2019).

The causes of food waste are multifaceted, and only a small part of it is inevitable (Bhatt et al., 2018), while many causes are preventable. For example retailers' cosmetic standards for produce due to buyers' stringent aesthetic requirements, which induce farmers to dispose 'abnormal', 'ugly' or 'substandard' fruit and vegetables (Aschemann-Witzel, Jensen, Jensen, & Kulikovskaja, 2017) or intentional overproduction to deal with short-term demand fluctuations (Devin & Richards, 2018). Furthermore, overstocked buffets in foodservice establishments for signalling abundance, and confusing regulations of legalities, for i.e. donating foods or on food expiry labels (Bhatt et al., 2018), are evitable causes which need to be solved.

In order to overcome these causes and meet the United Nations Sustainable Development Goals, which calls for halving "per capita global food waste at the retail and consumer levels" and reducing "food losses along production and supply chains, including post-harvest losses" by 2030 (Desa, 2016), multi-faceted changes in the agricultural and food sector are of particular relevance (Aschemann-Witzel & Peschel, 2019; Laureti & Benedetti, 2018). More resource-efficient, local,

and even circular approaches to agricultural production and food consumption are necessary (Aschemann-Witzel & Peschel, 2019).

Thereby, tackling the causes of food waste can offer great potential for environmental, economic, and social benefits. Current approaches, which involve composting or donating food, only represents cost-neutral or cost-carrying efforts (Bhatt et al., 2018). Instead, a holistic approach, in both social and scientific realms, that incorporates waste reduction and valorisation strategies (Morone, Koutinas, Gathergood, Arshadi, & Matharu, 2019) could be applied. The development of market-driven solutions represents an economically sustainable way (Van Loo, Hoefkens, & Verbeke, 2017) to feed people, create opportunities for employment and entrepreneurship, and lower environmental impact (Laufenberg, Kunz, & Nystroem, 2003).

A promising way to this holistic approach lies in the application of the concept of the circular economy (Ingrao, Faccilongo, Di Gioia, & Messineo, 2018; Pagotto & Halog, 2016; Secondi, Principato, Ruini, & Guidi, 2019). In general terms, a circular economy describes an economic system based on business models, which promotes the resource minimization through the combination of reducing, reusing, recycling, and recovering activities within the production, distribution, and consumption. Thereby the 'end-of-life' concept, where products are irreversibly disposed after usage, is replaced to turn the linear system into a circular system (Kirchherr, Reike, & Hekkert, 2017; Martin & Schouten, 2011; Woźniak & Pactwa, 2018), leading to a reduced generation of waste.

One emerging novel solution to food waste at the processing level, illustrating the circular economy principles in the food industry is called 'value-adding'. This approach involves reinserting by-products from production streams that are safe and healthy for consumption, like fruits and vegetable residues, and turning them into high-value products (Lin et al., 2013). These novel food products are called waste-to-value (WTV) products (Aschemann-Witzel & Peschel, 2019) or value-added surplus products (VASP).

VASP comes with various benefits as it allows to capture more value in the supply chain (McCarthy, Kapetanaki, & Wang, 2019) while generating additional profits, reducing disposal costs (Lin et al., 2013) and increasing conservation of scarce resources such as energy, water, labour, land and agrochemicals (CSIRO, 2017).

Recent studies are indicating a market potential by confirming that consumers are willing to buy VASP (Aschemann-Witzel & Peschel, 2019; Coderoni & Perito, 2020; McCarthy et al., 2019; McCarthy, Kapetanaki, & Wang, 2020). VASP seems to be a plausible solution to apply the circular economy concept in the production and supply chain of the food sector. Nonetheless, there are still barriers along the supply chain, which hamper the development of these products.

On the farmers and producers side, barriers in the form of added expenses and lack of time, knowledge, and markets, to produce VASP are identified (Duarte Alonso & Northcote, 2013) as these products are deviations from mainstream operations and thus do not fit the standardization process (de Hooge, van Dulm, & van Trijp, 2018). On the retailer side, it is argued, that consumers might perceive VASP as suboptimal food due to its association with food waste (McCarthy et al., 2020). Therefore, consumers need price discounts as for buying suboptimal products (Verghese, Lewis, Lockrey, & Williams, 2013) and lower prices compared to conventional products are recommended, which leads to an avoidance of selling it (de Hooge et al., 2018). These findings imply that the production and marketing of VASP may not appear economically rational and does not reflect a sustainable solution for supply chain actors (de Hooge et al., 2018).

However, there are also reasons to assume that VASP may be generally perceived as similar or even higher valued food than conventional food. A recent study by Bhatt et al. (2018) confirmed the assumption that VASP are perceived as pro-environmental products since their main goal is the reduction of food waste. Studies have shown that consumers are becoming more aware of the impact of food production and consumption on emissions (Gadema & Oglethorpe, 2011). By consuming "environmentally-friendly" or "green" products, individuals can transfer their environmental concerns into corresponding actions (Moser, 2016), leading to an increasing desire for brands that 'go green' (Yazdanifard & Mercy, 2011) and a willingness to pay premium prices (Bernard & Bernard, 2009; Marette, Messéan, & Millet, 2012). Furthermore, similar to organic food, VASP is associated with higher 'self and other benefits' than conventional food (Bhatt et al., 2018). This gives another reason to assume that it might be able to fetch a price premium like those afforded to organic foods (Laroche, Bergeron, & Barbaro-Forleo, 2001).

Against this background, it can be seen that consumers perception and evaluation of VASP is still under-explored in the academic literature, even though it is of crucial relevance. As policy and marketing challenges have been identified around the development and acceptance of novel foods (Veeman, 2002), further research in this area of VASP is necessary.

Given the current theoretical findings, it seems indispensable that the commercialization of VASP will only be possible when consumers are ready to pay a premium price. A willingness of consumers to pay premium prices for VASP could fulfil the supply chain actor's economical motivation to maximize value and financially reward them sufficiently for the production and marketing of it. If VASP can be positioned as premium food products, it could act as an incentive for supply chain actors to apply the circular economy approach and ultimately reduce food waste.

Therefore, the study aims to examine the plausibility of positioning value-added surplus products as a premium product with a price premium on the German market by identifying consumers perception and their willingness-to-pay for VASP food, as well as the factors influencing it. The central research question of this study is thus, as followed:

"To what extent are consumers willing to pay a higher price for a value-added surplus product (VASP) compared to a similar product produced conventionally?"

For answering this question, the willingness-to-pay (WTP) of consumers for VASP will be examined. More precisely, it will be examined if consumers value VASP lower than conventional products because of perceived lower quality ingredients, or higher because of the associated benefits that come with pro-environmental products.

1.2 Theoretical and practical contributions

The results of this study will contribute to the theoretical and the practical understanding of VASP in several ways:

1. Putting novel products on the market and waiting for consumer reactions is a costly and not very efficient method of introducing new products, especially regarding the high failure rates of new products in the food sector (Michaud & Llerena, 2011). Consumers' acceptance can support or hamper circular economy practices thanks to their final purchasing decisions (Coderoni & Perito, 2020). Thus, the evaluation of consumers' willingness to pay becomes crucial to appraise the eventual market success of such novel foods.
2. Several studies have already examined consumers acceptance or willingness to buy of VASP food. However, literature of VASP food lacks information regarding consumers'

willingness to pay. Thereby, the open question by Bhatt et al. (2018) if retailers can fetch a price premium like those afforded to organic foods for VASP food can be answered.

3. Latest research about the willingness to buy of VASP food suggests a lower price for value-added surplus products (McCarthy et al., 2020) as they may be associated with sub-optimal food or food waste. Such assumptions about consumers' association and willingness to pay of VASP food are critical in the analysis of the profitability of such products. Understanding how consumers value VASP food is necessary for any assessment of the economic viability of recycling food wastes back into the food supply chain. Examining the willingness to pay of VASP will give a clearer picture about the feasibility of commercializing VASP to deal with the food waste problem.
4. The results reveal the market prospects for VASP in the German market and identify promising consumer segments along with positioning strategies to assist marketers and policy-makers with more effective communication strategies to prevent pre-consumption food waste.
5. The study aims to give incentives for entrepreneurs and food producers to apply circular economy principles and explore new business models in the area of circular economy within the food supply chain.

2 Theoretical Background

2.1 Food waste and the circular economy

VASP or waste-to-value products are made of food waste. Food waste is defined as "any healthy and edible substance that, instead of being used for human consumption, is wasted, lost, degraded, or consumed by pests at any stage of the food chain" (FAO, 2019). Food waste can be further segmented into sub-categories based on the supply chain stages in which the food waste arises. For example, according to Dorward (2012), there is "pre-consumer waste", referring to food waste arising during the manufacturing, processing, distribution and retailing of food and "post-consumer waste", referring to food waste arising during food consumption. Other scholars differentiate between "food loss" and "food waste", while food loss refers to food lost in the production and processing stages and food waste refers to food lost at the retailer, catering, and household levels (Cristóbal, Castellani, Manfredi, & Sala, 2018). As the segmentations are not consistent and for simplicity reasons, in this paper, the term "food waste" will be used to name any kind of material addressed by the FAO definition which arises during the pre-consumption stage defined by Dorward (2012).

Numerous authors highlight waste and inefficiencies in the food supply chain and call for circular economy approaches (Ingrao et al., 2018; Pagotto & Halog, 2016; Secondi et al., 2019) to decrease food waste and increase the sustainability of food production systems. In general, circular economy approaches allow finite resources to generate more value for a longer period by establishing a closed-loop system within the production and continuous usage (McDonough & Braungart, 2002). Thereby the principles of reuse, repair, refurbish and recycle are used to turn previously considered wastes into new resources (Jurgilevich et al., 2016). Regarding food waste, the food waste hierarchy framework (see Figure 1: Food Waste Hierarchy) gives an orientation on how food waste should be proceeded concerning the circular economy principles. The framework consists of five steps, namely prevention, re-use, recycle, recovery and disposal (Papargyropoulou, Lozano, K. Steinberger, Wright, & Ujang, 2014). Prevention, in the form of food surplus and avoidable food waste reduction, is agreed to be the most advantageous option within the food waste hierarchy (Papargyropoulou et al., 2014). Due to the peculiarities of food regarding the materiality and temporality, re-use and recycling are strategies that cover only some parts of the food production (e.g.,

packaging or production inputs). However, they are not suitable as a general approach to reducing food waste (Del Giudice, La Barbera, Vecchio, & Verneau, 2016).

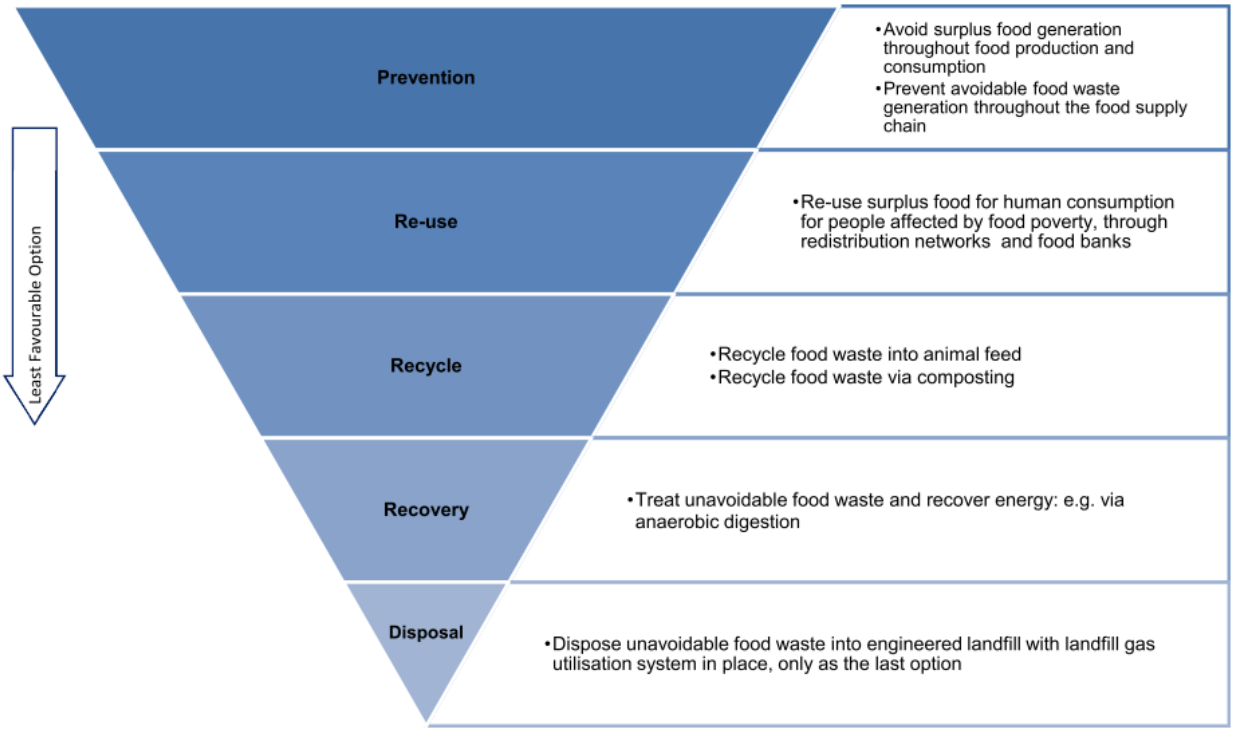


Figure 1: Food Waste Hierarchy (adapted from Europoean Parliament Council and Papargyropoulou et al. (2014))

The production of VASP represents a derived approach to the prevention strategy for food waste. Value-added surplus products are defined as "new foods that make use of surplus or underutilized food, (…) that are thrown away at different stages in the food chain and then transformed into value-added products" (Bhatt et al., 2018). Thereby, underutilized food also considers by-products which were formerly perceived as inedible but are safe and healthy for consumption, such as leaves, stalks, seeds, unused flesh, pomace, and peelings. This underutilized food can be retained and transformed into higher-valued foods with enhanced concentrations of micro-nutrients (Miller & Welch, 2013). Accordingly, VASP can come in different types which have not been clearly outlined yet in the scientific literature. A VASP can be a commonly known product, just with the difference to the conventional product that surplus or suboptimal food are used as ingredients. Or it can be a novel product where priorly underutilized food is converted into highly processed products with the use of differentiated production techniques.

