Waste or Want: Does processing have an effect on the desirability of upcycled food products?

A Swedish consumer acceptance study

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Abstract

Food waste presents a significant obstacle to the food system's transition to sustainability. With an ability to mitigate industrial food waste and its effects, the concept of upcycled food aims to safely adapt elements from the waste streams for human consumption by transforming them into ingredients to be used in novel 'upcycled' food products. Inherently therefore, all upcycled foods are processed to some extent. This thesis calls into question whether the degree of processing of (i) the upcycled food products and (ii) the upcycled ingredients themselves, have an effect on the consumer acceptance of upcycled foods. A survey constructed using contingent valuation method (CVM) was administered to 404 Swedish consumers online. Participants were first asked to choose between upcycled and conventional alternatives of hypothetical products (green juice, sourdough breads and vegan nuggets), then asked to elicit a willingness to pay (WTP) for the upcycled products relative to the conventional ones. Additional questions about food values and demographics were included to form a broader understanding of the sample. Results show that respondents had a higher relative WTP for less processed upcycled products, and a low relative WTP for highly processed upcycled products. The trend was not as clear for upcycled ingredients, where the only significant response showed that respondents were WTP less for more processed upcycled ingredients relative to conventional products. Results also reveal that respondents with a high valuation of environmental impacts are correlated with a higher relative WTP for upcycled foods. Participants valuing naturalness and safety in their food purchasing behaviour have a low relative WTP for upcycled foods. Finally, higher education, a younger age and being male were correlated to a greater acceptance of upcycled foods. Ultimately, upcycled foods are complex products, and whilst the degree of processing has an effect on acceptance, there are many important attributes in any one product, making it a challenge to select which aspects to communicate to the consumer for the largest consumer response.

Keywords: Upcycled foods, food processing, consumer acceptance, contingent valuation method, consumer behaviour.

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Abbreviations

BSG	Brewer's spent grains
CVM	Contingent valuation method
EC	European Union
EU	European Commission
FAO	The UN's Food and Agriculture Organisation
FLW	Food loss and waste
IPCC	Inter-governmental panel on climate change
UN	United Nations
WTP	Willingness to pay
WTA	Willingness to Accept

1. Introduction

1.1 Background

Food systems face significant challenges in securing long-term food security, nutrition and systemic resilience in today's globalized context (FAO et al. 2022). In addition, food systems contribute to a range of environmental impacts. For example, research estimates that food systems account for up to thirty percent of all greenhouse gas emissions (Crippa et al. 2021, Poore & Nemecek 2018, Foley et al. 2011). One major contributor to this is the prevalence of food loss and waste (FLW) throughout our value chains, with recent estimates suggesting that up to one third of food produced globally is wasted (IPCC 2019). Though the issue has been widely recognised, notably with the UN's Sustainable Development Goal 12.3 which aims to halve global food waste per capita by 2030, FLW persists. The European Commission has echoed these aims to bolster both the European Green Deal and the Circular Economy Action Plan with a proposal to set legally binding food waste reduction targets for 2030 (EC 2023). As an EU member state, Sweden recognizes the importance of FLW and has set its own national targets to reduce food waste weight by 20% per capita before 2025, though this only applies to waste occurring at household, restaurant, catering and retail (Livsmedelsverket 2018, sverigesmiljomal.se). Occurring before the point of retail, Swedish aims maintain that food losses should decrease and more should be made into food without stating any quantitative targets (sverigemiljömål.se). Generally, targets can be difficult to set, as harmonizing methodologies that record the prevalence of FLW is as significant an obstacle as combatting their causes (Corrado et al. 2019). FLW is a complex issue that requires a range of efforts by multiple actors, making coordinated and nuanced FLW definitions key to identifying and formulating actionable mitigation strategies (*ibid.*).

One potential FLW mitigation strategy that has received increased attention in recent years is the practice of food upcycling. Upcycling food refers to safely adapting food materials that would otherwise have gone to waste and valorising them for human consumption, most often in the context of other or novel food products (Spratt et al. 2021, Aschemann-Witzel et al. 2023, Moshtaghian et al. 2021). Essentially, food upcycling can be considered an application of Circular Economy principles to the food industry (Sousa et al. 2021). Also referred to as side-stream valorisation, value-added surplus and waste-to-value products

(Teigiserova et al. 2020, Coderoni & Perito 2020, Aschemann-Witzel & Peschel 2019), these solutions target FLW generated early in the supply chain, where literature suggest reduction efforts are most impactful (Bhatt et al. 2020). Recent estimates by the European Commission show that 31% of food waste in the EU is generated by production and processing (EC 2022). This puts the onus on industrial food production companies to take action in identifying, reporting and finding innovative pathways to upcycle their by-product streams. However, to incentivise this effort, industry actors must understand if there is a potential market for these new, upcycled, products.

1.2 Problem statement and research gap

As a relatively novel notion, upcycled foods face not only challenges in technical product innovation and development (Hellali & Koraï 2023), but also requires consumers to actively participate in purchasing and decision-making about upcycled foods (Bhatt et al. 2017). Proponents suggest that when such challenges are overcome, upcycled foods contribute to a more effective system of food production, in which a greater proportion of the nutrient profile of primary produced crops are put to use in a secondary food product. This suggests a reduction in stress on agricultural systems (as those reclaimed nutrients substitute otherwise additionally cultivated crops) and a reduction of FLW in the earlier stages of the supply chain. The Upcycled Food Association additionally maintains that upcycled foods should have lower environmental impacts than identical foods without upcycled ingredients (Upcycled foods definition task force 2020). A lower environmental impact has also been seen as one of the main aspects that attracts consumers to upcycled foods (Aschemann-Witzel et al. 2023; Peschel & Aschemann-Witzel 2020).

Today, it is relatively common practice for industrial food producers in Sweden to engage in side stream valorisation (Hagman 2023). This can happen in a number of constellations with other actors, as typified by Magnusson et al. (2019), some of which specialize in valorisation of side streams to food products, but most of which are focused on biogas or animal feed solutions (*ibid*.). Several studies hint at the potential economic benefits from upcycling foods (Mirosa & Bermer 2023, Sousa et al. 2021). However, this relies on how upcycled foods perform on the market, specifically, which upcycled foods have an appeal to what kind of audience.

It is perhaps why the majority of the studies surrounding upcycled foods are consumer acceptance and willingness to pay studies. From this literature, some consumer and product-related trends have emerged, upon which preliminary understandings can be formed on the potential performance of upcycled products. Processed food has had an increasing presence in our diets and acts as a cornerstone of food production, converting raw materials into functional, edible, safe and longer lasting food products (Knorr & Sevenich 2023). Additionally, processed foods are integral to the development of more sustainable food systems, where incorporation

of relevant technologies and methods can not only make industrial food production more resilient, but also effectively make use of the full nutritional profile of foods throughout the supply chain (Knorr et al. 2020). This being said, the effects of novel technologies in food production (or technophobia) has been seen as a potential cause of rejection of upcycled foods (Hellali & Koraï 2023; Coderoni & Perito 2020). Ultimately, as all upcycled food products require some extent of processing by nature, this thesis will focus on how the degree of processing may affect the consumer acceptance of upcycled foods.

1.3 Aim and Research Questions

Consumer acceptance for upcycled foods have been studied in a number of areas of the world, there are however, a limited amount of studies that pertain to the Swedish context. The aim of this thesis is to add to the literature of upcycled foods by conducting an acceptance study with a panel of Swedish consumers and to ascertain what role product and upcycled ingredient processing has on the acceptance of upcycled food. As there is no previous research about if the degree of processing can change the acceptance of upcycled foods. The study will be based on a contingent valuation methodology (CVM), which is used to elicit attitudes towards nonmarket or nonuse goods, hence allowing us to test for consumer acceptance of a hypothetical market.

Research questions:

1. *What are the motivating factors for Swedish consumers to purchase upcycled foods?*

2. *How does the degree of processing of (i) the whole upcycled product and (ii) the upcycled ingredient in the product affect the consumer acceptance of upcycled food products?*

1.4 Delimitations

This thesis uses respondent data from a panel of Swedish consumers and as such, any conclusions drawn cannot be applied to the context of other countries. Additionally, the study only focuses on consumer responses to questions asked about five different hypothetical upcycled products: (1) Sourdough Bread with upcycled brewer's spent grain from beer brewing, (2) Sourdough bread with dried broccoli leaves, (3) Sourdough bread with upcycled potato protein from potato starch production, (3) Green juice with dried broccoli leaves from unharvested broccoli and (4) Vegan nuggets with upcycled potato protein from potato starch production. This data is not based on stated preferences and not actual purchasing behaviors, which means that the questions are all hypothetical in nature.

2. Problem Description

2.1 Transitioning to a circular bio-economy

Fundamentally, upcycled food products are only symptomatic of a transition to a new circular bioeconomy paradigm in food production. Acknowledging that the term circular bioeconomy lacks a single definition, Muscat et al. (2021) argue that it's purpose is to stimulate regenerative practices, limit the loss and depletion of natural resources and encourage the recycling, reuse and valorisation of unavoidable by-products to maximize their potential value in the system. This entails a transition trajectory that decouples economic growth from the linear extraction-consumption-waste patterns of raw resource use, and involves both social and technical dimensions in its scalability (Cembalo et al. 2020). In many senses, this transition is already underway in the EU, with the 2018 Bioeconomy Strategy Update as well as the European Green Deal pushing for its presence on the political agenda (Kardung et al. 2021).