2.2 VASP food and market potential

The research area of food derived from surplus or yet underutilized food is relatively new (Aschemann-Witzel & Peschel, 2019; Bhatt et al., 2018; McCarthy et al., 2020; Perito Maria, Di Fonzo, Sansone, & Russo, 2019). Most studies in this field concentrated on exploring different sources of food waste (Garcia-Garcia, Stone, & Rahimifard, 2019; Garnett, 2011) or ways of converting food surplus to value-added products (Miller & Welch, 2013; Wolfe & Liu, 2003). But they did not put the market side in perspective.

In a literature review, four studies could be examined related to customer acceptance of VASP or waste-to-value products (Aschemann-Witzel & Peschel, 2019; Coderoni & Perito, 2020; McCarthy et al., 2019, 2020). All of them observed a general acceptance towards the novel food product with around 50% of the study participants indicating a willingness to buy.

To further investigate the market potential of VASP, not only the willingness to buy but also the willingness to pay of the consumers is of interest. The WTP is "the maximum amount of money that a consumer will pay in exchange for a good" (Hazen, Overstreet, Jones-Farmer, & Field, 2012). Thereby, the "perceived net utility (benefits minus costs) associated with purchasing and owning a certain product influences the WTP" (Harms & Linton, 2016, p. 894). This way, a potential pricing position for VASP can be determined, and the perception of the consumers towards these novel products can be further analysed.

2.3 VASP food and quality perception

A primary reason for food waste is the reluctance of consumers to purchase or consume suboptimal products (Aschemann-Witzel, De Hooge, Amani, Bech-Larsen, & Oostindjer, 2015), causing supply chains to waste these as a reaction to it (Göbel, Langen, Blumenthal, Teitscheid, & Ritter, 2015; Lebersorger & Schneider, 2014).

Suboptimal foods are defined as foods with aesthetic or cosmetic imperfections (Beretta, Stoessel, Baier, & Hellweg, 2013; North, Hargreaves, & McKendrick, 1997) which deviates from optimal products in 3 aspects. First, based on the appearance in terms of shape, weight or size (Bunn, Feenstra, Lynch, & Sommer, 1990). Second, based on the date labelling, best-before date or remaining shelf-life (van Giesen & de Hooge, 2019) and third based on their packaging (White, Lin, Dahl, & Ritchie, 2016). Even though these products do not deviate on the intrinsic quality (Aschemann-Witzel et al., 2015; Göbel et al., 2015; Halloran, Clement, Kornum, Bucatariu, &

Magid, 2014) consumers still experience an uncertainty about these products in exactly this and therefore try to avoid them, while favouring optimal products instead (de Hooge et al., 2017).

In order to motivate consumers to buy sub-optimal products despite this uncertainty, research suggests that price discounts are needed (Verghese et al., 2013) since, for example, the willingness-to-pay decreases with the extent of the remaining shelf-life (Tsiros & Heilman, 2005)

Concerning VASP, which amongst other food also make use of suboptimal foods to be transformed into new value-added products (Bhatt et al., 2018) it is anticipated that consumers may experience the same uncertainty as for suboptimal foods (McCarthy et al., 2020). Accordingly, it is suggested to position VASP with a lower price compared to conventional products, as consumers may associate it with food waste and sub-optimal food due to the nature of its ingredients, and therefore expect it to be discounted (McCarthy et al., 2020) as well.

On the contrary, aspects associated with sub-optimal products, like aesthetic imperfections, short shelf-life, or damaged packaging, which decreases the willingness to pay cannot be observed in VASP. As it goes through proper processing, its physical composition is altered, the shelf-life is prolonged, new packaging is applied, and its quality is guaranteed. The processing may eliminate the reasons of the consumers to experience uncertainty regarding the intrinsic quality of the product (Olson, 1977; Zeithaml, 1988) and consequently maybe the expected price discounts.

Moreover, in a study conducted by Bhatt et al. (2018) about how consumers perceive VASP compared to conventional or organic food, it was examined that VASP were perceived significantly different from conventional products and more similar to organic foods. Being perceived as similar to organic products could imply that consumers accord VASP, in contrast to suboptimal products, "a premium status vis-à-vis conventional products" (Bhatt et al., 2018).

Given these points, it can be assumed that VASP foods are not associated with the quality uncertainties associated with their ingredients, the suboptimal food. Consequently, an increased willingness to pay may be feasible, and price discounts below conventional products are not necessary.

H1: Customers do not associate VASP food with quality uncertainties compared to conventional products

2.4 VASP Food and green consumerism

The main purpose of VASP is to recycle formerly wasted products and bring them back to the store in a different form. As a result, VASPs are considered pro-environmental products, since they are leading to a reduced food waste emission within the supply chain (Bhatt et al., 2018). Furthermore, VASP are rated higher in terms of societal benefits compared to conventional products (Bhatt et al., 2018).

Hence, VASP can be classified as a green product. Green products have a reduced impact on the environment over their life cycle while having the same basic function as conventional products (Michaud & Llerena, 2011). Green products provide a private benefit for the consumer as well as a benefit for the public. Thus they are also defined as 'impure public goods' (Kotchen, 2005). By purchasing a green product, individuals voluntarily contribute to the environment, while satisfying a personal need.

Several studies have shown that consumers are increasingly concerned about the environmental impacts of their purchases (Sammer & Wüstenhagen, 2006). Additionally, it has been indicated that consumers are willing to pay a premium price for environmentally friendly, or green products (Bernard & Bernard, 2009; D'Souza, 2004; Lee, 2008, 2009; Marette et al., 2012; Rahbar & Wahid, 2011). This is because consumers desire to "go green" in order to contribute to a better and healthier life for present and future generations (Yazdanifard & Mercy, 2011).

For example, a study by Del Giudice et al. (2016) showed an increased willingness to pay for bread which had a lower carbon-footprint due to less food-waste generation during the production. Similarly, a literature review by (Aschemann-Witzel & Zielke, 2017) concludes that consumers are ready to pay a price premium of around 30% for organic food products.

Since VASP are perceived as green products and similar to organic products, the second hypothesis is:

H2: Customers are willing to pay a price premium for VASP compared to similar conventional products

2.5 VASP Food and food neophobia

Value-added surplus products are quite novel, and the production and sale of them have just emerged in recent years. Moreover, VASP foods are a radically new category of foods (Bhatt, 2018). It has been observed that consumers are likely to find it challenging to classify novel foods into their existing schema of products and product categories (Moreau, Markman, & Lehmann, 2001). This can lead to resistance or aversion against the novel food, also known as food neophobia. Neophobia related to food is the fear of trying new and potentially risky foods (Savchenko, Kecinski, Li, & Messer, 2019). For products produced with new technologies which are perceived as risky, like genetic engineering and nanotechnology, studies have shown that unknown risks play a significant role in consumers acceptance (Finucane & Holup, 2005; Slovic, 1987; Townsend, 2006; Townsend & Campbell, 2004) and hamper the willingness to pay. This is based on consumers safety considerations, as some production technologies are perceived as unsafe, and a negative attitude is developed towards products produced with these technologies (Grunert, 2005). For example, consumers' WTP for products that are genetically engineered is 23–28% less than their WTP for conventional food products (Lusk, Schroeder, & Tonsor, 2014; Messer, Costanigro, & Kaiser, 2017). Since the production process behind VASP is also relatively new in a way that formerly wasted foods are recycled to new products, risks might also be associated with this process. Consumer attitudes against VASP could range from concerns of poor food safety to even outright disgust due to the nature of its ingredients (Bhatt, 2018).

The wasted food used to produce VASP foods might be perceived as contaminated by spoiled food or other waste even after the contagion itself is removed, and the item cleaned. An item that comes into contact with a contaminated object is also perceived as contaminated (Rozin & Fallon, 1987). As it can be observed for reclaimed waste-water used to grow new produce (Savchenko et al., 2019) high production quality and safety standards might not necessarily mitigate individuals' perceived risks - "once in contact, always in contact" (Rozin & Royzman, 2001).

While (Aschemann-Witzel & Peschel, 2019) observed that the communication of food waste used as an ingredient did not seem to have a negative influence in the acceptance of VASP, a study by (Coderoni & Perito, 2020) indicates a strong influence of food technology neophobia on the likelihood of willingness to buy.

This can be explained by the fact that consumers not only fear the risks of unknown new food technologies but also show increasing interest in natural food, as organic or local food (Vidigal et

al., 2015), which on the contrary decreases the acceptance of new food technologies. Regarding these findings, the third hypothesis is:

H3: Customers with a higher food technology neophobia show a decreased willingness to pay for VASP food

2.6 VASP Food and awareness of food waste

The primary goal of VASP is to reduce the amount of food waste by making use of it instead of disposing it. This primary goal can also be seen as the unique selling point (USP) of VASP. The role of the USP is to make potential consumers desire it by setting the product apart from competing ones (Reeves, 1961). While consumers can translate their concerns through buying products for their positive qualities (de Pelsmacker, Driesen, & Rayp, 2005), the primary goal to reduce the amount of food waste can be seen as the differentiating positive quality and reason why consumers decide to choose VASP food instead of conventional food.

Research has shown that high awareness of food waste issues increases the purchase intention for sub-optimal food (de Hooge et al., 2017; McCarthy et al., 2019), as well as for VASP products (McCarthy et al., 2020). It can thus be assumed that high awareness of food waste triggers the concerns of the consumer for the negative consequences of food waste on the environment, which then leads to increased willingness to buy.

On the contrary, since consumers might differ in their knowledge or awareness of the food-waste issue (Porpino, Parente, & Wansink, 2015; Quested, Marsh, Stunell, & Parry, 2013), it can be assumed that a low awareness on food waste might let the USP of VASP seem irrelevant or less benefitting for certain consumers. Accordingly, a decreased willingness to buy might be observed. Hence, it can be assumed that:

H4: Customers with a strong awareness of the food waste issue will show a higher willingness to pay for VASP food

3 Methodology

3.1 Research Design

This study focused on examine the plausibility of positioning value-added surplus products as a premium product and fetching a price premium for it, while identifying influencing factors.

Therefore, the willingness-to-pay (WTP) of consumers for two conventional products and two similar value-added surplus products were examined. Furthermore, customers' food technology neophobia, awareness of food waste and socio-demographic factors were examined and analysed to see if moderating effects on the WTP are present. Additionally, the quality perceptions of VASP and conventional products are compared. The research design is presented in Figure 2: Research Design.

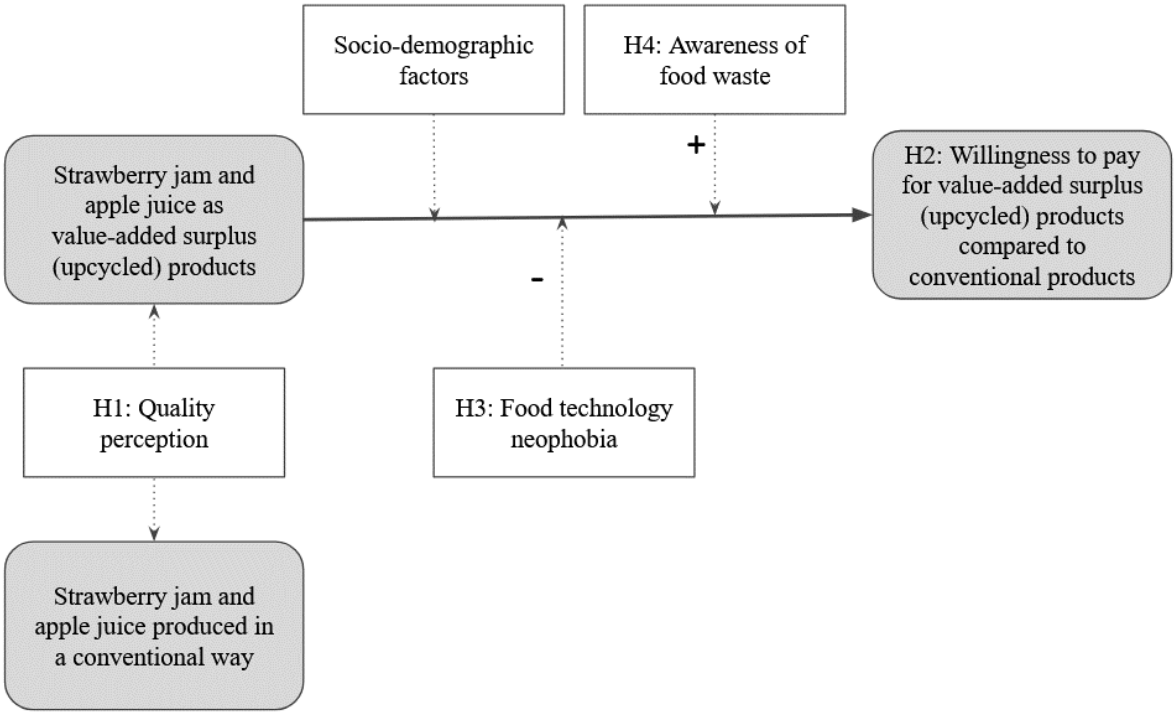


Figure 2: Research Design

In a second step, it was examined if consumer segments based on the willingness to pay can be identified, see Figure 3: Customer segmentation. Thereby, the extent to which the consumer segments are different in terms of socio-demographic characteristics and psychographic data which are influencing the purchasing behaviours will be elaborated.