Creating new relationships in the networks of industrial ecology to facilitate the transition to a circular bioeconomy is crucial. These relationships and by-product valorisation methods can manifest in a range of collaboration scenarios (see Magnusson et al. 2019). However, it remains the responsibility of the production companies to decide the best outcome for their waste and by-product management. A recent study suggests that Swedish food processing companies prefer to outsource their by-product management, which is often biogas production (Hagman 2023). In terms of national Swedish policy, the conversation about upcycled food products is affected both by national food waste reduction aims (Sveriges Miljömål 2023), and upcoming bioeconomy directives (SOU 2023:15), but to my knowledge there are is no law or policy pertaining to a requirement to valorise industrial food by-products, rather, it is driven by economic incentives in the branch (Westerman & Bicudo 2005). This is in reference to waste going to animal feed, biogas or other energy recovery methods, which are more established, especially in Sweden (Eriksson et al. 2015; Hagman 2023).

The absence of food upcycling on the waste valorisation hierarchy has been criticized by Moshtaghian et al. (2021), suggesting that its inclusion is crucial as it introduces another avenue for waste valorisation to human consumption (see figure 1). The preference order in the waste hierarchy is also based on the environmental

impacts of the management tactic (EC 2021). Notably, different methods of by-product valorisation can generate drastically different environmental impact savings (Eriksson et al. 2021; Jain & Gualandris 2023). Hence, organizations looking to upcycle a by-product should not assume that it will result in lower environmental impacts than a conventional alternative of that product, as this could depend on a number of factors i.e. valorisation technologies, geographic location and the final products that the upcycled ingredients constitute (Ott et al. 2023).

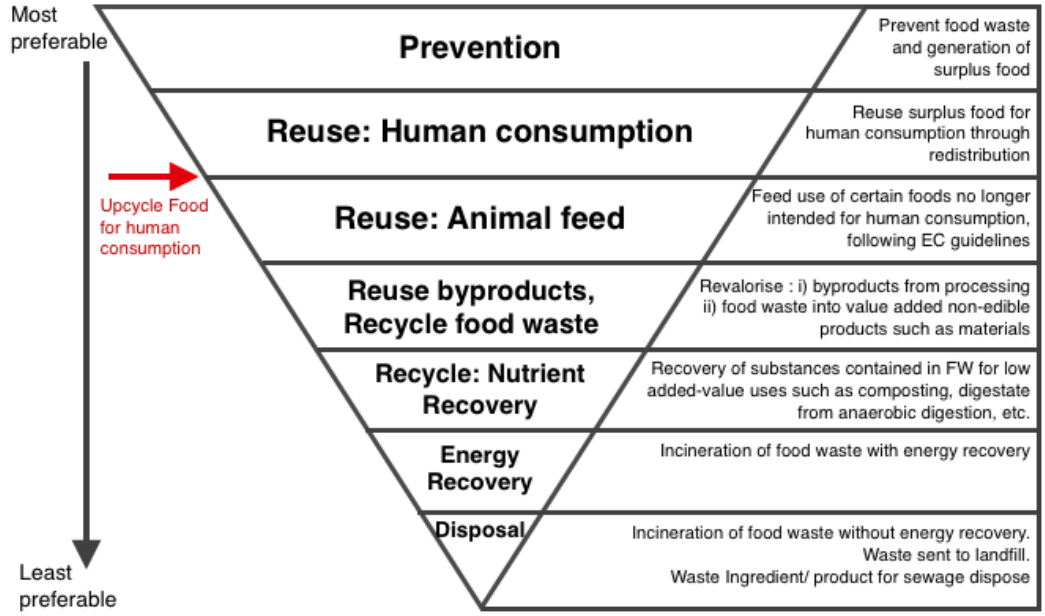

Figure 1: The food waste management hierarchy, showing mitigation strategies from most to least preferable (top to bottom). Own illustration, Adapted from (EC 2021), with addition of the upcycled foods (the red arrow) as suggested by Moshtaghian et al. 2021

2.2 Defining upcycled food

"Upcycled foods use ingredients that otherwise would not have gone to human consumption, are procured and produced using verifiable supply chains, and have a positive impact on the environment" (The Upcycled Food Definition Task Force, 2020).

Being the first country to see upcycled foods popularized in a marketable context, the above definition finds its origins in the USA, resulting from a collaboration with a range of actors from industry, government and academia (*ibid.*). Not only has the Upcycled Food Association (see upcycledfood.org) cemented the concept of upcycled food into the popular national imaginary as a singular recognisable term, but it has also formulated the grounds for certification of upcycled food products, as can be seen below in figure 2.

Figure 2: The Upcycled Food Association's product certifications symbols for upcycled food, horizontal version. (Source: https://progressivegrocer.com/upcycled-certified-mark-debuts)

The Upcycled Food Association's standard includes three categories for Upcycled Food product certifications: (1) PUI: Product Containing Upcycled Ingredients, where the product must contain ≥10% of an upcycled ingredient, (2) UI: Upcycled Ingredients, often the 'inputs' for PUIs, must, as ready to purchase products, contain ≥95% of directly upcycled food materials. Finally, (3) Minimal Content PUIs are products which do not meet the threshold requirements for PUIs or UIs, but still fulfill the standards for the certification (The Upcycled Certified™ Standards Committee, 2022).

The concept behind Upcycled food is not new, however, the term has emerged from and is informed by the era of large-scale industrial processing facilities, where food manufacturing byproduct streams are often homogenous and of sizable quantities (Jin et al. 2018; Corrado and Sala 2018). In a review of definitions of Upcycled food Aschemann-Witzel et al. (2023), point out three practical cornerstones in the categorisation of Upcycled food products: 1) the product must contain edible materials that would have gone to waste, 2) the final product is intended for human consumption, 3) the product is created in a process that increases the value of the material. The authors (*ibid.*) further argue that the value-creation of upcycled food is two pronged: on one hand, an upcycled product creates value in that it reduces food waste, and on the other, value is created because of the novel food product that is ultimately created.

2.3 Consumer acceptance of upcycled foods

Underpinning the success of valorisation of nutrients and increased resource use efficiency, is a positive consumer valuation of upcycled foods. The threat, however, is that consumers approach these novel food products with negative conceptions. An association of upcycled foods with waste may inspire thoughts of disgust or lack

of safety (Abbey et al. 2015) based on ideas of quality being lost in the process of recycling by-products (Camacho-Otero et al. 2018) or that there is a risk of contamination in the valorisation process (Baxter et al. 2017). Transparency within food production is paramount in inspiring consumer trust (Peschel & Aschemann-Witzel 2020) and any efforts by companies not to disclose the nature of upcycled foods may be detrimental, despite this potentially increasing the consumer acceptance of products created from valorised side-streams (Aschemann-Witzel & Stangherlin 2021). The preclusion of this information to the end-consumer may even limit potential benefits of upcycled products being associated with food system sustainability transitions and environmental benefits (Kamleitner et al. 2019, Bhatt et al. 2021). The following section will look at some of the emergent literature around the consumer acceptance of upcycled foods, and will be divided into two main factors: individual and product-related, in order to contextualize this thesis project.

2.3.1 Individual factors in consumer acceptance of upcycled foods

Research shows that individual factors, which make reference to demographic variables and personal characteristics, can inform if specific persons are willing to accept upcycled foods. Despite the recent attention paid to upcycled foods in academic literature, consumer knowledge about the concept is quite limited (Grasso & Alisoli 2020). Even so, upcycled foods garner some interest from participants when explained, though this does not translate to an increase in willingness to pay (*ibid.*). Ultimately, consumers are generally not willing to pay more for upcycled foods than their conventional counterparts (Bhatt et al. 2020; Peschel & Ascheman-Witzel 2020). In most cases, consumers require a discount in order to purchase these products (*ibid.*) This is interestingly contradicted by research done on Swedish panels, as will be seen in section 2.3.3 below. Notably, however, there remains a market opportunity for upcycled foods when they are sold at a lower price (McCarthy et al. 2020), even outside of the Swedish consumer context.

It is furthermore suggested that certain consumer segments are more willing to accept upcycled products. Higher consumer acceptance is for example correlated with participant characteristics such as more environmentally conscious consumers (Grasso & Alisoli 2020; Coderoni & Perito 2021) and high food waste problem awareness (McCarthy et al. 2020; Aschemann-Witzel et al. 2023). This is true in research where information about environmental and food waste impacts are communicated alongside the products (Aschemann-Witzel and Stangherlin 2021).

Sociodemographic factors have given ambivalent results across studies (Aschemann-Witzel and Stangherlin 2021); age, gender and level of education have contributed differing impacts on the acceptance of upcycled foods. As the upcycled foods category has the potential to span a vast variety of processed food products, it can be difficult to find trends in acceptance when products can have different target consumers (Spratt et al. 2021). The effect of how upcycled foods are communicated in the studies are hence fundamental to how they are perceived and

accepted by survey participants (Aschemann-Witzel et al. 2022; Peschel and Aschermann-Witzel 2020).

2.3.2 Product-related factors in consumer acceptance of upcycled foods

Several aspects of upcycled foods may cause consumers to make another, more familiar choice. Because upcycled foods often present similar to their conventional counterparts, the consumer choices are largely based on how the upcycled nature of the product is communicated.

Upcycled foods are no exception to the idea that consumers are hesitant to engage in purchasing a food product if it is unfamiliar to them (Hellali & Koraï 2023a; Coderoni & Perito 2021; Alisoli & Grasso 2021). Additionally, technophobia, also referred to as food technology neophobia, can also be cause for distrust in the unfamiliar technologies used in the ingredient upcycling process (Hellali & Koraï 2023b; Aschemann-Witzel et al 2022; Bhatt et al. 2021, Coderoni & Perito 2021). That being said, one study by Perito et al. (2020) suggests that food technophobia can be mitigated by informing consumers of the origin of the upcycled ingredient.

Though the extent of processing is not something that occurs in the literature around upcycled foods, there are mentions of perceived 'naturalness' of a product. Nitzko and Achim's (2019) study found that consumers are more willing to accept efficient use of products from plant origin, than animal origin, adding that the by-products were more accepted in a natural form as opposed to a processed form (*ibid.*). Another noted aspect that affects the upcycled food acceptance is if the product belongs to a vice or a virtue category. Ghazanfar et al. (2022) found that willingness to pay was higher in virtue than vice categories for both conventional and upcycled products, however, they also found that WTP increased more for vice than virtue products when presented with sustainability claims (*ibid.*).

Degree of processing, explored in this thesis, is another product related factor that is perceived to have an effect on the acceptance of upcycled foods, and is yet under-researched (e.g. Aschemann-Witzel and Stangherlin 2021). Processing extent, as a concept, overlaps with some of the themes of previous research, such as technophobia, 'naturalness' and vice vs. virtue categories, making it an interesting aspect of upcycled foods to study with reference to product development, and to see if trends for acceptance hold or diverge from previous studies looking at parallel factors.

2.3.3 Swedish consumer studies on the acceptance of upcycled foods

One group of researchers at the university of Borås in Sweden have contributed significantly to the understanding of consumer acceptance of upcycled foods in studies of Swedish panels; H. Moshtaghian, K. Bolton and K. Rousta. This section will outline the results from their publications.

One of the studies focusing on Swedish consumer's acceptability of upcycled foods (Moshtaghian et al. No year), shows a very positive response with 81% of 683 participants showing a clear inclination towards the consumption of upcycled foods vis à vis their conventional counterparts. It was also highlighted that the associations of willingness to eat upcycled foods with a lower price were important for participants in the ages 18-48. Income, education and gender were significant independent factors in willingness to eat upcycled foods.

Moshtaghian et al. (2022) focus their study on motivating factors that influence consumers to choose upcycled food products, and how these factors are tied to hesitancy in choosing products from this novel food category. Results show that most respondents (78%) are inclined to purchase upcycled foods. The factors, in order of most to least important in both hesitant and inclined groups were: ethical concerns, natural content, sensory appeal, price, healthiness, familiarity and impression.

Moshtaghian et al. (2023), in yet another study with Swedish participants, found that environmental and food safety characteristics were more important than nutritional characteristics in the choice between upcycled foods or conventional products. There was also a positive relationship between age and the importance of food safety and nutritional characteristics, where positive nutritional characteristics include a low amount of food processing. This study yet again echoes a high inclination amongst participants to purchase upcycled foods.

2.4 NOVA classification of processed foods

All upcycled products fundamentally require some degree of processing. Given that the focus of the thesis is to investigate if the acceptance of upcycled foods varies with the degree a food product is processed, the NOVA classification system is used to identify suitable products with different stages of processing. The NOVA system was first proposed by researchers at Sao Paulo university in 2010 to classify the extent and purpose of industrial food processing (Monteiro et al 2010). Since then, it has gained recognition by the UN's Food and Agricultural Organization (FAO) (see Monteiro et al. 2019), and has been used in studies internationally, often in relation to nutrition, health and epidemiology (Monteiro et al. 2018, Moubarak et al. 2014, Corvetto and Uauy, 2012). The NOVA classification system is made up

of four groups to describe the different levels of processing. These are listed and clarified in table 1 below.

Table 1. NOVA grouping classifications for processed foods, their definitions and clarifications, own table with information adapted from Monteiro et al. (2016).

NOVA classification	Definition	Clarification
Group 1	Unprocessed or minimally processed foods.	Unprocessed: Parts of plants or animals that are edible, including animal products such as eggs and milk. Minimally processed: Natural foods altered by processes such as freezing, drying, filtering, grinding, crushing and others that do not involve the addition of any other ingredients.
Group 2	Processed culinary ingredients	Ingredients created for domestic use or use in restaurant or catering kitchens to elevate group 1 foods, such as oil, salt, sugar, butter and honey.
Group 3	Processed foods	Group 1 foods processed with Group 2 ingredients, to elongate shelf life of the products and elevate their sensory profile. Examples include canned or bottled fruits and vegetables, cheeses, breads, salted and cured meats.
Group 4	Ultra-processed foods	Food or drink products, typically with five or more ingredients. Only small quantities of Group1 foods are present if at all. Some substances that only occur in ultra-processed products are extracted from foods (i.e. gluten, lactose, whey, casein), or derived from further processing (i.e. hydrogenated oils, isolated proteins, high fructose corn syrup). Other such additives include coloring agents, emulsifiers, sequestrants and humectants.

The classification facing some criticism (i.e. Petrus et al. 2021; Lawrence 2023), however its use in this thesis is based on its widespread use and application to industrial processing specifically. The NOVA classification system is employed only to categorize the final upcycled products; green juice, sourdough bread and vegan nuggets. The chosen upcycled products each fall into a separate NOVA group category, with green juice in group 1, sourdough bread in group 3 and vegan nuggets in group 4. For the purposes of this study, the level of processing applied to the conventional products is also assumed for the upcycled products with upcycled ingredients that may otherwise complicate their classifications. This is only true in one upcycled product scenario, where upcycled potato protein features in one iteration of the upcycled sourdough bread.

2.5 Chosen upcycled ingredients

To satisfy the experimental design of the study conducted in this thesis, a selection of hypothetical upcycled food products were chosen to represent the levels of processing. The decisions of products therefore needed to fulfill certain feasibility requirements, as informed by the literature, and cues are taken from existing upcycled products, existing upcycled ingredients as well as other hypothetical upcycled products from other studies in the literature (see for example Bhatt et al. 2021). The three selected upcycled products are, in order from least to most processed: Green Juice, Sourdough Bread and Vegan Nuggets. Additionally, upcycled ingredients were chosen in tandem with the selection of these products. These are each explained individually below. Upcycled ingredients were chosen with the following criteria in mind: (i) the by-product stream should originate from a production of industrial scale, (ii) the by-product stream should be of Swedish origin, (iii) the by-products should require different methods in their valorisation to become upcycled ingredients, of varying complexities and finally, (iv) the upcycled ingredients should be feasible matches for the selected upcycled products in which they feature.

2.5.1 Dried Broccoli Leaves from unharvested broccoli

Unharvested vegetables left on the field at harvest are not an uncommon phenomenon (Johnson et al. 2018, Joensuu et al. 2021). Eriksson et al. (2021) identify unharvested broccoli as an untapped source of valuable nutrients, with Swedish production only harvesting around a third of the ripe crop, where the leaves in particular are not desirable by retailers. The study demonstrates with the use of life cycle assessment, the difference in greenhouse-gas saving impacts between three upcycling scenarios: Unharvested broccoli leaves were processed into a powder to replace (i) wheat, as a bread additive, (ii) imported florets, as a soup additive and (iii) Unharvested florets of improper size were sliced and sold as salad additives. Of these, the soup additive scenario was the most impactful in reducing global warming impact of the conventional product. Additionally, broccoli leaves are rich in nutrients and bioactive compounds, and can contribute these qualities to the upcycled food products they comprise (Krupa-kozak et al. 2021). Aside from satisfying the requirements, this upcycled ingredient has the potential to feature in two products in this study: the green juice and the sourdough bread.

2.5.2 Brewer's Spent Grain from beer brewing

Another industry by-product that occurs in large homogenous quantities is brewer's spent grain (BSG). The annual production of wet spent grain in Europe alone amounts to about 8 million tonnes (Petit et al. 2020). Sweden's domestic beer production facilities sold approximately 476 million liters of beer in 2022 (Sveriges Bryggerier 2022). With 20kg of BSG generated for every 100 liters of beer produced (Devnani et al. 2023) at least 95,200,000kg of BSG was generated from Swedish beer production in 2022. There are several methods available for upcycling BSG, all which require relatively intensive drying (Petit et al. 2020). BSG is rich in polysaccharides such as protein, lignin and cellulose (Ramu Ganesan et al. 2023), and can be used in a number of baked goods as a replacement, though not a complete substitution, for wheat flour (*ibid.*). In this study BSG features in one iteration of Sourdough Bread.

2.5.3 Potato protein from CRISPR-Cas9 potato starch production

The final upcycled ingredient included in this study is potato protein derived from a by-product of potato starch production. In 2022, 500,000 tonnes of potato were cultivated in Sweden, of this, 351,200 tonnes were potatoes destined for the production of potato starch (Jordbruksverket 2022). The potato protein by-product is a liquid potato fruit juice derived after the fibers and starch have been removed from the potato pulp (Johansson & Samuelsson 2018). Patatin, the main structure in isolated potato protein, has a full amino acid profile that does not occur commonly in plant-derived proteins (Peksa & Miedzianka 2021) and has emulsifying properties which allows it to replace egg or dairy products in food applications (Fu et al. 2020).

CRISPR-Cas9 is a promising novel genome editing technique that can introduce, remove or alter genetic information at a particular point of the genome (Es et al. 2019). Its application in the production of potato starch potatoes can lead to a higher recovery of potato protein (Johansson & Samuelsson 2018). It is considered to be an optimistic avenue for the future of the production of the staple crop (Bartek et al. 2022), however, genome-edited foods have struggled with their consumer acceptance in the past (Ishii & Araki 2016) and EU legislation currently prohibits their use (EC 2021). Nonetheless, the recovery of protein from the genome-edited potato is seen to significantly reduce environmental impacts of current protein recovery practices (Bartek et al. 2022). In this study, CRISPR-Cas9 potato protein is used as a substitute for other plant based proteins, such as soy, in vegan nuggets and additionally in Sourdough Bread as an emulsifying ingredient. As novel technologies such as gene-editing have the potential to develop crops with greater side-stream valorisation prospects, it is important to consider their acceptability in the polarity of technology neophobia and technological determination (Gorgianto et al. 2017).

2.5.4 Complexity of upcycled ingredients

There are no known methods for classifying the processing extent of upcycled ingredients, and yet origins of upcycled ingredients may play a significant role in the consumer acceptance of upcycled foods (Coderino & Perito 2020). Hence, the selected upcycled ingredients discussed above are also selected because they differ in how much the product is manipulated, both before and after cultivation, and in tandem with the primary product they are cultivated to constitute. In table 2 the upcycled ingredients are displayed along with the amount of steps, and the nature of the steps that comprise the processing of the by-products.