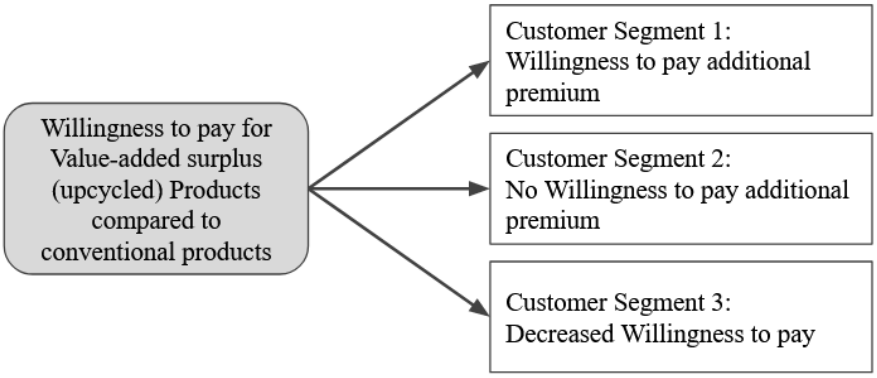


Figure 3: Customer segmentation

3.2 Online survey

To answer the research question and derived hypothesis, a questionnaire-based survey methodology was employed to collect quantitative data of potential consumers. The questionnaire was constructed using the online survey program Qualtrics. The format of an anonymous online survey was chosen to make it as convenient as possible for participants to take part in the study and to reach a high number of participants. The questionnaire was designed for self-completion by respondents. Therefore, open-ended questions were kept to a minimum. Self-completion questionnaires are one of the most common social survey design instruments for gathering data and have the benefit to eliminate interviewer effects, for example, biases in answering the questions through the ethnicity, gender, or the social background of the interviewer (Becker, Bryman, & Ferguson, 2012).

Furthermore, online surveys combined with a guarantee of anonymity are used to reduce social desirability biases (Van de Mortel, 2008) and counteract inclinations to give "socially correct" answers. Participants were reached via different social media networks like Facebook and WhatsApp, as well as the personal network of the author. Social media are becoming a more popular means of reaching participants in social sciences research (Coderoni & Perito, 2020). The survey was available in German and English language to make sure also English-speaking persons living in Germany can participate.

The survey consisted of two sections. In the first section, the survey contained the elicitation of WTP for the two sample products, a conventional jar of strawberry jam and a bottle of apple juice, as well as for the upcycled counter variant. The second section contained a questionnaire to

examine socio- and psychographic data of the participants. The survey structure is similar to previous studies on upcycled products in the food sector (Aschemann-Witzel & Peschel, 2019; McCarthy et al., 2020) or refurbished products in the technology sector (Harms & Linton, 2016)

Before the survey publication, a pre-test was carried out with 12 persons who were not familiar with the topic of upcycling or value-added surplus products, as well as three people who were familiar with the topic. This was done to validate if the survey questions corresponded to the answers. With the results of the pre-test, the length of the survey was shortened, superfluous questions were removed, difficult questions simplified, and the order of questions changed to optimize the flow of answers. Additionally, the wording of those questions that often resulted in 'I do not know' responses or stayed unanswered was adapted to minimize misunderstandings or uncertainty and increase the degree of the valuable outcome. Lastly, ethics approval for the study was secured from the Ethics Committees in the authors' University. The final survey as carried out can be seen in *Appendix B.*

3.3 Willingness to pay

A hybrid version of a direct questioning approach and a conjoint analysis was applied to elicit consumers' preferences and their WTP for two commonly available products, an apple juice and a strawberry jam, which are produced in either a conventional way or with formerly wasted products. The latter procedure will be termed as 'upcycled' since this term is perceived the most favourable for VASP food (Bhatt et al., 2018).

If one attempts to examine consumer willingness to pay for products, the evident way is to ask the customers directly. Directly asking respondents to state acceptable prices is referred to as a direct approach to measure WTP (Breidert, Hahsler, & Reutterer, 2017). As simple as this method seems, it comes with several drawbacks. For example, customers do not necessarily have an incentive to reveal their true WTP. They might overstate prices because of prestige effects (Nagle & Holden, 2002) or social desirability (Paulhus, 1984) or understate prices because of consumer collaboration effects (Hanna & Dodge, 2017).

Another critical point is that directly asking for WTP, especially for complex and unfamiliar goods is a cognitively challenging task for respondents (Brown, Champ, Bishop, & McCollum, 1996). While it remains unclear whether this leads to over- or understating of proper valuations, a bias is likely to occur. Lastly, buyers often misjudge the price of a product, especially if it is not a high-

frequency purchase or an indispensable good (Marbeau, 1987). Because of this, it is not recommended to use a direct approach as a standalone method to elicit the WTP of consumers (Balderjahn, 2003; Nagle & Holden, 2002).

To further increase the reliability of the measurement, the approach is paired with a conjoint analysis. Conjoint analysis is an indirect measurement method where products are presented as a set of attributes which can be exchanged. This way systematic variations of product attributes are possible. These variations are then compared to each other and rated, e.g., by indicating a rank order according to the degree of preference. These overall preference evaluations are used to make inferences of the relative contributions of the different attributes (Breidert et al., 2017). Conjoint analysis realistically models day-to-day consumer decisions by simulating real marketplace situations where consumers often must choose between several similar products with slightly different attributes. Therefore, it is said to have a reasonable ability to predict consumer behaviour (de Pelsmacker et al., 2005).

To not only get a rank of which attributes are mostly preferred but also examine the willingness to pay, often a 'standard' product with a set price is given as status quo (for example, see de Pelsmacker et al. (2005)). This product can then act as an orientation to valuate adjusted product variations with different attributes. People can then indicate how much more or less they would be willing to pay by, for example, choosing a percentage rate. One problem with this approach occurs since respondents' heterogeneity regarding the price of the status quo product is not necessarily given. As various participants might consider different prices as their best alternative, using the same status quo product price for all participants might not yield correct WTP predictions.

To equalize the critic points of both methods, a hybrid version of the direct approach and the conjoint analysis was chosen for this study. Other methods to elicit WTP, which are using revealing preferences approaches instead of stated preferences approaches, like Customer Experiments (CE) were also reviewed as potential methods. However, due to restricted possibilities to meet and talk with people in person because of the Covid-19 pandemic, it was decided not to perform Customer Experiments. Furthermore, a literature review by Aschemann-Witzel and Zielke (2017) concluded that there is no noticeable difference in the degree of WTP resulting from stated versus revealing preferences for the WTP of organic products. Since value-added surplus products are associated as similar to organic food (Bhatt et al., 2018), this effect is expected to be the same for this study.

This study put the focus on one attribute, the method of production. Therefore, two products from different product categories are used in two variations, with the method of production as the differentiating attribute. This way, a 2x2 conjoint analysis with four different products variations, two conventional and two upcycled, was constructed. To ensure that no other attributes are unintentionally attributed to the products than the changed production method, a text was used to describe the products in more detail. This text was identical for both product variations except that the production method changed. The text was adapted from Bhatt et al. (2018) and can be seen in *Appendix B.1*.

The two products chosen for the study are an ordinary jar of strawberry jam (250 gr.) and a bottle of apple juice (1 litre). There are several reasons why these two products are considered the most suitable for this study. First, apple juice and strawberry jam are well-known products as both products are the most consumed in their respective categories in Germany (Oltersdorf & Ecke, 2003; VdF, 2019). Therefore, the participants are very likely to have a price estimation for the conventional product and can solely focus on the different production attribute. Additionally, the risk of misjudging the product price is reduced as it a rather frequently bought product. Second, apple juice and strawberry jam are rather uncomplex in their composition, which reduces the degree of cognitive challenge to evaluate them, and therefore the potential bias which could occur. Third, using a product for drinking and a product to eat enhances the generalizability of the findings.

For a visual stimulus, all products were presented in two pictures, whereby the conventionally produced products were in one picture as well as the upcycled products. Both pictures were identical; only the word ‘upcycled’ was added to the label on the upcycled products.

For getting a precise indication of the willingness to pay, the participants were not asked to rank the product variations, but to state the exact amount of money they are willing to pay. In contrast to the typical way of giving a status quo price, the participants were asked to state their price for the standard product variant. This way, the aspect of missing heterogeneity regarding participants price range could be avoided.

The participants were first asked to state the price for the conventional products. In the next step, an introduction of the upcycled production method was presented as can be seen in *Appendix B*. The introduction was formulated in a neutral way to reduce a potential influence on the participants regarding their opinion. Afterwards, the participants were asked to state the price they are willing to pay for the upcycled products.

3.4 Socio- and psychographic data

The questionnaire adapted scales to measure perceived quality, awareness of the food waste problem, measures of food technology neophobia as well as demographic information. These data were then used to explain consumers' WTP and to find out which consumer groups would be most responsive to VASP food. For all the measures on motivational factors, participants were asked to "rate the level of agreement or disagreement with the following statements". The response format was a seven-point Likert scale (Likert, 1932), anchored from 'very strongly disagree' (1) to 'very strongly agree' (7), For the perceived quality scale, participants were asked to compare the quality from 'quality is clearly below' (1) to 'quality is clearly above' (7).

To measure if the perceived quality of VASP food differs compared to conventional food, the "perceived quality scale" adopted from Aschemann-Witzel et al., (2019) was used. The scale assessed the quality of the upcycled products on dimensions of subjective quality which included taste, healthiness, freshness, and overall quality (Grunert, 2005; Oude Ophuis & Van Trijp, 1995) compared to the conventional products.

For measuring the general awareness of the food waste problem, nine items taken from a scale developed by Delley and Brunner (2017) was used. Four items are from the dimension "Environmental impact of food waste" and five from the dimension "Awareness of food waste". Some of these items were previously used by Stefan, van Herpen, Tudoran, and Lähteenmäki (2013) and Gjerris and Gaiani (2013).

For measuring the food technology neophobia of the consumers, eight items selected from the 'New food technologies are unnecessary' dimension and the 'Perception of risks' dimension of the Food-Technology Neophobia Scale (FTNS) developed by Cox and Evans (2008) were used.

Items included in all scales are shown in *Appendix C.1*. The scores of the items of the scales were merged into one score per scale afterwards. The score is simply the sum of the individual item scores. For the food technology neophobia, the scores for statements that have negative correlations with the aspect being measured have been reversed.

Demographic information which has been shown to influence general food waste behaviour were chosen to be examined as well. Demographic information will be collected mostly following a selection of the demographic questions published by McCarthy et al. (2020), Zander & Feucht (2018) and questions by Statistisches Bundesamt (2016), as presented in *Appendix C.2*.

3.5 Data Sample

The survey was performed in July 2020 in Germany. Germany was chosen as several trends have emerged, which makes it a promising country for VASP. First, consumers are very sensitive in their appreciation of food as 91% indicate they rely on their senses and not on the best-before date when evaluating food edibility. Second, over half of the population always or mostly look for the organic seal when buying food, implying a high grade of green consumers. Third, 83% indicate that environmentally friendly production is essential for them (BMEL, 2020).

Additionally, regarding the format of an online survey, the proportion of Internet users in Germany stands at 86% (ZDF, 2020). Therefore, the bias towards households with internet access is minimal. To also include non-German speakers, the survey was developed in English and German language.

In total, 314 consumers participated in the survey. Since only completed surveys resulted in complete data sets and are therefore suitable for further analysing, 206 responses (65%) could be used. For enhancing the quality of the data sets, a minimum of three minutes responding time to complete the survey was a condition to be fulfilled. By this, it was ensured that participants took time and read the questions thoughtfully. 4 responses did not fulfil this condition and were excluded. As the last step to enhance the quality of the data set, responses from participants under 18 years were excluded since they are commonly not involved with the shopping for groceries and have limited knowledge in pricing questions. After all, 201 responses could be used as data sets for further analysing.

Most respondents of the sample were male with 54,2%. As regards income, with 21,9% the most respondents stated a monthly net income of 1.000-1.500€. People between the age of 25–34 (45,3%) were most represented in the sample, whereas the oldest age group (over 65 years) with 7% had the lowest share. The low volume of older people is mainly because older people are less likely to participate in online surveys since more than 45% of people over 60 in Germany (Allensbach, 2020) indicate not to use the internet at all. The high volume of people from the age group of 25-34 can be traced back to the age of the author of this study, who is in the same age group and used his personal network to find respondents for the survey. The same effect can be observed regarding the educational background, where 55,7% of the sample have a university degree. This is in line with the finding of Coderoni and Perito (2020), who addresses the representativeness of the data, as samples obtained through online surveys within personal networks are

generally biased, with an overrepresentation of younger people with a higher level of education than the average population.

Although the sample cannot be considered representative of German consumers, the relationships between the variables analysed and the purchase intention expressed remain valid and allow us to obtain interesting results. Furthermore, by separating the sample into the groups, group-specific results can still be obtained.

Table 1 shows the profile of the respondents in terms of their socio-demographic factors.

Table 1: Profile of respondents

Attribute		Absolute (N)	Relative (%)
Gender	Female	92	45,8
	Male	109	54,2
Income	< 1.000€	41	20,4
	1.000 - 1500€	44	21,9
	1.500 - 2.000€	36	17,9
	2.000 - 2.500€	35	17,4
	2.500 - 3.000€	19	9,5
	over 3.000€	26	12,9
Age	18 - 24	21	10,4
	25 - 34	91	45,3
	35 - 44	21	10,4
	45 - 54	22	10,9
	55 - 64	32	15,9
	65 or older	14	7,0
Employment Status	Employed full time	84	41,8
	Employed part-time	27	13,4
	Unemployed	0	0,0
	Retired	14	7
	Student	58	28,9

Attribute		Absolute (N)	Relative (%)
	Homeduties	1	0.5
	Self-employed	11	5,5
	Other	6	3,0
Educational Background	No qualification	0	0,0
	Secondary or elementary schooling	5	2,5
	High school	39	19,4
	College or university entry qualification	45	22,4
	University Degree	112	55,7
Children in Household	0	163	81
	1	16	8
	2	18	9
	3	4	2

4 Analysis

4.1 Variables

Statistical analyses were performed using the statistical software SPSS Version 26. Various analysis methods were used for examining the collected data regarding the quality and the objectives of this study.

In Table 2, all variables obtained in the survey, as well as a short description, can be seen. For analysing the survey data, several variables were added. These variables show the differences between the four prices per respondent representing their willingness to pay.

Table 2: Variables, description, and calculation

Variable	Description	Formular
$WTPCJ$	Willingness to pay for conventional Jam (€)	
$WTPCA$	Willingness to pay for conventional Apple juice (€)	
$WTPUJ$	Willingness to pay for upcycled Jam (€)	
$WTPUA$	Willingness to pay for upcycled Apple juice (€)	
$RDIFFWTPUJ$	Relative Difference in WTP for upcycled Jam to conventional Jam (%)	$\frac{WTPUJ}{WTPCJ} - 1$
$RDIFFWTPUA$	Relative Difference in WTP for upcycled Apple Juice to conventional Juice (%)	$\frac{WTPUA}{WTPCA} - 1$
$ADIFFWTPUJ$	Absolute Difference WTP for upcycled Jam to conventional Jam (€)	$WTPUJ - WTPCJ$
$ADIFFWTPUA$	Absolute Difference WTP for upcycled Apple Juice to conventional Juice (€)	$WTPUA - WTPCA$
$ADIFFWTP$	Mean absolute Difference in Willingness to pay for both upcycled products (€)	$\frac{ADIFFWTPUJ + ADIFFWTPUA}{2}$

Variable	Description	Formular
$RDIFFWTP$	Mean relative Difference in Willingness to pay for both upcycled Products (%)	$\frac{RDIFFWTPUJ + RDIFFWTPUA}{2}$
$TRIED$	Have consumers already tried products produced in an upcycled production method?	
$FTN1_{1-4}$	Food Technology Neophobia Scale "New food technologies are unnecessary."	
$FTN2_{1-4}$	Food Technology Neophobia Scale "Perceived risks."	
FWA_{1-5}	Food Waste Awareness Scale "Food waste awareness."	
$FWEI_{1-4}$	Food Waste Awareness Scale "Food waste environmental impact."	
PQ_{1-4}	Perceived Quality Scale	
QUAL_CONVENTIONAL	Dummy variable for the quality expectation of conventional food	
$GENDER$	Gender of participant	
$INCOME$	Monthly net income of the participant	
AGE	Age of participant	
$EMPLOY$	Employment Status of the participant	
EDU	Educational Background of participant	
$CHILD$	Person under 14 in Household of participant	

4.2 Factor analysis

As a first step, to ensure high-quality results, confirmatory factor analysis was conducted to check whether the variables match the theoretically expected structure of the scales used to measure the FTN, FWA and PQ of the respondents. In a Confirmatory Factor Analysis (CFA), it is checked whether certainly expected correlations exist between the variables examined. This is also referred

to as a hypothesis testing procedure (Thompson, 2004). To check if the variables are suitable, two pre-tests, the Barlett-Test and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO), were conducted. Afterwards, the factors' reliability was checked with Cronbach's Alpha (Cronbach, 1951).

4.3 T-Test

To answer H1: 'Customers do not associate VASP food with quality uncertainties as they do for sub-optimal products' and H2: 'Customers are willing to pay a price premium for VASP compared to similar conventional products' t-tests were conducted. A t-test for dependent samples tests whether the mean values of two dependent samples are significantly different.

Regarding H1, to see if there is a difference in the quality perception of conventional and upcycled products, the value of Factor 3 - Perceived Quality of upcycled products was compared to a dummy variable QUAL_CONVENTIONAL. The dummy variable is representing the perceived quality of conventional food and is always valued with 4. This is because if the respondents were asked to rate the quality of the conventional food compared to conventional food, the answer would always be 4 - Quality is the same. By conducting a t-test for paired samples, it was examined if a significant difference in the mean of the perceived quality of upcycled food, represented by Factor 3, compared to conventional food is present.

Regarding H2, to see if the difference in the willingness to pay for upcycled products is significant, two t-tests were conducted, one for each product type. For the strawberry jam, the variables WTPCJ and WTPUJ were compared within the t-test. For the apple juice, the variables WTPCA and WTPUA were compared.

4.4 Correlation

To see how the psychographic factors (FTN, FWA, PQ), as well as the socio-demographic factors (income, education, age and child in household), are related to each other, a Pearson-correlation analysis was conducted. The Pearson-correlation calculates the linear relationship between two variables. Two variables are linearly related if they vary linearly with each other. Furthermore, it will be checked if no multicollinearity is present between the factors, a precondition which must be met for multiple regression analysis.

4.5 Multiple Regression

A correlation analysis only indicates if two variables influence each other but do not indicate from which direction the influence comes; therefore, a causality cannot be determined. This means, i.e. when the willingness to pay correlates with the factors of food technology neophobia, it is only possible to say that they are linearly related to each other. However, it is not possible to say if food technology neophobia influences the willingness to pay, or if the willingness to pay influences the food technology neophobia.

To answer H3: 'Customers with food technology neophobia show a decreased willingness to pay' and H4: 'Customers with a strong awareness of the food waste issue will show a higher willingness to pay', a multiple regression, or ordinary least square, analysis was therefore also conducted. A multiple regression analysis tests whether there is a relationship between multiple independent variables and a dependent variable. This way not only the influence as such, but also its direction can be determined. As a dependent variable, the relative difference in willingness to pay (RDIFFWTP) is chosen as the most suitable variable describing the WTP for VASP. It describes how much consumers would pay for upcycled products compared to conventional products. A RDIFFWTP of 0.09 means that a consumer is willing to pay an additional premium of 9% for an upcycled product than he would pay for a similar conventional product. The RDIFFWTP of a consumer is the mean of the relative difference in willingness to pay for the two upcycled products (strawberry jam and apple juice) used in the study. The factors measuring the constructs of food waste neophobia, food waste awareness and perceived quality were set as the independent variables.

4.6 Cluster Analysis

For identifying different consumer segments, a two-step cluster analysis was performed. Cluster analysis groups objects of an investigation into natural groups, or so-called "clusters". By applying cluster-analytical methods, objects can be combined into clusters based on their characteristics. Each cluster itself should be as homogeneous as possible, while the clusters should differ as much as possible from each other. It was decided to use the Two-step cluster analysis because it combines both approaches of the k-mean cluster method as well as the hierarchical cluster method and can handle mixed different levels of measurement like ordinal and scale data. Clusters analysis was conducted in two ways. First, clusters were created based on the socio-demographic factors gender, age, income, educational background, employment status and children in household, to create

segments which are easy to target for marketing and communication and distinguishable from other segments. The second cluster analysis was based on the RDIFFWTP. Since the participants with a medium to high WTP for upcycled products are of particular interest, participants were clustered according to their willingness to pay additional premiums, and the segments described by the major socio-demographic characteristics.

Lastly, it was tested if the clusters mean values of the psychological factors food technology neophobia, food waste awareness, and quality perception of upcycled products can be used to characterize the clusters.

5 Results

5.1 Factor analysis

A confirmatory factor analysis was conducted to check whether the variables match the theoretically expected structure of the scales used for determining the psychological factors food technology neophobia, perceived quality and food waste awareness of the respondents.

First, pre-tests were conducted. To continue with the factor analysis, a KMO of 0.50 is set as the lower acceptable limit, but a value above .80 is desirable (Kaiser, 1981). Additionally, the Bartlett test was used to test the null hypothesis whether the variables are completely uncorrelated. Both, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO = .805) and the Bartlett test (Chi-square (231) = 1880.065, $p < .001$), indicate that the variables are suitable for the factor analysis.

Thus, a principal component analysis was performed with Varimax rotation. Although this indicates the presence of five factors with eigenvalues greater than 1.0 (see *Appendix A.1*), a four-factor solution was chosen based on the screen plot (see *Appendix A.2*) and theoretical considerations, which explains 58,9% of the variance. The analysis confirms the structures of the FTN scale and the PQ scale. Furthermore, it indicates that the items of the Food waste awareness scale represent two factors, which are not congruent with the two dimensions of the scale. Thus, the FWA scale will be split into two scales with 3 and 5 items, representing two new factors. The four factors identified are:

Factor 1 - "Food technology neophobia "
Factor 2 – “Awareness of the environmental impact of food waste”
Factor 3 – “Quality perception of upcycled products”
Factor 4 – “Awareness of food value”.

The cross-charges found indicate that item FWA_1 cannot be separated. Therefore, it will not be considered in the factors. The results of the factor analysis can be seen in Table 3.

Table 3: Factor analysis of the rotated component matrix

Items	Factor 1 – Food technology neophobia	Factor 2 – Awareness of environmental impact of food waste	Factor 3 – Quality perception of upcycled products	Factor 4 – Awareness of food value
PQ_1 -"How good it tastes."			,841	
PQ_2 - "The healthiness of the product as such."		,131	,777	
PQ_3 - "How fresh it is."			,772	-,170
PQ_4 - "The quality overall."			,861	
FTN1_1 - “There are plenty of tasty foods around, so we don’t need to use new food technologies to produce more."	,823			
FTN1_2 - “The benefits of new food technologies are often grossly overstated.”	,813	-,139		
FTN1_3 - “New food technologies decrease the natural quality of food.”	,823			
FTN1_4 - “New food technologies are something I am uncertain about.”	,598	-,160	-,104	,227
FTN2_1 - “Society should not depend heavily on technologies to solve its food problems.”	,771	-,143		,102
FTN2_1 - “New food technologies may have long term negative environmental effects.”	,838			
FTN2_3 - ”It can be risky to switch to new food technologies too quickly.”	,781			,113
FTN2_4 - ”New food technologies are unlikely to have long term negative health effects.”	,449	,178	-,170	
FWEI_1 - “Food thrown away is natural and biodegradable and thus not an issue for the environment.”		,711		,171
FWEI_2 - “In Germany, packaging waste is a greater environmental issue than food thrown away.”		,610	,193	-,100
FWEI_3 - “Food thrown in compost or biowaste is not a problem, as it is natural and biodegradable.”		,870		
FWEI_4 - “Composted food is not a problem for the environment since the nutrients are recycled.”	-,103	,830	,104	
FWA_1 - “In Germany, households are responsible for a great proportion of the food waste.”			,223	,338
FWA_2 - “Food waste is a big environmental issue.”		,608		,342

Items	Factor 1 – Food technology neophobia	Factor 2 – Awareness of environmental impact of food waste	Factor 3 – Quality perception of upcycled products	Factor 4 – Awareness of food value
FWA_3 - "Food waste is an important social issue (e.g. hunger in the world)"		,158		,777
FWA_4 - "Foods are gifts of nature and have to be treated as such"	,147			,743
FWA_5 - "Foods are scarce over the world and should be consumed consciously."	,192	,108		,742

(Note: Factor-loadings between -0,1 – 0,1 are not displayed)

Cronbach's alpha was calculated to ensure the reliability of the factors. For all factors, acceptable internal consistency could be proved as they all are above 0.7 (Field, 2013), see Table 4.

Table 4: Cronbach's alpha of the four factors

Factor	Cronbach a
Factor 1 - Food Technology Neophobia	0,886
Factor 2 - Awareness of environmental impact of food waste	0,801
Factor 3 - Quality perception of upcycled products	0,841
Factor 4 – Awareness of food value	0,705

5.2 T-test

5.2.1 Perceived Quality

Regarding H1: 'Customers do not associate VASP food with quality uncertainties as they do for sub-optimal products' a t-test for paired samples was conducted to examine if a significant difference in the perceived quality of upcycled food compared to conventional food is present. Descriptive statistics already indicates a very similar quality perception as can be seen in Table 5.

Table 5: Descriptive statistics perceived quality

Descriptive Statistic						
	N	Minimum	Maximum	Mean	Std.-Deviation	Variance
Factor 3 - Quality perception of upcycled products	201	1,50	6,50	3,9714	,62259	,388
(DUMMY) Perceived quality of conventional products	201	4,00	4,00	4,0000	,00000	,000

The mean of the sample referring to the quality perception is 4 or extremely close to 4, indicating that the quality is regarded as the same for upcycled products as for conventional products. To have a closer look into the four quality dimensions and to get a statistically proven statement on this, a t-test for paired samples was performed. The results can be seen in Table 6.

Table 6: Paired differences for perceived quality of upcycled and conventional products

Paired differences						
Quality dimensions	Mean	Std.-deviation	Standard error of the mean value	T	df	Sig. (2-sided)
Perceived quality - How good it tastes	,05970	,70457	,04970	1,201	200	,231
Perceived quality - The healthiness of the product as such	,06965	,73833	,05208	1,337	200	,183
Perceived quality - How fresh it is	-,23881	,78274	,05521	-4,325	200	**,000****
Perceived quality - Its quality over-all	-,00498	,79685	,05621	-,089	200	,930
(Combined) Perceived quality of upcycled products - Perceived quality of conventional products	-,02861	,62259	,04391	-,651	200	,516

*(Note: **p < 0.01; *p < 0.05)*

The test statistic shows that no significant difference (t = -0,651, p = 0,516, n = 201) can be found in the perceived quality dimensions between conventional and upcycled products when all dimensions combined are considered. When looking at an individual level of the dimensions, no differences can be observed except for the dimension of freshness which shows a significant difference (t = -4,325, p = .000, n = 201). With 3 out of 4 dimensions showing no significant difference in the perceived quality, it is shown that participants mostly had no doubts in the quality of upcycled products and perceive it with the same quality as conventional products. Accordingly, based on the data collected, H1 can be partially confirmed.

5.2.2 Willingness to pay additional premiums for upcycled products

Regarding H2: ‘Customers are willing to pay a price premium for VASP compared to similar conventional products’ two t-tests for paired samples was conducted. This way, it can be examined if

a significant difference between the means of the WTP for the conventional and upcycled products is present.

Descriptive statistics of the variables representing the WTP of the upcycled products can be seen in Table 7.