Table 2. Complexity of upcycled ingredients, as shown by which points along the supply chain the product is manipulated (coloured boxes in the table).

Upcycled ingredient	Pre-production	Primary production	Industrial processing	By-product processing
Powdered broccoli		Broccoli cultivation		Drying and grinding into powder
Brewer's Spent Grain		Wheat grain cultivation	Beer brewing	Drying and grinding into powder
Potato protein	CRISPR-Cas9 gene-editing	Potato cultivation	Potato starch production	Separation of protein

3. Methodology

3.1 Research philosophy

Instrumental to the development process of a study are the philosophical assumptions the researcher makes about reality and knowledge, where ontology describes what constitutes reality, and epistemology, how knowledge is created (Slevich 2011). As this study employs a quantitative methodology based in statistical analysis of a panel survey of Swedish consumers, this research adheres to the positivist research paradigm. This paradigm assumes an objectivist ontology which considers social phenomena to exist independently of, and external to individuals (Bell et al. 2019). Epistemologically, the positivist position holds that knowledge can be gathered empirically and measured, following the rules and constructs of methods originating from the natural sciences (*ibid.*).

3.2 Method for measuring consumer acceptance

This study aims to understand consumer acceptance of upcycled ingredients in food and if the degree of processing of a product affects the acceptance for upcycling. This is done by means of a quantitative online survey. The survey is designed using a contingent valuation method (CVM). CVM is a non-market valuation method that uses a survey-based approach to estimate WTP or willingness to accept (WTA) compensation for not getting a desired good or service (Boyle 2017).

WTP is commonly used in market research on novel food products (see for example; Alemu & Olsen 2020; Nazzaro et al. 2019), and often as an indicator in acceptance research on upcycled food (Bhatt et al. 2020, Hellali et al. 2023, Ghazanfar et al. 2022, etc.). There are two approaches for estimating WTP; revealed preferences, which uses data collected from actual purchases, and stated preferences, which are determined by asking consumers what they would pay for a hypothetical good or service (Klingemann et al. 2018).

As there is a very limited range of commercially available upcycled products on the Swedish market, this study uses hypothetical products in the consumer survey, and thus employs the stated preference method of estimating WTP. Additionally, likert scale questions are used to elicit an understanding of the food values held by the respondents, to better gauge their purchasing behaviors.

3.3 Hypotheses

H_1: Consumers prefer conventional food products over upcycled food products when equally priced.

H_2: Consumer's relative willingness to pay is lower for the upcycled food products that are more processed. Products included, from lowest to highest level of processing, are (i) Green Juice with dried broccoli leaves, (ii) Sourdough Bread with BSG and (iii) Vegan Nuggets with potato protein.

H_3: Consumer relative willingness to pay is lower for upcycled foods with more complex upcycled ingredients. Products included in this test are, in order of least complex to most complex, (i) Sourdough Bread with dried broccoli leaves, (ii) Sourdough Bread with BSG and (iii) Sourdough Bread with potato protein.

H_4: Respondents who indicated that the food value 'naturalness' was of high importance in their purchasing behaviors have a lower valuation of upcycled products.

H_5: Respondents who indicated that the food value 'safety' was of high importance in their purchasing behaviors have a lower valuation of upcycled products.

H_6: Respondents who indicated that the food value 'climate impacts' was of high importance in their purchasing behaviors have a higher valuation of upcycled products.

3.4 Data Collection

The online survey was made using Qualtrics as a survey creation and pilot test distribution tool. The survey was shared with another master's thesis student who was conducting research about a similar topic. Certain sections, such as socio-demographic questions, of the survey were tailored to contribute to both projects. These were decided upon after each student had developed their experimental design separately. A step-by-step illustration of the complete survey is visible in Figure 3. Visible here is the informed consent section at the very beginning of the survey, where participants were acquainted with the aims of the survey (which were

kept broad so as to not create a self-selection bias), the right to withdraw from the study as well as their anonymity. A validation question was embedded amongst the likert scale questions to test the alertness of participants, simply asking respondents to select '2' on the likert scale. Those who failed to do this, were disqualified from the results. Additional screening questions followed the likert scale questions, where participants who were not at all responsible for the food purchasing in their household were screened out.

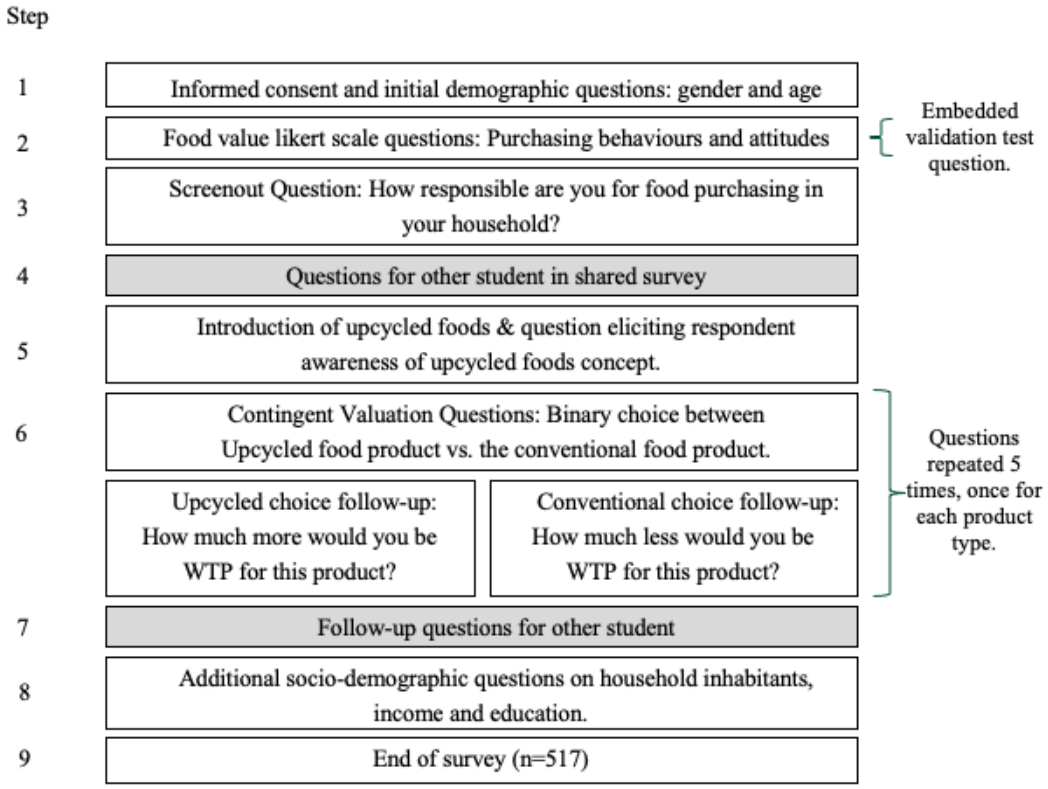

Figure 3: Summary of the structure of the survey. Own illustration.

A seven-point likert scale was used to present questions on food values. This was done in order to find out more about how the respondent's individual values and contexts might explain the distribution of the data. The likert scale approach was chosen for ease of understanding amongst survey participants (Nemoto & Belgar 2014), and because of its ability to adapt to Lusk & Biggerman's (2009) food values. The authors have constructed the following list of food values based on a broader approach to the attributes of the product itself, moreover considering the consequences of food consumption that have the potential to explain a consumer's selection amongst a wider range of products (*ibid.*). The food values are as follows: 'naturalness', 'taste', 'price', 'safety', 'convenience', 'nutrition', 'tradition', 'origin', 'fairness', 'appearance' and 'environmental impacts'. Respondents were asked to indicate on the scale how important these food values were for them whilst purchasing food; '1' for not at all important or '7' for very important. Though this study was primarily interested in the effects of just two of these values on the CVM

choices of respondents, all values were included as to not highlight a specific topic of research to respondents and cause a self-selection bias, where participants may opt-out of making a choice at all (Verbeek & Nijman 1996). Following this, an additional screening question was posed to the respondents. The data collected from participants who were not fully responsible nor partially responsible for the food purchasing choices in their household was not included in the final analysis of the panel data.

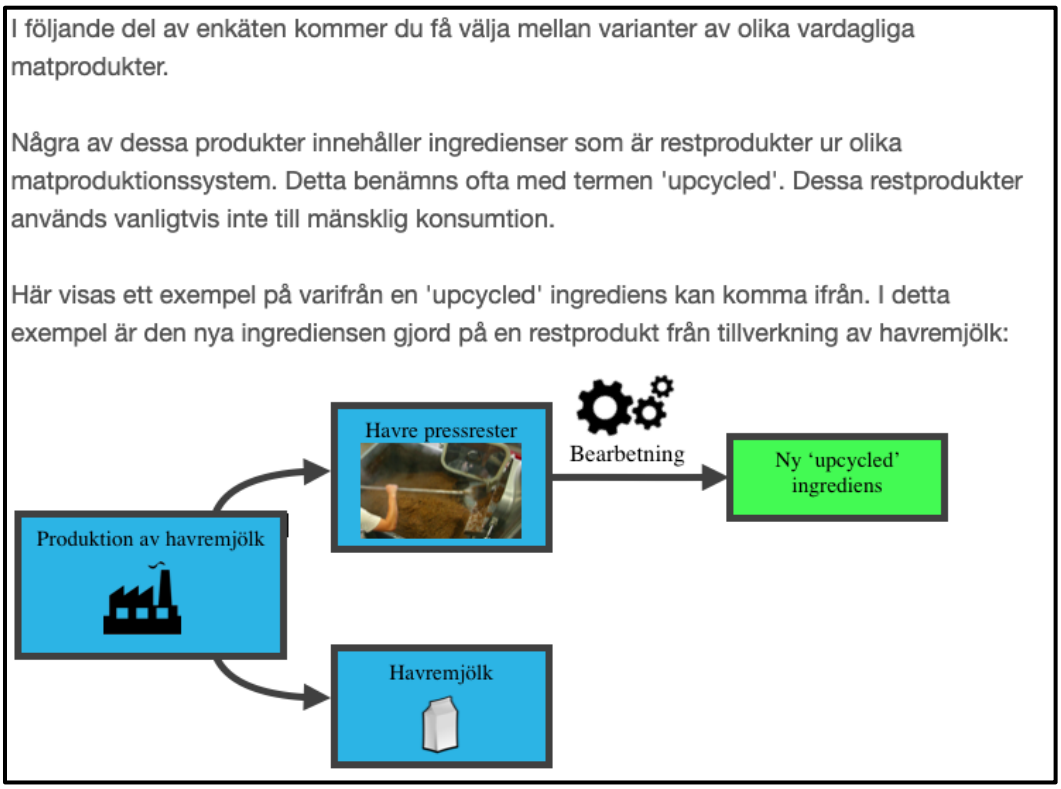

Figure 4: The slide preceding the CVM questions in the survey, introducing the concept of upcycled foods. Translation from Swedish: In the following section of the survey, you will be asked to choose between regularly available food options. Some of these products contain ingredients that are by-products from different food production systems. These are dubbed 'upcycled'. These by-products are usually not destined for human consumption. Here, an example is shown of where an 'upcycled' ingredient can come from. In this example the new ingredient is made from a by-product from the production of oat milk.

Then, participants were introduced to the topic of upcycled foods to give some context for the upcoming CVM questions. This was done by showing participants an illustration (figure 4) alongside a brief explanation of the concept of upcycled foods. At the bottom of this figure respondents were asked to indicate their familiarity with the concept of upcycled foods by selecting one of three responses to the question 'Have you previously heard about upcycled foods?'. The available answers translate from Swedish to mean 'yes, I have heard about this and know exactly what it is', 'yes, I have heard the term, but I am uncertain what it means' and 'no, I have never heard about this'.

3.4.1 CVM: The first question and hypothetical products

The elicited WTP (or WTA) is conditional to the specific hypothetical market described to survey participants (Ahmed & Gotoh 2006). Close-ended question formats are used in the surveys of the CVM, producing discrete responses and cognitively simplifying the task for participants in comparison to open-ended format alternatives (Hanley 1989). This study employs a binary choice (upcycled vs. conventional) and respective follow-up questions for each to determine WTP (if the respondent chooses upcycled product) or WTA (if the respondent chooses the conventional product). CVM is widely used in studies valuing both non-use and non-market goods and services in sustainability academia (see for example: Botelho et al. 2016; Huang et al. 2019; Julie & Goddard 2022). Participants were then asked about the following products in the order presented in table 3 below.

Table 3. Order of appearance of upcycled products in the CVM questions presented in the survey.

Order of questions	Product	Upcycled ingredient
1	Sourdough Bread	Brewer's spent grains
2	Sourdough Bread	Dried Broccoli leaves
3	Sourdough Bread	CRISPR-Cas9 derived potato protein
4	Green Juice	Dried Broccoli leaves
5	Vegan Nuggets	CRISPR-Cas9 derived potato protein

Participants were asked to make a binary choice between upcycled and conventional products, an example of which is visible in figure 5, the first of the CVM questions. The following prompt was given (as translated from swedish):

Assume that you want to purchase a loaf of bread, and the two following alternatives are available. If the price and the taste of these products are identical, which bread would you purchase?

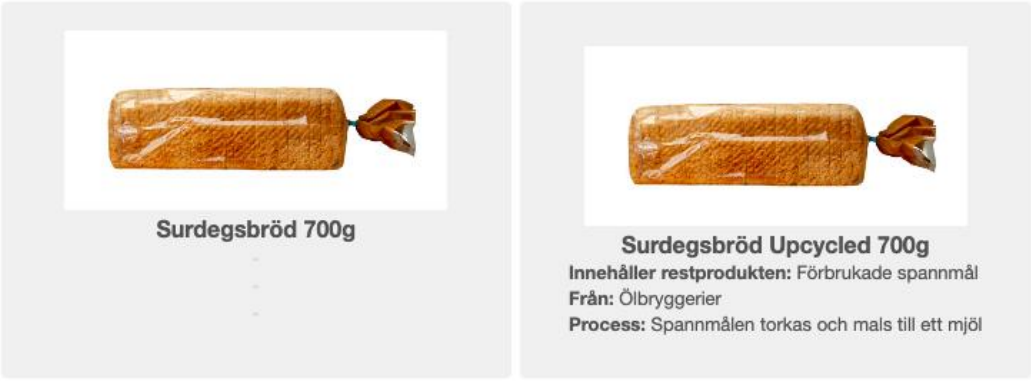

Figure 5: Binary CVM choice as it appears in the survey. The conventional product (left) is labeled 'Sourdough bread 700g' in Swedish. The Upcycled product (right) is labeled 'Upcycled Sourdough bread 700g', with further information about (i) the upcycled ingredient: Brewer's spent grain, (ii) the origin of the upcycled ingredient: Beer Breweries and (iii) the process used to derive the ingredient: the grains are dried and ground into a flour.

As the objective of this thesis is to assess the differences in consumer acceptance of upcycled foods with respect to the different levels of processing used in their production, the selection of products to represent the hypothetical market are key. This is commonly the case in upcycled food consumer research, as not many upcycled food products have reached the market (see for example Grasso & Asioli 2020; Yang et al. 2021). The aforementioned selection criteria for the upcycled food products' inclusion in this study highlighted that the products should represent different levels of processing as per the NOVA classification system. In addition to this, products should be able to contain one or more of the upcycled ingredients in this study. To ensure that the upcycled products and their conventional alternatives are relevant to the Swedish consumer panel, the products chosen mirror currently available commercial food products sold in Swedish supermarkets that are produced at an industrial scale. Selections were based on products available at ICA, COOP and Hemköp supermarket chains.

Whilst all upcycled food products require some amount of processing by nature, there is an additional variable to consider, namely that the upcycled ingredient also requires processing in order to be safely adapted from the waste stream. The NOVA classification system only considers the final product as it appears at the point of sales, enmeshing the effect of a key attribute in the uptake of upcycled food products; the origins and processing methods used to derive the upcycled ingredients themselves. As information and labeling regarding upcycled food ingredients can have an effect on consumer acceptance (see for example Asioli & Grasso 2021), it is important to consider the effects of these attributes in what the consumer sees when they confront the product in a supermarket setting.

Ultimately, five combinations of upcycled ingredients and final product are chosen to feature in the survey. The Sourdough bread combinations, where all upcycled ingredients (dried broccoli leaves, BSG and potato protein) feature as additives in respective sourdough breads, are chosen to elicit a response in regards to the differences in perception of upcycled ingredient processing. The remaining two combinations, green juice with broccoli powder and vegan nuggets with potato protein, are selected to be analyzed alongside the sourdough bread containing BSG, to elicit a response as to which final upcycled products have a higher acceptance amongst the consumer panel.

3.4.2 CVM: The follow-up questions

For each selected item, the respondents were presented with a follow-up question. For the selection of the upcycled products, respondents were prompted by the phrase:

> *Assume that the bread with the upcycled ingredient from beer brewing costs more than the conventional bread. What is the most that you would be willing to pay for this bread?*

The choices in the follow-up question are similarly discrete and close-ended, asking respondents to choose between the options: 'I would not be willing to pay more for the bread' (0% more), 5% more, 10% more, 15% more, 20% more and more than 20%. Contradicting the commonly used continuous or open-ended expression for WTP, this categorical approach was chosen as it can increase validity of the experiment (McFadden 2017). Additionally, many studies have used a premium (or discount) strategy to measure WTP with respect to a reference product (i.e. Just & Goddard 2022). Had the conventional product been selected, the prompt given was:

> *Assume that the bread with the upcycled ingredient from beer brewing costs less than the conventional bread. What is the most you are willing to pay for this bread?*

The following discrete options were available: 5% less, 10% less, 15% less, 20% less, 50% less and 75% less and 'I would not purchase the bread with an upcycled ingredient from beer brewing'. A no-purchase option was included to reflect a more realistic choice situation (customers can always choose not to purchase a product), and to increase the validity of the results (McFadden 2017).

Additionally, socio-demographic questions were spread out in the survey, asking questions that can be perceived as more sensitive, (i.e. household income and education) at the end of the survey (Fernandez et al. 2016).

3.5 Sample

The online survey was distributed to a panel of Swedish consumers by Norstat in April of 2023. Respondents, using non-probability sampling, are chosen from Norstat's database of individuals pertaining to the desired demographics of the population in the sample study (Norstatpanel.com). Demographic identifiers such as age, gender, postcode and income are used to select the sample and individuals are contacted by email to fill out the survey online (*ibid.*).

The total number of participants whose responses met the criteria of inclusion were 517, however, some errors were discovered in the raw dataset that may have resulted from an issue in the coding of the questionnaire in qualtrics, resulting in the need to remove 113 panel responses. The final sample includes 404 responses. Table 4 shows the descriptive statistics of the sample. The median time for completion of the survey was 10 mins. The 404 participants whose responses were included in the analysis, had a mean age of 51 with a standard deviation of 16.8.

70.7% of respondents consider themselves to be "all eaters", 17.3% as meat eaters, 7.7% as flexitarians, 2.4% as pescetarian and 1.6% as vegetarians or vegans. The majority of participants (39.1%) live in a 2-person home. 22.3% live alone, 15.1% in a 3-person household, and 16.1% in a home with four or more inhabitants. Of the sample, 79.2% of participants do not live with children under 12 years of age, whilst 20.8% do.