Table 7: Descriptive statistics WTP for upcycled products

Differences in willingness to pay of upcycled products compared to conventional products						
	Relative difference WTP for upcycled Jam (%)	Absolute difference WTP for upcycled Jam (€)	Relative difference WTP for upcycled Apple Juice (%)	Absolute difference WTP for upcycled Apple Juice (€)	Relative difference WTP for upcycled Products (%)	Absolute difference WTP for upcycled Products (€)
Mean	0,0713	0,1019	0,1264	0,1776	0,0989	0,1398
Std. deviation	0,29141	0,64276	0,39616	0,56283	0,32259	0,56724
Variance	0,85	0,413	0,157	0,317	0,104	0,322
Minimum	-0,70	-3,50	-0,57	-1,49	-0,63	-2,25
Maximum	1,01	2,00	3,00	3,00	1,95	2,45

For upcycled strawberry jam participants would pay in general 7,13% or 10ct absolute more. For upcycled apple juice participants would pay in general 12,64% or 18ct absolute more. When combining both products to get a more general value for upcycled products, it is observable that consumers are in the mean willing to pay 9,89% or 14ct more for upcycled products than for conventional products.

5.2.2.1 Willingness to pay an additional premium for upcycled strawberry jam

For testing if the differences in the WTP for upcycled strawberry jam are significant, t-tests were conducted. Table 8 shows the results of the t-test.

Table 8: t-test results WTP upcycled strawberry jam

Paired Differences						
	Mean	Std.-Deviation	Standard error of the mean value	T	df	Sig. (2-sided)
Willingness to pay for conventional Jam - Willingness to pay for upcycled Jam	-,10189	,64276	,04534	-2,247	200	**,026***

*(Note: **p < 0.01; *p < 0.05)*

It is shown that the production method has a statistically significant influence on the willingness to pay (t = -2.247, p = .026, n = 201). If strawberry jam is produced using the upcycling method (M = 2.518, SD = 0.9936), the subjects are willing to pay significantly more than for conventionally produced jam (M = 2,4161, SD = 0.9005). The effect strength is r = .15 and thus corresponds to a weak effect, according to Cohen (1992).

5.2.2.2 Willingness to pay an additional premium for upcycled apple juice

For testing if the differences in the WTP for upcycled apple juice are significant, t-tests were conducted. Results can be seen in Table 9.

Table 9: t-test results WTP upcycled apple juice

Paired Differences						
	Mean	Std.-Deviation	Standard error of the mean value	T	df	Sig. (2-sided)
Willingness to pay for conventional Apple juice - Willingness to pay for upcycled Apple juice	-,17761	,56283	,03970	-4,474	200	**,000****

*(Note: **p < 0.01; *p < 0.05)*

It is shown that the production method has a statistically significant influence on the willingness to pay (t = -4.474, p = .000, n = 201). If apple juice is produced using the upcycling method (M = 1.97, SD = 0.88559), the subjects are willing to pay significantly more than for conventionally produced jam (M = 1.79, SD = 0.72870). The effect strength is r = .33 and thus corresponds to a medium effect, according to Cohen (1992).

The results of the t-test demonstrate that the difference in the willingness to pay for both upcycled products differs significantly than for conventional products. As the difference is positive regarding upcycled food, the results confirm that price premiums are possible. Thus, based on the data collected, H2 can be confirmed.

5.3 Correlation

For examining how the four psychographic factors, as well as the socio-demographic factors (income, education, age and child in household), are related to each other, a Pearson-correlation analysis was conducted. Table 10 reports the results of the analysis.

Table 10: Correlation matrix

Correlation after Pearson Significance (one-sided)	Relative difference in willingness to pay for upcycled products	Factor 1 - Food technology neophobia	Factor 2 -Food waste environmental impact	Factor 3 - Quality perception	Factor 4 - Awareness of food value	Age	Monthly net income	Educational background
Relative Difference in Willingness to pay for upcycled Products	1							
Sig.								
Factor 1 - Food Technology Neophobia	,046	1						
Sig.	,257							
Factor 2 - Awareness of Food Waste Environmental Impact	**,356****	**,149***	1					
Sig.	**,000**	**,018**						
Factor 3 - Quality perception/expectation of upcycled products	**,359****	,078	**,181****	1				
Sig.	**,000**	,135	**,005**					
Factor 4 - Food Waste Awareness	-,111	**,225****	-,152*	,075	1			
Sig.	,059	**,001**	,016	,144				
Age	**-,128***	**-,240****	**-,341****	-,098	**-,126***	1		
Sig.	**,035**	**,000**	**,000**	,082	**,037**			
Monthly net income	,043	-,025	-,146*	,062	,044	**,335****	1	
Sig.	,270	,361	,019	,193	,267	**,000**		
Educational Background	**,139***	**,304****	**,303****	,073	,137*	**-,468****	-,084	1
Sig.	**,024**	**,000**	**,000**	,152	,026	**,000**	,118	
Children (Person under 14 years) in Household	-,084	**-,193****	-,020	-,060	-,045	,132*	,147*	**-,304****
Sig.	,119	**,003**	,387	,197	,262	,031	,019	**,000**

*(Note: **p < 0.01; *p < 0.05)*

Regarding the WTP for upcycled products, several observations can be made from the correlation matrix. It can be seen that Factor 2 - Awareness of food waste environmental impact ($r = .356$, $p = .000$) and Factor 3 - Quality perception of upcycled products ($r = .359$, $p = .000$) show a strong ($p < 0,01$) significant correlation with the WTP for upcycled products. This indicates that both factors are related to WTP. Higher awareness of the environmental impact of food waste and higher quality perception of upcycled food products leads to a higher WTP. Contrary, a higher WTP leads

to more awareness of the environmental impact of food waste and higher quality perception of upcycled food products

Furthermore, the educational background ($r = .139$, $p = .024$) is significantly ($p < 0,05$) correlated with the WTP, indicating that a higher educational background lead to a higher WTP. Additionally, the age ($r = -.128$, $p = .035$) is significantly ($p < 0,05$) negatively correlated with the WTP for upcycled products. This indicates that the older a person is, the less the person is willing to pay for upcycled products. Since the educational background and the age cannot adapt to the WTP, a causality is given.

Lastly, no strong multicollinearity can be observed between the factors, as no value is above 0.7. Thus, multiple regression analysis can be conducted. Other interesting correlations can be observed but are not important for the objective of this study.

5.4 Multiple Regression

An F-test is performed to verify whether the regression model is significant overall. This test checks whether the prediction of the dependent variables is improved by adding the independent variables. That means, the F-test checks whether the model as a whole contributes to the explanation.

The test results in that the model as a whole is significant ($F (4,196) = 14.147$, $p = .000$). For this reason, the analysis can be continued.

Table 11 shows the results of the multiple regression analysis.

Table 11: Multiple regression analysis results

Relative Difference in Willingness to pay for upcycled Products							
	Non-standardized coefficients		Standardized coefficients			Collinearity statistics	
	Regression coefficient	Std.-Error	Beta	T	Sig.	Tolerance	VIF
Factor 1 - Food Technology Neophobia	-,000019	,015	,000	-,001	,999	,915	1,093
Factor 2 - Awareness of the environmental impact of food waste	,069	,016	,285	4,315	**,000****	,909	1,100
Factor 3 - Quality perception of upcycled products	,163	,033	,314	4,880	**,000****	,956	1,046
Factor 4 - Awareness of food value	,031	,023	,091	1,377	,170	,906	1,104

*(Note: **p < 0.01; *p < 0.05)*

The t-tests for the regression coefficient of factor 2 – Awareness of the environmental impact of food waste (t = 4,315, p = .000), and of factor 3 – Quality perception of upcycled products (t = 4,880, p = .000) are significant. The significant coefficients of the variables indicate that their regression coefficients are not 0, and therefore these variables have a significant influence on the willingness to pay for upcycled products. It can be further deduced both factors have a positive coefficient: If the awareness of environmental impact of food waste increases by one unit (1 point on the Likert-scale), the willingness to pay increases by 0.07 units (Euro), when all other variables kept constant. If the perceived quality increase by one unit (1 point on the Likert-scale), the willingness to pay increases by 0.16 units (Euro), when all other variables kept constant.

Factor 1 - Food technology neophobia and Factor 4 - Awareness of food value do not show significant coefficients, indicating that both factors have no significant influence on the willingness to pay.

To visualize the results, a scatter plot, see Figure 4Figure 4: Scatter plot willingness to pay - Factor 1-4, was generated. In the figure, four regression lines are displayed, with each representing the relation of the factors to the willingness to pay. The stronger the influence, the stronger is the increase or decrease of the line.

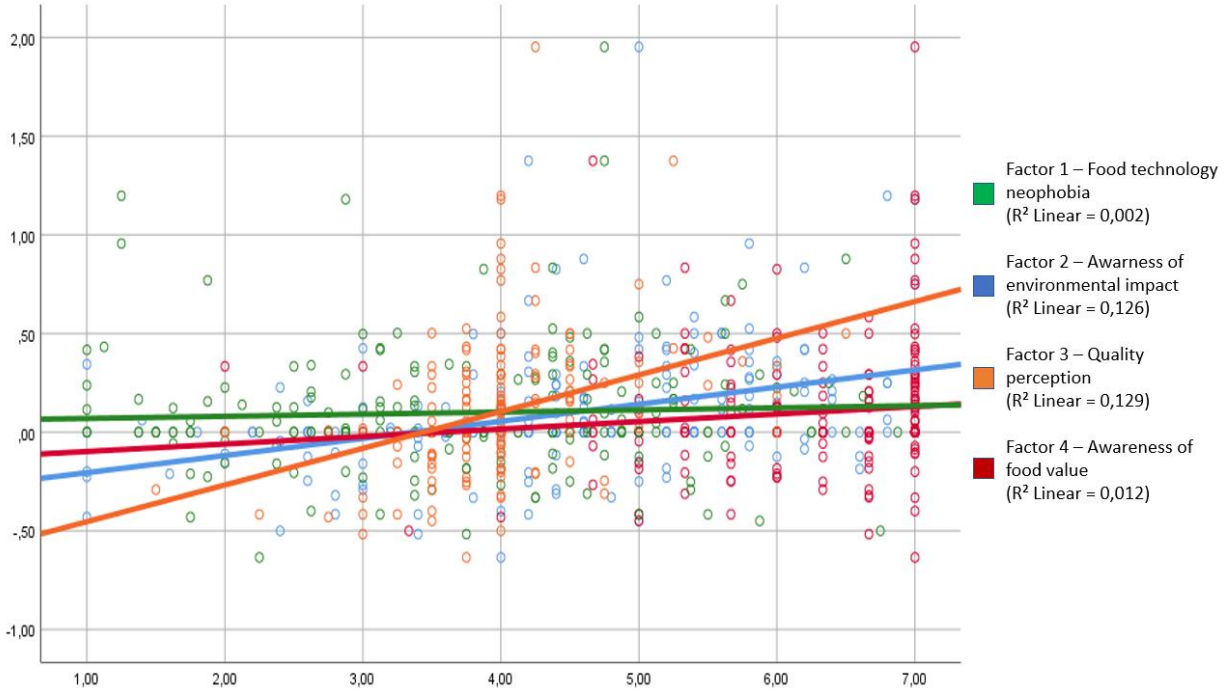


Figure 4: Scatter plot willingness to pay - Factor 1-4

With these results, we can answer hypothesis H3 and H4. Regarding H3: 'Customers with food technology neophobia show a decreased willingness to pay', based on the data collected, this hypothesis cannot be confirmed. There is no significant effect on the willingness to pay of a person for upcycled products depending on the person's neophobia for food technologies.

Regarding H4: 'Customers with a strong awareness of the food waste issue will show a higher willingness to pay', based on the data collected, this hypothesis can be partially confirmed. The awareness of the food waste issue is measured with two factors, awareness of the environmental impact of food waste (1) and awareness of food value (2). The correlation analysis resulted that only the awareness of the environmental impact of food waste influences the willingness to pay, while the awareness of food value has no significant influence on the willingness to pay.

5.5 Cluster Analysis

For identifying different consumer segments, two two-step cluster analysis were conducted. The first objective was to cluster the responses to segments based on the socio-demographic factors, gender, age, income, and educational background. The second objective was to cluster the responses to segments based on their RDIFFWTP.

In the first cluster analysis based on the socio-demographics, it was not able to compute clear clusters. Clear clusters are present when a clear cluster structure can be observed. Evidence of a clear cluster structure is the average silhouette width which can be measured with the silhouette width-based method developed by Kaufman and Rousseeuw (2009). A silhouette coefficient of 1 indicates that all responses are located directly on their cluster centres. A value of -1 would mean all responses are located on the cluster centres of the other clusters. A value of 0 means, on average, responses are equidistant between their cluster centre and the nearest other clusters. With an average silhouette width of 0.3, the clusters derived from the first analysis are considered weak evidence of cluster structure and are therefore not considered relevant in this study.

The second cluster analysis, based on the RDIFFWTP, was able to identify five clusters. With an average silhouette width of 0.7 according to the silhouette width-based method, the clusters can be considered reasonable or strong evidence of cluster structure (Kaufman & Rousseeuw, 2009).

The clusters are ranked according to the willingness to pay for VASP compared to conventional products with cluster I representing the highest average willingness to pay a premium, followed by

cluster II, III, VI and V. According to this the names of the clusters and their additional average WTP can be seen in Table 12.

Table 12: Cluster derived from two-step cluster analysis

Cluster	Description	Mean additional WTP	N
I	Very high willingness to pay a premium	133%	5
II	High willingness to pay a premium	55%	22
III	Willing to pay a premium	22.5%	48
IV	Willing to pay the same price	-0.5%	96
V	Decreased willingness to pay	-30.5%	30

To better identify potential consumers and to address them in a well-targeted manner based on their socio-demographic characteristics, the clusters were analysed on the attributes of gender, age, monthly net income, educational background, employment status and children in household. By standardizing the attributes based on the sample distribution, it can be seen which characteristics of each cluster were most present, as can be seen in Table 13.

Table 13: Standardized attributes of socio-demographic factors of the clusters

Variable	Cluster I: Very high willingness to pay a premium	Cluster II: High willingness to pay a premium	Cluster III: Willing to pay a premium	Cluster IV: Willing to pay the same price	Cluster V: Decreased willingness to pay
Mean additional price premium willingness to pay for upcycled product compared to conventional product	133.00%	55.27%	22.34%	-0.52%	-30.54%
N	5	22	48	96	30
% of sample	2.49%	10.95%	23.88%	47.76%	14.93%
Gender					
Female	63.99%	40.37%	52.15%	46.90%	60.77%
Male	36.01%	59.63%	47.85%	53.10%	39.23%
Income					
< 1.000€	0.00%	15.45%	19.40%	17.12%	14.56%
1.000 - 1500€	14.57%	21.59%	23.01%	11.39%	21.71%
1.500 - 2.000€	17.81%	17.59%	16.07%	14.86%	23.21%
2.000 - 2.500€	18.32%	22.62%	12.40%	16.24%	20.47%

Variable	Cluster I: Very high willingness to pay a premium	Cluster II: High willingness to pay a premium	Cluster III: Willing to pay a premium	Cluster IV: Willing to pay the same price	Cluster V: Decreased willingness to pay
2.500 - 3.000€	0.00%	16.67%	15.22%	21.11%	6.28%
over 3.000€	49.31%	6.09%	13.91%	19.28%	13.77%
Age					
18 - 24	0.00%	32.02%	22.22%	16.61%	4.69%
25 - 34	0.00%	22.17%	22.22%	16.10%	11.90%
35 - 44	80.73%	8.01%	11.11%	13.29%	23.43%
45 - 54	19.27%	15.28%	21.21%	15.85%	13.42%
55 - 64	0.00%	10.51%	12.15%	20.71%	18.45%
65 or older	0.00%	12.01%	11.11%	17.44%	28.12%
Edu. Background					
Secondary or elementary schooling	0.00%	0.00%	0.00%	21.12%	46.51%
High school	29.16%	17.31%	38.72%	25.73%	20.87%
College or university entry qualification	50.54%	37.50%	16.78%	30.51%	18.09%
University Degree	20.31%	45.20%	44.50%	22.63%	14.53%
Children in household					
0	14.00%	69.87%	23.48%	46.91%	11.34%
1	0.00%	0.00%	29.10%	33.34%	21.00%
2	86.00%	30.13%	34.49%	19.76%	4.67%
3	0.00%	0.00%	12.93%	0.00%	63.00%
Employment status					
Employed full-time	6.13%	23.20%	13.12%	15.36%	20.88%
Employed part-time	38.16%	21.65%	12.34%	19.68%	9.99%
Retired	0.00%	13.92%	9.16%	16.26%	48.19%
Student	8.88%	23.52%	10.61%	22.25%	20.94%
Homeduties	0.00%	0.00%	25.64%	0.00%	0.00%
Self-employed	46.83%	17.71%	16.31%	13.80%	0.00%
Other	0.00%	0.00%	12.82%	12.65%	0.00%
Unemployed	0.00%	0.00%	0.00%	0.00%	0.00%

Lastly, the clusters mean of the four factors were analysed to see if they show significant differences and can be used to characterize the clusters. Table 14 shows the means of the clusters for the four factors. The highest scores are highlighted green and the lowest red.

Table 14: Clusters and mean values of the four factors

Factor	Cluster I: Very high willingness to pay a premium	Cluster II: High willingness to pay a premium	Cluster III: Willing to pay a premium	Cluster IV: Willing to pay the same price	Cluster V: Decreased willingness to pay
Factor 1 - Food technology neophobia	2.98	4.14	3.84	3.65	3.72
Factor 2 - Food waste environmental impact	5.76	5.19	4.94	4.36	3.57
Factor 3 - Quality perception of upcycled products	4.30	4.34	4.22	3.86	3.62
Factor 4 - Awareness of food value	6.53	6.35	6.19	6.25	5.83

Cluster I has the highest mean in food waste environmental impact and food waste awareness, as well as the lowest mean in food technology neophobia. On the other side is cluster 5 with the lowest mean in food waste environmental impact, awareness of food value, and quality expectation. Cluster II shows the highest mean in food technology neophobia as well as quality perception. Cluster III and IV do not show any peak values.

A T-test was conducted to see if the means of the factors 1 - 4 between the cluster I and V show significant differences. The result says the difference for food waste environmental impact ($t(76) = -4.505$, $p = .000$) and quality perception ($t(76) = -4.008$, $p = .000$) are significant.

6 Discussion

6.1 Key findings

VASP has been identified as a new solution to reduce food waste by using it to produce new products. While several studies have identified ways to convert the food waste to value-added surplus products, the market side is relatively unexplored with only a few studies investigating in the consumer perception of this novel kind of food. Since not all consumers would like to accept suboptimal foods (Aschemann-Witzel, de Hooge, et al., 2017), and new food products tend to have high failure rates (Stewart-Knox & Mitchell, 2003) it is necessary to understand who potential customers are, how they perceive the products and how they can be targeted within marketing strategies. Accordingly, the goal of this study was to examine the willingness to pay of German consumers for two VASP products, an apple juice and a strawberry jam, and analyse how several factors influence it. Furthermore, a cluster analysis was executed to identify potential customer segmentation for the new type of food.

Overall, it can be observed that the attitude towards the two VASP was positive, with 78,5% of the survey participants indicate they would pay at least the same amount as they would pay for conventional products. Assuming a willingness to pay the same price is comparable to a willingness to buy, the acceptance rate is higher than other studies observed before on VASP products. McCarthy et al. (2019/2020) reported around 50%, Aschemann-Witzel and Peschel (2019) reported less than 50% and Coderoni and Perito (2020), around 56%. Reasons for that can be the different geographical location, different product examples or differences in the sample distribution.

After all, the results indicate a clear market potential for VASP. Food processors should explore commercialization opportunities for VASP in Germany as well as in culturally similar markets like Austria and Switzerland. Furthermore, the result supports the call for technological solutions (Papargyropoulou et al., 2014) for recovering more fruits and vegetables from the food system and transforming them into novel products.

6.2 Hypothesis 1: Quality

H1: Customers do not associate VASP food with quality uncertainties compared to conventional products

Recent studies anticipated that VASP might be regarded as lower quality food compared to conventional food products. Customers may experience quality uncertainty as they associate the VASP with their ingredients based on food waste and sub-optimal food. Sub-optimal food comes with intrinsic quality uncertainties (de Hooge et al., 2017) as it deviates from optimal products in terms of aesthetic imperfections, short shelf-life or damaged packaging.

To test if these anticipations are justified, customers were asked to rate four dimensions of their perceived quality of two VASP after being informed about the production process and origin of ingredients. Three out of four quality dimensions showed no significant difference in the perceived quality of VASP compared to conventional products. Only in the quality dimension of freshness, a significant difference was observed. Combining all dimensions, no significant difference could be observed. Accordingly, it can be assumed that the quality perception of VASP is comparable to conventional products. Hence an association with food waste or sub-optimal food is not likely.

This is an interesting finding. Despite the ingredients were communicated to have been formerly 'wasted', it did not seem to have a significant negative influence. Similar as for reclaimed water (Savchenko et al., 2019), this information could have created a perception of contamination and rejection. The result supports the suggestion of (McCarthy et al., 2020) that due to the additional processing of the sub-optimal foods, the reasons of the consumers to experience uncertainty regarding the intrinsic quality are eliminated.

A reason for the significant difference in the quality dimension for freshness might be that consumers expect the time from field to processing of the VASP ingredients to be longer than for conventional products ingredients. This makes sense as an additional step in the production chain is necessary to 'rescue' the formerly wasted ingredients and return them into the value-chain again, which comes at an additional time expense. These data are consistent with the findings of Fillion and Kilcast (2002), who found that time from harvest was one of the most important contributors to the perception of freshness, especially for fruits and vegetables. In the study, both VASP presented were based on fruits as ingredients.

With VASP having a perceived quality similar to conventional products, the probability that consumers are willing to pay an additional premium can be expected to be increased.

6.3 Hypothesis 2: Premium status

H2: Customers are willing to pay a price premium for VASP compared to similar conventional products

VASP can be classified as a green product since they are leading to reduced food waste emission within the supply chain (Bhatt et al., 2018). As consumers are willing to pay more for environmentally friendly products (Bernard & Bernard, 2009; D'Souza, 2004; Lee, 2008, 2009; Marette et al., 2012; Rahbar & Wahid, 2011), it was assumed that consumers are willing to pay an additional premium. To test this, people had to indicate their willingness to pay for two VASP products

Overall, 43% of the survey participants indicate they would pay a premium for food products when an upcycled production approach is used. The result is comparable to earlier studies on organic food from Meier-Ploeger and Woodward (1999), where 52% of the German consumers of their sample were willing to pay more for organic fruits and vegetables. Regarding the whole sample, the consumers are on average willing to pay an additional 10% more for VASP compared to conventional products. After equalizing the age bias in the sample to get a more representative value, an average willing to pay of 10,37% additional premium for upcycled products than for conventional products could be observed. This indicates that there is a significant difference in the willingness to pay for VASP compared to conventional food products.

Regarding the fact that consumers are ready to pay a price premium of around 30% for organic food products (Aschemann-Witzel & Zielke, 2017), the results are clearly in line with the assumption of Bhatt et al. (2018) that participants see VASP foods as a unique food category within the spectrum of foods ranging from conventional to organic (Bhatt et al., 2018).

Moreover, the willingness to pay an additional premium implies that consumers accord VASP, in contrast to suboptimal products, “a premium status vis-à-vis conventional products” (Bhatt et al., 2018). This signals the possibility to position VASP as premium products with a premium price, as VASP comes with additional benefits to society. Interestingly, this finding contrasts with McCarthy et al. (2020) who suggest a higher price may not be appropriate for VASP since consumers may expect it to be discounted due to its association with food waste and sub-optimal food. As discussed earlier, the quality perception of VASP is similar to conventional products, hence an

association with food waste or sub-optimal food is not likely. Even worse, a price reduction could trigger associations with suboptimal foods and food waste as price discounts can simultaneously signal and confirm consumers' perceptions that the product is of lesser quality (Tsiros & Heilman, 2005). Thus, the dual role of price should be leveraged to increase the quality perception of VASP. The dual role of price concept argues that a higher price could discourage purchase intention, but can also signal quality, safety or health cues (Erickson & Johansson, 1985).

After all, the results suggest that the consumers value the effort for rescuing the food with a higher price acceptance. Consumers are open to paying more money in order to reduce the amount of food waste. This is especially interesting for supply-chain actors who cite barriers in the form of added expenses to sell value-added products (Duarte Alonso & Northcote, 2013). Emphasizing on Del Giudice et al. (2016) the price premiums for VASP could compensate for the added expenses of the food producers and ensure the profitability of their businesses.

6.4 Hypothesis 3: Food technology neophobia

H3: Customers with food technology neophobia show a decreased willingness to pay for VASP food

Value-added surplus products are relatively novel, and accordingly, the production process behind VASP is also relatively new in a way that novel technologies are used to recycle formerly wasted foods. As a consequence, consumers might be averse to VASP due to risk aversion and perceptions of "unnaturalness" (Lusk et al., 2014). This so-called food technology neophobia can hamper the willingness to pay for products. For examining if food technology neophobia also influences the WTP for VASP, consumers degree for food technology neophobia was measured and compared concerning their willingness to pay for VASP.

The results indicate that the degree of food waste neophobia of a consumer does not influence their willingness to pay for VASP. Accordingly, it can be assumed that consumers do not perceive the modified production process with novel recycling technologies as risky or unnatural.

When looking at the dimension of riskiness, indeed, the production process of the two VASP product presented is just slightly changed compared to the conventional process. Only the selection criteria of the ingredients are adapted, but the ingredients itself remained the same. This might also be the reason why the results of this study contradict the findings of Coderoni & Perito (2020), who observed a strong influence of FTN on the willingness to buy VASP food. The production

process behind the VASP used as example products in their study were more complex, as they were enriched with underutilized by-products deriving from olive oil production, which represents a novel ingredient. Accordingly, it can be assumed that the complexity of the VASP products regarding their ingredients is an essential driver on the degree of influence of the consumer's food technology neophobia on the willingness to pay.

When looking at the dimension of unnaturalness, explanation for missing influence of FTN can be found in the perception of VASP. As already discussed, VASP is perceived as green or environmental-friendly food (Bhatt et al., 2018). This is in contrast to the associations with new food technologies, which are perceived as unnatural (Lusk et al., 2014). Accordingly, using technologies to avoid wastage in the supply chain might be perceived as an additional process quality, increasing the naturalness of the product, similarly to organic foods (van Herpen, van Nierop, & Sloot, 2012; Van Huylenbroek et al., 2009). Thus, it can be expected that pro-environmental attitudes (Loebnitz, Schuitema, & Grunert, 2015) or sustainability-related motives in food choice (Sautron et al., 2015) might overweight the aversion of new food technologies in VASP products.

6.5 Hypothesis 4: Food Waste Awareness

H4: Customers with a strong awareness of the food waste issue will show a higher willingness to pay for VASP food

As the reduction of food waste is the differentiating point between VASP and conventional products, it was argued that consumers would only be ready to pay an additional premium for VASP if they show a high awareness of the food waste problem.

By measuring consumer's awareness of food waste for two factors and compare it with the willingness to pay for VASP products, it was tested if this assumption can be confirmed. The two factors used, termed 'Awareness of the environmental impact of food waste' and 'Awareness of food value', emerged from a factor analysis of a set of questions which measures the awareness of food waste in different dimensions.

Interestingly, the results are not exact, and the hypothesis can just be partly confirmed. From the two dimensions of food waste awareness, only the factor measuring the awareness of the environmental impact of food waste indicates a significant influence on the willingness to pay a premium price. The factor measuring the awareness of food value does not seem to influence the willingness to pay a premium significantly.