Table 4. Descriptive statistics of the sample (n=404)

Variables	n	%
Gender		
Male	195	48.3
Female	208	51.5
Non-Binary	1	0.2
Age		
18-20	6	1.5
21-30	50	12.4
31-40	77	19.1
41-50	70	17.3
51-60	50	12.4
61-70	86	21.3
71-80	61	15.1
Decline to answer	4	1.0
Education (Swedish system)		
No education	0	0.0
Primary school	19	4.7
High School	162	40.0
University	213	52.6
Do not wish to say	10	2.5
Income		
0-10,000kr/month	9	2.2
10.001-30,000kr/month	94	23.2
30,001-50,000kr/month	129	31.9
50,001-100,000kr/month	86	21.2
>100,000kr/month	12	3.0
Do not wish to say	74	18.3
Household food purchasing responsibility		
Full responsibility	167	41.3
Shared responsibility	237	58.7
No responsibility	0	0

3.6 Data Analysis

Statistical Analysis was conducted in excel and in Stata. First, WTP and WTA data from the follow-up questions of the CVM were coded into a single variable for each product. The available WTA options; No purchase, 25%, 50%, 80%, 85%, 90% and 95% of the cost of the conventional product were coded into numerical values 0, 0.25, 0.5, 0.8, 0.85, 0.9 and 0.95 respectively. These options were only available to participants who chose the conventional product in the first CVM question. The available WTP options: No more than the conventional product, 5%, 10%, 15%, 20% and >25% more than the conventional product were coded into 1, 1.05, 1.1, 1.15, 1.2 and 1.25 respectively.

An Ordinary Least Squares (OLS) regression was performed in Stata to observe trends in acceptance amongst the respondents. These were calculated in reference to the relative WTP for upcycled Sourdough with BSG, as this product occurs in two of the prominent hypotheses.

Some demographic variables, such as age, gender and level of education were also included in the regression, as coded into two separate variables in order to determine correlations between for e.g. high level of education, or younger respondents with relative WTP for upcycled Sourdough with BSG.

Likert scale data was coded into binary variables with 0 indicating options 1(not at all important) to 5, and 1 indicating options 6 and 7 (very important). Certain key food values were analyzed in the regression, in order to answer hypothesis 4, 5 and 6.

3.7 Theoretical Framework: Approach-Avoidance Motivaitions

Using the lens of a theoretical framework can help us understand the relevance of consumer perception and the enigma surrounding acceptance of upcycled foods. The consumer behavior theory that will be used to discuss the results of this thesis is approach-avoidance motivations for purchasing foods. Grounded in behavioral psychology, there are a couple of formulations of approach-avoidance motivations theory that complement each other (Monni et al. 2020). This theory has been applied to consumer behavior to explain patterns of purchasing, even being applied to food purchasing behaviors to investigate trends such as clean label (Asioli et al. 2017)

It is generally understood that consumers purchasing foods today are acting in highly stimulating environments. What motivates consumers to act on purchasing a product is that they have identified a need (Asioli et al. 2017). This need generates

a sense of purpose to attain a goal, which the consumer is more aware of when making real-time purchasing decisions (Schiffman & Wisenblit 2015). Generally, goals can be defined as approach or avoidance goals; ultimately aiming to achieve a sought-after 'end state', that can either be accomplished by taking action toward or away from certain attributes and stimuli (Monni et al. 2020). An example from food purchasing is 'approaching' foods that are seen as healthy, or that can help achieve 'well-being', or conversely, 'avoiding' foods that are unhealthy, or seen as detrimental to health (i.e., avoiding additives).

One key aspect behind approach and avoidance motivation is that they represent separate psychological and physiological systems (Nezlek et al. 2021). If, for example, there is an absence of approach motivation, it does not imply that the avoidance motivation system is inherently activated. Or, in terms of consumption of novel food products, the absence of motivation to try something new does not mean there is active avoidance or food neophobia (*ibid.*). Depending on the perspective of the individual, the formulation of the 'end state' may determine if the person will have approach or avoidance goals in their consumption patterns. Individuals with aims of self-betterment are more likely to formulate approach goals, being more stimulated by rewards. Individuals motivated by perceptions of what they ought to achieve, aiming to prove competence to others, are more likely to formulate avoidance goals and are stimulated by risk or uncertainty (Monni et al. 2020). When foods are regarded, there are many aspects that might make foods both attractive and unattractive, in this thesis Likert scale questions on the topic of food values reflect some of these aspects.

4. Results and Analysis

This chapter will present a summary of the results of the study. Trends in the data will be noted, and further developed in the discussion chapter. First, results of the CVM questions will be presented, starting with the binary question and proceeding with the follow-up questions, displaying the sample's (n=404) relative WTP for the upcycled product types. Here, hypotheses 2&3 are tested as a result of the regression analysis. Then, the analysis will also lend itself to tests for hypotheses 4,5&6 regarding the food values of the sample. Finally some demographic identifiers are analyzed for general trends in the sample data to further color the discussion.

4.1 Conventional vs. Upcycled products result

Before respondents were asked to complete the acceptance questions, they were asked how familiar they were with the concept of upcycled foods. Only 1.6% of the sample were confident in their knowledge of upcycled foods, whereas 16.0% had some idea and the vast majority, 82.4%, had no idea of what upcycled foods meant or entailed. Following a short introduction to the concept, respondents were asked to select one of two product alternatives (upcycled vs. conventional), for five different product types, eliciting a response to the first hypothesis.

H1: Consumers prefer conventional food products over upcycled food products when equally priced.

Not once were the indications of preference more numerous for the upcycled alternatives. Figure 6 shows how the respondents' selection is distributed in the binary choices for every product type. There are, however, some variations amongst the products. The green juice with broccoli powder was the most attractive upcycled product type with 46.8% of respondents selecting the upcycled alternative, and 53.2% selecting the conventional. The order of popularity of the remaining upcycled products is as follows: Sourdough with broccoli powder (37.1% selected upcycled, 62.9% selected conventional), Sourdough with BSG and Sourdough with potato protein tied for third place (35.1% selected upcycled, 64.9% selected conventional), the least accepted upcycled product type was the vegan nuggets with potato protein (34.2% selected upcycled, 65.8% selected conventional). Ultimately

we can confirm our hypothesis, as the conventional product alternatives were undoubtedly the more popular preference in all instances.

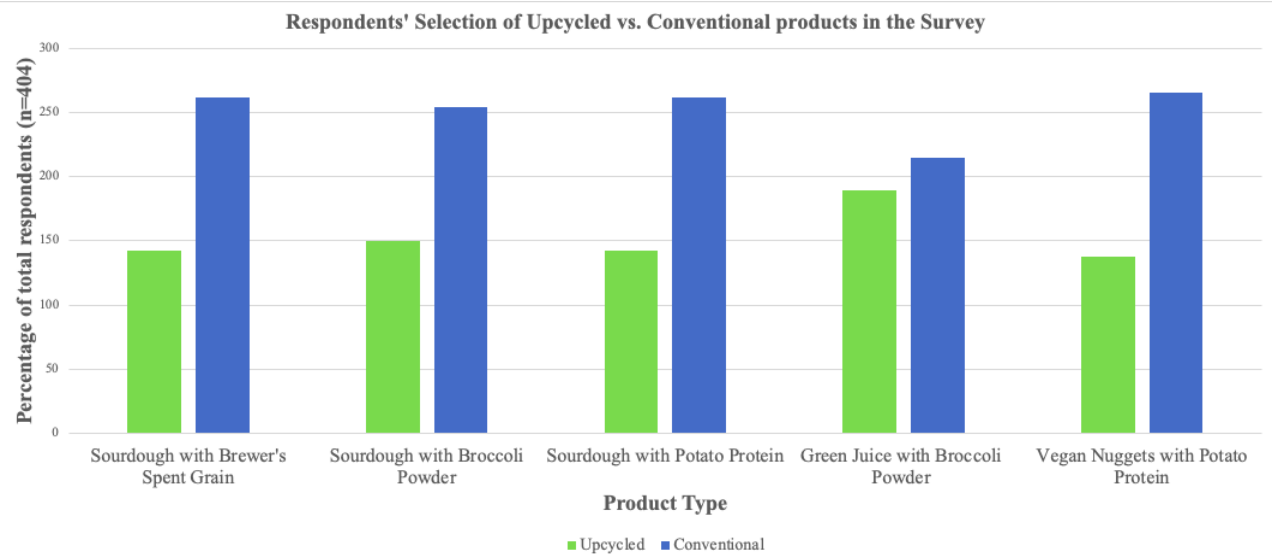

Figure 6: Bar graph presenting results from questions asking respondents to choose between upcycled and conventional alternatives of hypothetical products. Each product type presents one question, with green indicating the upcycled choice and blue, the conventional choice. Own illustration.

4.2 Relative WTP and level of processing

Choosing an upcycled product in the binary selection, however, does not equate to a greater WTP for that product. As WTP for the upcycled product types are expressed as relative to the cost of the conventional product, we can see that the highest average WTP for an upcycled product type does not exceed 70% of the conventional cost (as seen in table 5). One prominent reason for this being the popularity of the 'no purchase' option, expressing that respondents were unwilling to purchase the upcycled product at any price. This option was only available to consumers who selected the conventional product in the binary choice.

Table 5. Relative WTP data, coded into single variables for each product type, denoting how much respondents would pay for upcycled products as relative to the conventional. The range of available responses to the relative WTP questions is 0 - 1.25. 1=matching the conventional price, 1.05=5% more, 1.25=>20% more, 0.95=5% less, 0=no purchase. Product types are listed in order of occurrence in the survey.