Regarding the missing influence of the factor ‘Awareness of food value’, it can be assumed that just appreciating food is not enough to encourage a pro-environmental purchasing behaviour like paying a premium for VASP products to reduce food waste. An explanation for this can be found in the relation of norms and behaviour. Attribute high value to food and knowing that food waste should be avoided can be seen as a long-established, cross-cultural moral norm which says to appreciate food and always be thankful for it. But for moral norms to influence behaviour, they must be activated by the person's awareness of the consequences of his potential actions (Schwartz, 1968). However, being aware of the value of food does not necessarily indicate that the person is aware of the consequences caused by wasting these and therefore do not see a need to act against it. Thus, only being aware of the value of food is just a pre-condition, but not a driver to change the purchasing behaviour in order to take action.

Another reason why there is no relation observed might be in the simplicity of the questions used to determine the factor. As consumers had to indicate how much they agree with statements which represents a commonly moral norm, high ratings are very likely. This can also be seen in the mean of the factor representing the three statements, which is at 6,2 on a scale from 1-7, whereby 7 indicates the highest possible agreement. Therefore, the factor is not ideal to evaluate the consumer's awareness of the food waste problem.

Clearer results could be observed with the second factor. Consumers who are aware of the consequences of food waste on the environment tend to be encouraged a pro-environmental behaviour and are willing to pay a premium price. This result emphasizes the results of Schwartz (1968) that foremost the awareness of consequences influences the behaviour. When knowing about the massive impact of food waste on the environment, consumers are open to paying more as a consequence to reduce the impact. These findings are in line with the research findings on sub-optimal food (de Hooge et al., 2017) and VASP in Australia and UK (McCarthy et al., 2020), where a high awareness of the food waste issue drives consumers purchase intentions and increases the willingness to buy. With the results of this study, it can now be seen that consumers with a high awareness of the environmental impact of food waste would be not only willing to buy but also willing to pay a premium for VASP.

6.6 Customer Segmentation

As VASP are a novel kind of food product with a new set of characteristics, it will presumably attract new customer segments that have not been identified yet. For identifying and define the customer segments, a two-step cluster analysis was conducted.

Unfortunately, no clear customer segments could be discovered based on socio-demographic data.

This result indicates that there are no consistent preferences among the customers and an ideal customer segment is not definable, based on the data available. Reasons for that can be based on the bias in socio-demographic data towards highly educated consumers between 25-34 or because the number of socio-demographic attributes asked for were not big enough.

Furthermore, the psychographic data per consumer could have been included and extended with additional data like values and beliefs, purchasing behaviour, or attitudes towards society and the environment. Including these, the clustering may have resulted in more precise segments.

Since the clustering based on socio-demographic data could not lead to clear segments, a clustering based on the customer's willingness to pay for VASP was conducted. This cluster analysis identified five clusters representing five levels of consumer's willingness to pay. For characterizing the clusters, the socio-demographic attributes which were most strongly presented in the clusters and the means of the four psychographic factors were used. The clusters identified can be seen in Table 15.

Table 15: Cluster identified in two-step cluster analysis

Cluster	Attributes
Cluster I – Very high willingness to pay a premium	People who have a very high willingness to pay a premium price of around 133% are mainly female, with a monthly net income of over 3.000€, aged between 35-44, completed a University entry qualification, have two children and are self-employed. Furthermore, they are showing the highest mean in awareness of food waste impact and awareness of food value and the lowest mean in food technology neophobia. This cluster is by far the smallest and only represented by 5 study participants.
Cluster II – High willingness to pay a premium	People who have a high willingness to pay a premium price of around 55% are mainly male persons with a monthly net income of 2.000-2.500€, aged between 18-24, completed a university degree, have no children and are students. Furthermore, they are showing the highest mean in food technology neophobia and quality perception of upcycled products.
Cluster III – Willing to pay a premium	People who are willing to pay a premium price of around 22% are mainly female persons with a monthly net income of 1000-1.500€, aged 18-34, completed a university degree, have two children and do homeduties. In psychographics, they are showing average means in all factors.

Cluster IV – Willing to pay the same price	People who are willing to pay the same price for VASP as for conventional products are mainly male with a monthly net income of 2.500-3.000€, aged 55-64, have a university entry qualification, have no children and are students. In psychographics, they are showing average means in all factors.
Cluster V – Decreased willingness to pay	People who have a decreased willingness to pay for VASP compared to conventional products are mainly female with a monthly net income of 1.500-2.000€, aged 65 or older, completed the secondary or elementary qualification, have 3 children and are retired. Furthermore, they are showing the lowest mean in awareness of environmental impact of food waste, quality perception of upcycled food and awareness of food value.

As the indicated price premiums might seem unrealistic, evidence for plausibility can be found by Zanoli and Naspetti (2002) who concludes that the amount of premiums is generally underestimated as respondents' "free-riding" behaviour is underrated. For example, studies found out that final consumers may even pay up to 300% premiums for organic purchases (Krystallis & Chryssohoidis, 2005).

Some of the clusters identified show similarities to clusters observed in other studies for different variations of food. For organic food and sustainable seafood, it was observed that higher income and better education lead to significantly higher probabilities of belonging to the cluster with a WTP an additional premium (Hjelmar, 2011; Van Huylenbroek et al., 2009; Zander & Feucht, 2018). These findings can be partly confirmed with the clusters identified in this study. Income seems to play a minor role as consumers of cluster III have a comparably small monthly income but are willing to pay a premium, in contrast to consumers belonging to cluster IV who have a comparably high monthly income. This supports recent research indicating that education can be a more significant discriminating factor than income (Krystallis & Chryssohoidis, 2005; Monier, Hassan, Nichèle, & Simioni, 2009) for the willingness to pay. Regarding this similarity, it can be assumed that people who are willing to pay a premium for organic food and sustainable seafood are also willing to pay more for VASP. Accordingly, these customer segments can be used as an orientation for future marketing efforts.

Consumers of cluster 1 of this study are comparable with the consumers of the cluster "status and convenience seekers" identified from McCarthy et al. (2020) regarding VASP. There, the consumers are young (below 40 yrs. Old), have a full-time or part-time job, and more of them have a larger family size (three or more family members). Excluding age, the employment status, and size of family in terms of children living in the household are comparable with cluster 1 of this study. Regarding this, it can be assumed that German consumers, who are willing to pay a very high premium for VASP, show similar characteristics in status and convenience seeking.

The main attributes of cluster V are for the most prominent part comparable with a recent study about sub-optimal food purchasers. It was observed that respondents needed a higher discount before they would purchase sub-optimal products when being female, higher in age, lower in education and less aware of the consequences of food waste (de Hooge et al., 2017). In line with the quality perception of upcycled food, it indicates that consumers of cluster V are still uncertain about the quality of VASP and still see a similarity to suboptimal products.

The consumers of the five cluster show different psychographic and socio-demographic profiles. This is in line with the general food marketing literature, which suggests that there are multiple types of sustainability-conscious consumers showing different expectations, attitudes, and demographics (McCarthy, 2020). Therefore, companies should implement targeted strategies instead of a "one size fits all' mentality (Balderjahn, 2003).

6.7 Implications

6.7.1 General

With 78% indicating to be willing to pay at least the same amount of money as for similar conventional products, VASP products are very likely to be accepted by consumers in Germany. Therefore, VASP shows high potential to reduce food waste in a sustainable way. Food supply chain actors like farmers, food processors and distributors are thus encouraged to adopt circular economy principles and reinsert formerly wasted fruits and vegetables into the production process to produce new food products.

6.7.2 Quality

The results show that people do not perceive VASP products as of lesser quality than conventional food. Only on the dimension of freshness, VASP is perceived as of less quality. Research could dig more in-depth on the causes for this, as possible reasons stated in this study are just anticipated. For organizations, communication efforts to promote VASP should emphasize this and highlight how the freshness of the fruits and vegetables is secured within the supply-chain. This could be done, for example, by showing the real-time difference in the production time of conventional and VASP products.

6.7.3 Premium status

The study results indicate a possible positioning of VASP as premium products. Around 43% of the study participants were willing to pay an additional price premium. Thereby, premiums of up to 10% compared to similar conventional products are realistic. Accordingly, VASP products do not have to be positioned with a lower price compared to conventional products, as suggested by former research. On the contrary, in general, people seem to value the aspect of the additional effort to safe food from being wasted and do not expect price discounts due to an association with suboptimal food or food waste. Furthermore, the results also confirm the assumption that VASP can be defined as a new kind of food product similar to organic food.

6.7.4 Food Technology Neophobia

On the contrary to other studies on VASP products (Coderoni, 2020), the VASP products used in this study did not trigger food technology neophobia. This indicates that a general statement about food technology neophobia influencing consumers perception of VASP cannot be made. Moreover, it turns out that VASP should be separated in different types, while each type comes with different attributes which trigger different psychological factors.

6.7.5 Food Waste Awareness

The awareness of environmental impact of food waste strongly influences the willingness to pay for VASP, indicating that especially environmentally conscious consumers are a promising customer segment. Drawing from this, this study shows that VASP should be considered in studies on ethical and sustainable consumption. The acceptance of novel products made from formerly wasted foods is expected to be for a significant part dependent on ethical behaviour. Additionally, the study indicates that moral norms like the awareness of food value do not seem to influence the willingness to pay. This result should be treated as an indication, whereas more research on the influences of morals and norms on purchasing behaviour for VASP can emphasize on. Moreover, the results suggest that marketing effort should emphasize on the consequences of food waste on the environment and how buying VASP products could reduce it. General statements about how much food waste is generated every year and that food should be valued more are less prone to increase the willingness to pay.

6.7.6 Customer Segments

Five customer segments could be identified, whereby each shows a different willingness to pay. As age and educational background and have a significant influence on the willingness to pay, customer segments with high educational background and younger age (>40 years) are the most promising. Strong emphasize on sustainability and societal benefits through the reduction of food waste is anticipated to increase the likelihood of purchase for these segments. For older and less educated people, awareness campaigns could help to increase the awareness of the environmental impact of food waste. Furthermore, advertisement focusing on the transformation of food waste to VASP could help to increase the quality perception and therefore, the willingness to pay. All in all, the rough personas of the five segments can be used to frame marketing appeals for VASP products, create targeted strategies to reach the consumer segments and conduct more research on the clusters indicating a willingness to pay premium prices.

7 Limitations and Future Research

When looking at the limitations of the study, various aspects must be considered. First, the sample size used for this study is sufficient, but a bigger size could further increase reliability.

Second, the sample is not representative of the German population. Hence, there are limitations regarding the extent to which the findings can be generalized to the broader population. The examined WTP might be biased as most participants may be more aware of sustainability issues, compared with other generations, as young adults seem to be particularly sensitive to this topic (Del Giudice et al., 2016). Future research should examine the WTP for VASP of more equally distributed samples considering the socio-demographics for more reliable results.

Third, a limitation stems from the used method to examine the WTP as the stated preference approach may be subject to response biases (Mishra, 2003). This bias leads to a gap between stated and revealed or real WTP. This gap is also called attitude-behaviour gap and is a commonly cited phenomenon (Coderoni & Perito, 2020; de Pelsmacker et al., 2005; Michaud & Llerena, 2011; Zander & Feucht, 2018) in WTP studies as consumers state high WTP in surveys but behave differently at the point of sale. Future studies should try to narrow this attitude-behaviour gap by using more complex WTP measuring methods. For example, experimental methods which elicit the WTP of participants instead of requesting them to state their WTP could be used.

A fourth limitation can be found in the limited use of psychographic attributes to describe customer segments. A large number of studies contend that socio-demographics lack explanatory power (Bartels & Reinders, 2010; Buder, Hamm, Bickel, Bien, & Michels, 2010; Gracia & de Magistris, 2008; Krystallis & Chryssohoidis, 2005; Renko, Vignali, & Żakowska-Biemans, 2011) and fall behind psychographic factors (Van Huylenbroek et al., 2009). Future studies should examine more psychographic factors of the participants, to get a better understanding of the constructs determining attitude towards the willingness to pay for VASP food and their behaviour.

Apart from the limitations, future research on VASP should test other constructs that might influence the willingness to pay, such as taste, eating/drinking habits, branding and labelling, eco-certification, natural attributes, or visual appearance. Also, the influence of the purchasing situation and setting factors (i.e. supermarket and farmers market (see van Giesen and de Hooge (2019)) on the WTP are of interest. Furthermore, as there are different types of VASP already observable (as discussed in section 2.1 and 6.3), a classification of VASP would be helpful to better understand

and conduct research on it. Moreover, future research could try to calculate the additional cost supply-chain actors had to face to rescue and re-insert wasted foods. By this, it could be determined if the additional premium prices for VASP can compensate the additional cost for producing them. Lastly, future research should examine the willingness to buy on an organisational level. More precisely, if public or private organisations consider VASP as a potential substitute for conventional food products within their purchasing behaviour.

8 Conclusion

This study examined the market side of value-added surplus products (VASP), a novel food product category which makes use of previously wasted foods. By conducting an online survey with 201 participants, it was tested how much people would be willing to pay for VASP and what are the drivers for it. Additionally, customer segments were formed based on the willingness to pay for easier targeting of marketing and policy activities. This paper provides several contributions to the food waste and ethical and sustainable consumption literature. Being the first to identify consumers segments for VASP in Germany, this study additionally enriches the literature on customer segmentation for novel foods.

The data observed from consumers in Germany shows a high potential and market feasibility for VASP, a novel food product that can help to reduce food waste. With 78% of the participants willing to pay at least the same as for conventional products, an overall positive attitude towards VASP as a new kind of food can be observed. Based on the obtained data, earlier assumptions on a potential decreased quality perception of VASP due to associations with suboptimal food or food waste can, for the most part, not be confirmed. Moreover, a general willingness to pay an additional premium price of around 10% for VASP was examined, emphasizing the suggestion that VASP is perceived as a new kind of food within the spectrum of conventional and organic food (Bhatt et al., 2018). Thereby, the quality perception towards VASP and the awareness of the environmental impact of food waste are the most critical drivers of the willingness to pay a premium. Food technology neophobia did not influence the willingness to pay, even though VASP is a novel food. It is assumed that this is mainly because the VASP presented as examples in this study showed very high similarities with well-known products. Finally, it could be observed that customer segments for VASP are equal to customer segments for organic and sustainable food, whereas older people with lower educational background are less open for VASP and expect price discounts. These segments can be used to better target marketing strategies and policies to increase the acceptance and purchase likelihood of VASP.