	Respondents selecting 'no purchase' (0), (*n=404*)	Average relative WTP (0-1.25)	Standard Deviation
Sourdough with BSG	75	0.67	0.39
Sourdough with Broccoli Powder	83	0.67	0.41
Sourdough with Potato Protein	91	0.64	0.41
Green Juice with Broccoli Powder	85	0.70	0.42
Vegan Nuggets with Potato Protein	123	0.59	0.45

We can see here that the products containing potato protein as their upcycled ingredient are the lowest in average relative WTP. They additionally hold the largest 'no purchase' responses, though vegan nuggets break out ahead, with 32 more respondent selections than their runner-up. This is also visible in figure 7.The standard deviations of the relative WTP data for each product type increases parallel to their presentation in table 5, which is also the order in which they were presented to the survey participants. This denotes that throughout the course of the CVM questions in the survey, responses increased in variance and in extreme responses. This might imply that participants, in the process of familiarizing themselves with the CVM question format as well as the upcycled products, may have been more conservative in their opinions in the beginning of the survey (Kniivilä 2006). Given that this increase is relatively consistent, one avenue for further study could be to make a longer survey where the order of the questions are randomized for each participant to combat this effect on standard deviation.

Other trends that are made more visible in figure 7 are that a large proportion of respondents, irrespective of upcycled or conventional selection in the first of the CVM questions, chose the lowest available relative price for the upcycled product. Even in the case of the more popular upcycled broccoli juice, the majority of respondents were not willing to pay more for this product compared to the conventional product. Additionally, for respondents who chose the conventional product and were asked at what price they would be willing to accept the upcycled alternative, there is a small spike around the -20% and -50% option. This indicates that some consumers from the panel, who would normally select the conventional alternative, would be willing to purchase upcycled foods if offered at a lower price than the conventional product.

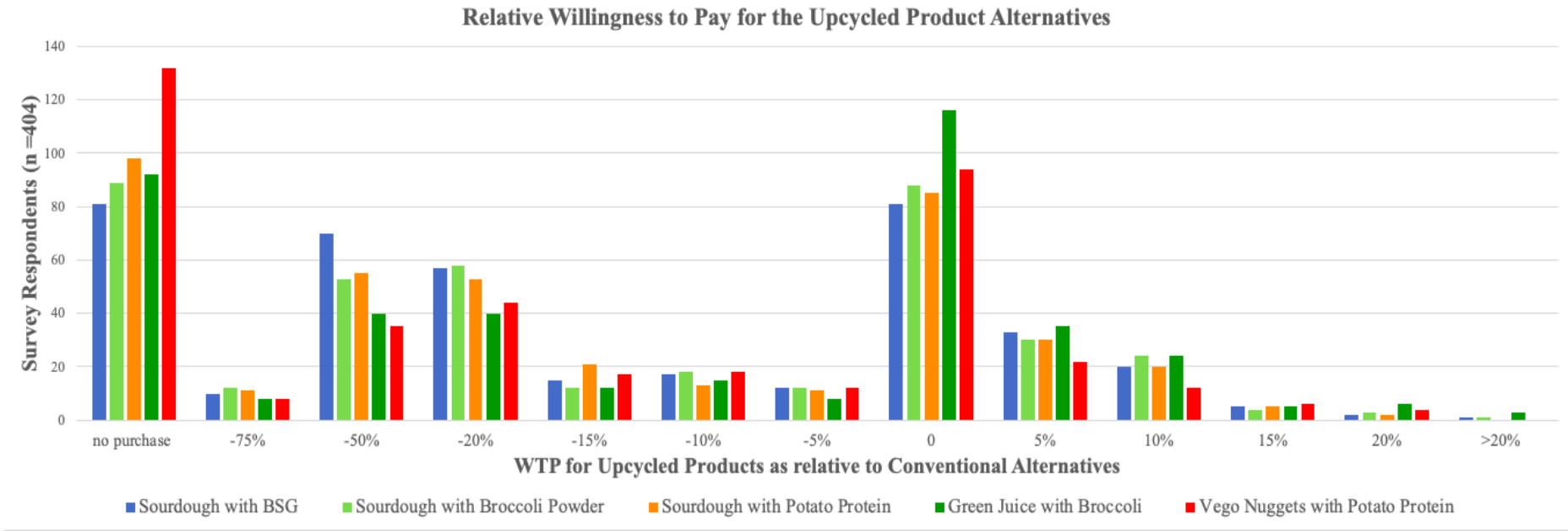

Figure 7: Relative willingness to pay for the upcycled product alternatives included in the survey. These are based on the raw results from the follow-up questions in the CVM section of the questionnaire. Own illustration.

4.2.1 Testing Hypothesis 2

The relative WTP regression was done with reference to the Sourdough BSG product alternative. This is because this product appears in both H_2 & H_3 as the product in the middle of the three tiers of ingredient and product processing respectively. Table 6 shows the results of the OLS regression.

*H_2: Consumer's relative willingness to pay is **lower** for the upcycled food products that are **more processed**. Products included, from lowest to highest level of processing, are (i) Green Juice with dried broccoli leaves, (ii) Sourdough Bread with BSG and (iii) Vegan Nuggets with potato protein.*

The hypothesis suggests that the participants relative WTP for the included product types should mirror this progression: relative WTP for Green Juice > relative WTP for Sourdough Bread > relative WTP for Vegan Nuggets. The results of the regression support this hypothesis. The coefficient for vegan nuggets is negative and statistically significant. Respectively, the coefficient for the green juice is positive, confirming the hypothesized trend. Whilst the p-value for the vegan nuggets is below the accepted level of significance ($p<0.05$), this is not the case for the green juice. However, t-statistic for the green juice is above the critical value (1.645) for a one sided test, meaning that its relative WTP is significantly larger than the relative WTP for Sourdough with BSG. Hence we can reject the null hypothesis and confirm the anticipated trend for the second hypothesis.

4.2.2 Testing hypothesis 3

*H_3: Consumer relative willingness to pay is **lower** for upcycled foods with **more complex upcycled ingredients**. Products included in this test are, in order of least complex to most complex, (i) Sourdough Bread with dried broccoli leaves, (ii) Sourdough Bread with BSG and (iii) Sourdough Bread with potato protein.*

The hypothesis suggests that the participants relative WTP for the included product types should mirror this progression: relative WTP for Sourdough with broccoli powder > relative WTP for Sourdough with BSG > relative WTP for Sourdough with potato protein. Again, the sourdough with BSG acts as the base level in this regression. Here, the coefficient for sourdough with broccoli is not significant in its p-value or its t-statistic, meaning that it is not statistically significantly different from zero, and that for the higher end of this trend, we fail to reject the null hypothesis. However, in line with expectations, the coefficient for sourdough with potato protein is both significant and negative. Ultimately, we fail to reject the null hypothesis on this trend as a whole, but we are able to see that the potato protein upcycled ingredient is less accepted by this panel of respondents than the upcycled ingredient of BSG, suggesting some effect of upcycled ingredient complexity on acceptance.

Notably, the products containing potato protein were visibly the least popular in both the binary choice and the follow-up questions of the CVM if we consider only the descriptives of the dataset. This is affirmed by the regression analyses that place the potato protein products at the lowest relative WTP, in relation to the sourdough with BSG.

Table 6. OLS regression results of willingness to pay for upcycled products as relative to their conventional alternatives. The reference is the relative WTP for Sourdough with BSG.

Relative WTP	Coefficient	Robust Std. Err.	t	P> | t |	95% Confidence interval	
Sourdough with Broccoli Powder	-.0011166	.0166197	-0.07	0.946	-.0337891	.0315558
Sourdough with Potato Protein	-.0255583	.011877	-2.15	0.032	-.048907	-.0022096
Green Juice with Broccoli Powder	.0297767	.0170286	1.75	0.081	-.0036996	.063253
Vegan Nuggets with Potato Protein	-.0509926	.0145355	-3.51	0.001	-.0795676	-.0224176
Education_Low	-.0608717	.0725999	-0.84	0.402	-.2035946	.0818511
Education_ High	.0881664	.034261	2.57	0.010	.0208132	.1555195
Age_Low	.1512674	.037245	4.06	0.000	.0780481	.2244867
Age_High	-.114619	.0424271	-2.70	0.007	-.1980257	-.0312122
Female	-.0640075	.0324001	-1.98	0.049	-.1277024	-.0003127
Food Values: **Naturalness**	-.0260588	.0148246	-1.76	0.080	-.0552022	.0030846
Food Values: **Safety**	-.0423479	.0144334	-2.93	0.004	-.0707223	-.0139736
Food Values: **Environmental Concern**	.0670332	.0117607	5.70	0.000	.0439131	.0901534
_cons	.7030703	.0873744	8.05	0.000	.5313025	.874838

4.3 The effects of food values: testing hypothesis 4,5 and 6

This section will present the results for H_4, H_5 & H_6 concerning food values. These will be based on the results from the OLS regression and will base a section in the discussion chapter.

*H_4: Respondents who indicated that the food value 'naturalness' was of high importance in their purchasing behaviors have a **lower** valuation of upcycled products.*

The coefficient for naturalness is negative and statistically significant with a one-sided test (t > (+/-)1.654). Hence, there is support for hypothesis 4. Signifying that

participants that hold naturalness as an important food value are less accepting of upcycled foods. In total, 67.1% of the sample voted that naturalness was an important product attribute (5, 6 or 7 on the 7-point likert scale for food values) when food shopping.

*H_5: Respondents who indicated that the food value 'safety' was of high importance in their purchasing behaviors have a **lower** valuation of upcycled products.*

The food value safety and its importance resulted in a negative coefficient in the regression, with a significant result. Hence, there is support for H5. Ultimately, in accordance with this sample, those with a high valuation of safety in their food shopping choices are not as willing to pay for upcycled food products. In the sample, 67.3% of participants selected safety as an important food value in the likert scale questions.

*H_6: Respondents who indicated that the food value 'climate impacts' was of high importance in their purchasing behaviors have a **higher** valuation of upcycled products.*

The resulting coefficients for climate impacts are positive and statistically significant. Therefore, we are able to confirm that respondents with high valuation of environmental impacts are positively correlated with a higher relative WTP for upcycled foods. 47.0% of the sample considered climate impacts to be an important food value (selecting 5, 6 or 7 on the likert scale question).