In conclusion, VASP can be considered a promising solution to tackle the problem of food waste in an economically sustainable way. Existing food manufacturers should start examining the integration of VASP products in their portfolio, and new start-up companies can use the insights of this study to build new business models for promoting VASP food.

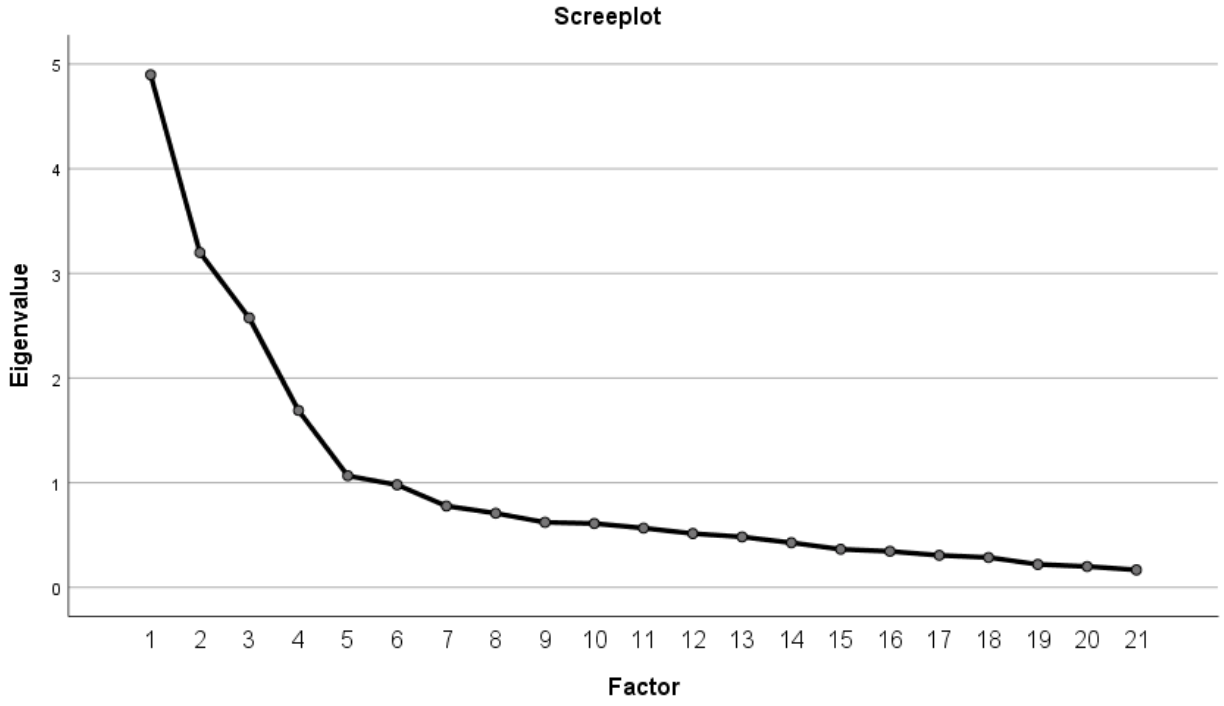
9 Appendix

9.1 Appendix A – Factor analysis

Appendix A.1: Factor analysis explained total variance

Explained total variance						
	Initial Eigenvalues			Rotated sum of squared charges		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,898	23,323	23,323	4,581	21,815	21,815
2	3,199	15,233	38,556	2,866	13,645	35,460
3	2,574	12,259	50,815	2,810	13,379	48,840
4	1,690	8,048	58,862	2,105	10,023	58,862
5	1,066	5,078	63,941			
6	980	4,666	68,606			
7	777	3,700	72,306			
8	708	3,373	75,679			
9	622	2,960	78,639			
10	611	2,907	81,546			
11	566	2,696	84,241			
12	514	2,450	86,691			
13	482	2,297	88,988			
14	426	2,031	91,019			
15	364	1,733	92,751			
16	345	1,642	94,393			
17	306	1,457	95,850			
18	286	1,360	97,210			
19	219	1,045	98,255			
20	200	950	99,205			
21	167	795	100,000			
Extraction method: principal component analysis.						

Appendix A.2: Screeplot Factor Analysis



9.2 Appendix B – Survey

9.2.1 Survey block 1 – Willingness to pay

In the picture you can see a regular jar of strawberry jam (250 gr.) and a bottle of apple juice (1 liter) produced with conventional methods. The apples and strawberries are produced through farming methods that may use acceptable amounts of synthetic fertilizers, pesticides, or herbicides. The vast majority of foods are produced using conventional methods.

QUESTION 1:

Please indicate the amount of money (x,y€) you would be willing to pay for the **Strawberry Jam.**

QUESTION 2:

Please indicate the amount of money (x,y€) you would be willing to pay for the **Apple Juice**.

Introduction to the Upcycled production method

Around a third of all food that is produced is lost at some point across the food supply chain. This occurs from farm to fork: during on-farm to post-harvest handling and storage; processing and

packaging; distribution and in the market; and lastly by the consumer. There are several reasons for this, for example large proportion of foods are sorted out because of aesthetic defects.

Upcycled products are foods created using these by-products (the “lost food”). By rescuing the by-products from being discarded and re-insert them into the value-chain, the amount of food being lost can be reduced.

In the picture you can see a jar of strawberry jam (250 gr.) and a bottle of apple juice (1 liter) produced with **upcycled production methods***. The apples and strawberries are produced through farming methods that may use acceptable amounts of synthetic fertilizers, pesticides, or herbicides.

QUESTION 3:

Please indicate the amount of money (x,y€) you would be willing to pay for the **upcycled* Strawberry Jam.**

QUESTION 4:

Please indicate the amount of money (x,y€) you would be willing to pay for the **upcycled* Apple Juice**.

9.2.2 Survey block 2 – Perceived quality

QUESTION 5:

Have you already consumed products produced in an upcycled production method*?

- ○ Yes
- ○ I am not sure
- ○ No

QUESTION 6:

Compared to the products produced in a conventional way, how do you expect the quality of the products produced in an upcycled way, with regard to:

	1 – Quality is clearly below	2	3	4 – Quality is the same	5	6	7 – Quality is clearly above
How good it tastes	○	○	○	○	○	○	○
The healthiness of the product as such	○	○	○	○	○	○	○
How fresh it is	○	○	○	○	○	○	○
Its quality overall	○	○	○	○	○	○	○

QUESTION 7:

Compared to the products produced in a conventional way, how did you perceive the quality of the products produced in a upcycled way, with regard to:

	1 – Quality is clearly below	2	3	4 – Quality is the same	5	6	7 – Quality is clearly above
How good it tastes	○	○	○	○	○	○	○
The healthiness of the product as such	○	○	○	○	○	○	○
How fresh it is	○	○	○	○	○	○	○
Its quality overall	○	○	○	○	○	○	○

9.2.3 Survey Block 3 – Food technology Neophobia

The following questions are not especially related to the upcycled production method, but your general attitude towards new technologies used in the food production sector.

QUESTION 7:

When thinking generally about new food technologies, please indicate how much you agree with the following statements:

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
"There are plenty of tasty foods around so we don't need to use new food technologies to produce more."	○	○	○	○	○	○	○
"The benefits of new food technologies are often grossly overstated."	○	○	○	○	○	○	○
"New food technologies decrease the natural quality of food."	○	○	○	○	○	○	○
"New food technologies are something I am uncertain about."	○	○	○	○	○	○	○

QUESTION 8:

Please indicate how much you agree with the following statements:

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
"Society should not depend heavily on technologies to solve its food problems."	○	○	○	○	○	○	○
"New food technologies may have long term negative environmental effects."	○	○	○	○	○	○	○
"It can be risky to switch to new food technologies too quickly."	○	○	○	○	○	○	○
"New food technologies are unlikely to have long term negative health effects."	○	○	○	○	○	○	○

9.2.4 Survey Block 4 – Food Waste Awareness

The following questions are related to food waste and its impact on the environment.

QUESTION 9:

Please indicate how much you agree with the following statements:

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
"Food thrown away is natural and biodegradable and thus not an issue for the environment"	○	○	○	○	○	○	○
"In Germany, packaging waste is a greater environmental issue than food thrown away"	○	○	○	○	○	○	○
"Food thrown in compost or biowaste is not a problem, as it is natural and biodegradable"	○	○	○	○	○	○	○
"Composted food is not a problem for the environment since the nutrients are recycled"	○	○	○	○	○	○	○

QUESTION 10:

Please indicate how much you agree with the following statements:

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
"In Germany, households are responsible for a great proportion of the food waste"	○	○	○	○	○	○	○
"Food waste is a big environmental issue"	○	○	○	○	○	○	○
"Food waste is an important social issue (e.g. hunger in the world)"	○	○	○	○	○	○	○
"Foods are gifts of nature and have to be treated as such"	○	○	○	○	○	○	○
"Foods are scarce over the world and should be consumed consciously"	○	○	○	○	○	○	○

9.2.5 Survey block 5 – Socio-demographics

The following questions are about socio-demographic information. Have in mind that your answers are 100% anonymous, so they cannot be traced back to you.

QUESTION 11

How do you currently describe your gender identity?

- ○ Male
- ○ Female
- ○ Diverse

QUESTION 12

What is your monthly net income?

- ○ < 1.000€
- ○ 1.000 - 1500€
- ○ 1.500 - 2.000€
- ○ 2.000 - 2.500€
- ○ 2.500 - 3.000€
- ○ over 3.000€

QUESTION 13

Age

- ○ Under 18
- ○ 18 - 24
- ○ 25 - 34
- ○ 35 - 44
- ○ 45 - 54
- ○ 55 - 64
- ○ 65 or older

QUESTION 14

Employment Status

- ○ Employed full time
- ○ Employed part time
- ○ Unemployed
- ○ Retired
- ○ Student
- ○ Homeduties
- ○ Self-employed
- ○ Other

QUESTION 15

Educational Background

- ○ No qualification
- ○ Secondary or elementary schooling (German: Haupt-/Volksschulabschluss)
- ○ High school (German: Realschulabschluss)
- ○ College or university entry qualification (German: Abitur)
- ○ University Degree (German: Hochschulabschluss)

QUESTION 16

Children (Person under 14 years) in Household

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ > 3

End of Survey

9.3 Appendix C – Items used to measure socio-demographic and psychographic data

Appendix C.1: Items used to measure psychographic data

Topic/ Construct	Question(s)	Scale	Operationalization	Source
Experience with upcycled products	Have you already consumed upcycled products?	Categorial	Yes No Not sure	Self-designed
Perceived Quality (PQ)	Compared to the products produced conventionally, how do you perceive the quality of the products produced in an upcycled way, with regard to: How good it tastes The healthiness of the product as such How fresh it is The quality overall	Likert	Quality is clearly below (1) – Quality is clearly above (7)	Aschemann-Witzel et al., (2019) modified from Grunert, 2005; Oude Ophuis & Van Trijp, 1995
Food waste awareness (FWA)	Environmental impact of food waste: "Food thrown away is natural and biodegradable and thus not an issue for the environment." "In Germany, packaging waste is a greater environmental issue than food thrown away." "Food thrown in compost or biowaste is not a problem, as it is natural and biodegradable." "Composted food is not a problem for the environment since the nutrients are recycled." Awareness of food waste: "In Germany, households are responsible for a great proportion of food waste." "Food waste is a big environmental issue." "Food waste is an important social issue (e.g. hunger in the world)" "Foods are gifts of nature and have to be treated as such."* "Foods are scarce over the world and should be consumed consciously."	Likert	Strongly disagree (1) – Strongly agree (7)	Modified from Delley and Brunner (2017) *Gjerris and Gaiani (2013)
Food technology neophobia (FTN)	New food technologies are unnecessary: "There are plenty of tasty foods around, so we don't need to use new food technologies to produce more." "The benefits of new food technologies are often grossly overstated." "New food technologies decrease the natural quality of food."	Likert	Strongly disagree (1) - Strongly agree (7)	Cox & Evans, 2008

Topic/ Construct	Question(s)	Scale	Operationalization	Source
	"New food technologies are something I am uncertain about." Perceived risks: "Society should not depend heavily on technologies to solve its food problems." "New food technologies may have long term negative environmental effects." "It can be risky to switch to new food technologies too quickly." "New food technologies are unlikely to have long term negative health effects."			

Appendix C.2: Items used to measure socio-demographic data

Question	Answer options	Source
How do you currently describe your gender identity?	- Male - Female - Diverse	Self-designed
What is your age?	- Younger than 18 - Between 18 and 24 - Between 25 and 34 - Between 35 and 44 - Between 45 and 54 - Between 55 and 64 - Older than 64	Modified from (Zander & Feucht, 2018)
What is your monthly net income?	- < 1.000€ - 1.000 - 1500€ - 1.500 - 2.000€ - 2.000 - 2.500€ - 2.500 - 3.000€ - over 3.000€	Self-designed
What is your Employment Status?	- Employed full time - Employed part-time - Unemployed - Retired - Student - Home duties - Self-employed - Other	Modified from McCarthy et al. (2020)
What is your educational background?	- No qualification - Secondary or elementary schooling (German: Haupt-/Volksschulabschluss) - High school (German: Realschulabschluss) - College or university entry qualification (German: Abitur) - University Degree (German: Hochschulabschluss)	Self-designed

Question	Answer options	Source
Children (Person under 14 years) in the household?	- 0 - 1 - 2 - 3 - More than 3	Self-designed

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