4.4 Demographic indicators

Understanding how some demographic factors correlate with the data in the regression analysis can explain certain trends in consumers' approach to the idea of upcycled foods. We can for example see that there is a positive coefficient and significant result for both more educated individuals and those of lower age in the sample, meaning that there are demographic trends in the elicitation of higher relative WTP for upcycled food products. Additionally significant factors that produce negative coefficients are the older segment of the sample and the female respondents, suggesting that these individuals are more likely to reject or have a lower relative WTP for upcycled foods. Lastly, there is no significance for the demographic segment with less or non-traditional further educational background.

5. Discussion

5.1 Situating the sample

Research Question 1: What are the motivating factors for Swedish consumers to purchase upcycled foods?

According to the results, the avoidance motivation of upcycled foods have a greater presence than the approach motivations. Which attributes become the focus of the product marketing of future upcycled products could very well affect how the product performs on the market. Approach and avoidance motivations will be discussed over sections 5.1 and 5.2 as it has implications for both research questions.

In comparison to other acceptance studies on Swedish consumers (Moshtaghian et al. no year, 2022), the intention to eat upcycled foods is much lower in the surveyed sample. In this study, the majority of respondents always selected the conventional products vis-à-vis the upcycled ones. Moshtaghian et al.'s questionnaire studies (*ibid*.), though using different designs, elicited that more than 90% of participants chose upcycled foods over conventional (no year), and that 78.6% of participants in another study were inclined to eat upcycled foods (2022). This dsicrepancy could be partially explained by how upcycled foods were communicated to the survey respondents, or perhaps the survey respondents themselves were more familiar with upcycled foods. For instance, 49% of participants in Mostaghian et al.'s first study (no year) had already eaten upcycled foods, whereas this study reflected that 82.4% of participants were unaware of the concept of upcycled foods. This also highlights that intention to eat upcycled foods is not the same as willingness to pay for them. If anything, the general results reflecting the willingness to pay for conventional and upcycled foods are similar to those in a US-based study by Bhatt et al. (2020), where the conventional product alternatives were steadily more popular than the upcycled. An additional study on Pakistani undergraduate students returned a similar result (Ghanzanfar, 2022).

Demographically, the study shows that more educated respondents, as well as younger and male participants are positively correlated to the relative WTP for Sourdough Bread with BSG. Moshtaghian et al. (no year), having conducted a study on the intention to eat upcycled foods amongst Swedish consumers have stated that

for younger groups (18-48), there are correlations between intention to eat upcycled foods, income, gender and education. Moreover, price was shown to be a key factor of acceptance as well as food waste reduction (*ibid.*).

Results point to that naturalness, safety, environmental impact and degree of processing is an important factor in consumer acceptance of upcycled foods, and this is echoed in Mostaghian et al.'s study on groups hesitant and inclined to eat upcycled foods (2022). Natural content of the upcycled foods was deemed to be the second most important factor in upcycled foods for both groups, after ethical concern.

5.2 Degree of processing

Research Question 2: How does the degree of processing of (i) the whole upcycled product and (ii) the upcycled ingredient in the product affect the consumer acceptance of upcycled food products?

As the aforementioned results convey, results of this study elicit that the degree of processing of the whole product has an effect on consumer acceptance, whilst the degree of processing of the upcycled ingredient has some effect on the consumer acceptance of upcycled food products. The hypothesized trend for the acceptance of upcycled food products was confirmed, suggesting that the more processed an upcycled product is, the less attractive it will be to a consumer. For the latter half of this research question, the least processed upcycled ingredient showed no relationship to the trend, whilst the most processed upcycled ingredient was revealed as particularly unattractive to the consumer panel. The following sub-headings will explore which of these product attributes may have elicited an avoidance or approach response in the consumer, in order to speculate about what might contribute to the development of a successful upcycled product.

5.2.1 Avoidance motivation

Avoidance motivation is associated with individuals perceiving risk (Monni et al. 2020). In the context of choosing food products, consumers can often rely on heuristics when making decisions about products in a choice setting, especially when considering novel products, or products with new and unfamiliar attributes (Asioli et al. 2017), as participants were asked to consider in this study. This could explain why the majority of respondents opted for the conventional product, as well as why the 'no purchase' and 'not willing to pay more' were popular with the survey participants.

Risk aversion is also echoed in the results of hypothesis 5, where consumers who had high valuation of safety in their food purchasing value systems were negatively correlated with a high WTP for upcycled foods. Additionally, the upcycled ingredient of potato protein, which the participants were informed was derived from the CRISPR-Cas9 gene modification process, was the least accepted in both products in which it was featured. Notably, gene modification does not have a high reputation amongst consumers, and is not an easily accepted phenomenon (Ishii & Araki 2016), given that it is also not allowed in EU legislation (EC 2021). Given the amount of evidence that would suggest that there was an avoidance of certain upcycled product attributes as included in this survey, the factors point to that this result is not simply participants lacking interest in upcycled foods, but rather, having a stronger rejection reaction of more processed upcycled foods.

5.2.2 Approach motivation

Despite the fact that most respondents would not purchase upcycled foods given the option, there was still some variation in the response data for the different products suggesting that certain consumers are more likely to be attracted to certain upcycled foods. Participants who value the environmental impact of their food are one such group. This is supported by previous research on consumer acceptance of upcycled foods (see i.e., Coderoni & Perito 2021, Peschel & Aschemann-Witzel 2020). The environmental impacts of foods is something that the consumer cannot inherently confirm from the experience of consuming the foods themselves, unless the product itself has associations with climate implications (i.e., red meat) but is rather identified by the marketing of the food products, certifications or claims made by the production companies (Wikström et al. 2014). The same is true for upcycled foods (Asioli & Grasso 2021, Aschemann-Witzel & Peschel 2019, Aschemann-Wizel & Stangherlin). However, upcycled foods are more complicated to communicate, as there is more information needed to transparently relay the sustainability aspects of the product, such as the upcycled ingredient and its origin. Any positive attributes associated with the upcycled ingredient (i.e.,what nutrients are won from the upcycled ingredient, upcycling in accordance with the food waste hierarchy or supporting local industrial ecology matrices) may add even more information for the consumer to process in an already information rich environment. Ultimately, though there are environmentally conscious consumers willing to purchase and even pay more for upcycled products, there is a risk in overwhelming even these consumers in the highly stimulating choice environment.

Similarly, research has also shown that virtue categories are given a higher WTP response than vice categories (Ghazanfar et al. 2022). Though the range products are limited in this study, the results still support these findings as nuggets, a product more associated with fast foods, had a lower acceptance than the green juice, which has more healthy implications. Though study respondents who valued naturalness in their foods were less accepting of upcycled foods, the product that was the least processed, the green juice, received the highest WTP of all product iterations. This in part reflects the association with upcycled foods as unnatural, however, also

suggests that less processed upcycled foods may be more accepted by consumers as they may associate with approach motivations. Supporting this, a study of Swedish consumers by Moshtaghian et al. (2023), suggests that naturalness is a factor more important to individuals inclined to purchase upcycled foods than individuals that are hesitant.

Ultimately, given the stronger correlation of more processed products and upcycled ingredients with low WTP than less processed upcycled products and ingredients with high WTP, we can conclude that avoidance motivations are more influential in the choice of upcycled foods.

5.3 Limitations and future research

The central focus of the research has been to look at the effects of degree of processing on the acceptance of upcycled foods, however, degree of processing has overlap with a lot of other important attributes of upcycled foods that could lead to a selection or a deselection of an upcycled product alternative. Associations such as healthiness or environmental impact may have more weight than how processed the product appears to be. Though the intention of the research was to investigate processing as a point of interest for potential manufacturers of upcycled foods and elicit a response as to how a consumer may react to the appearance of that food, the degree of processing may be a more concrete tool to navigate acceptance from a perspective of production.

The CVM method that was used to design the survey is a good tool to asses values of non-market goods, however, the hypothetical market described in the questionnaire is largely what is reflected on the results. In the future, this design could perhaps have been repeated with a wider variety of product iterations. In particular, more highly-processed food products that do not include an element of gene-manipulation in their upcycled ingredient. The CRISPR-Cas9 potato protein was included as an upcycled ingredient to elicit a consumer response to an ingredient that was not only very processed and complex, but also because recent research has shown the potential benefits of gene-editing on byproduct valorisation. Nonetheless, the pre-existing bias against genetically modified foods likely affected how the sample responded to the prompts in the survey.

Similarly, the way the products are presented in the questionnaire do not include information other than the nature of the upcycled component of the product. In a real-world context, the product would most likely be marketed in a way that calls more attention to its desireable attributes. Studies on packaging of upcycled foods do suggest that if they are marketed with low environmental impacts or healthy attributes, consumers are more likely to purchase upcycled foods (Coderoni & Perito 2020). One sudy even suggests that upcycled vice foods with such marketing can increase the willingness to pay more than it will for virtue categories, though virtue categories are still more attractive to consumers.

Another important avenue of future research is to explore the assumed universality of lower climate impacts of upcycled foods. This is key for product development, as the range of possibilities in the production of upcycled foods are as diverse as there are homogenous and adaptable industrial byproducts from food production. Finally, the impact of labelling something as upcycled may not be as effective as labelling a product with more familiar attributes tied to approach motivations. This could be an interesting development in understanding how consumers may perceive upcycled foods, if they are communicated with more familiar positive associations than unfamiliar positive associations that ultimately may be tied to risk.

6. Conclusion

There are a number of aspects that can affect weather we might choose an upcycled food from a conventional product. After having conducted a questionnaire study with a panel of Swedish consumers, we can say that the extent to which the upcycled products are processed is one of these aspects. Less processed upcycled foods have more attribute associations with approach motivation, rather than avoidance, which is the case for more processed upcycled food products. Furthermore, the food values of certain consumers can be a predictor of WTP for upcycled foods, such as valuing the environmental impact of your foods. Younger, individuals with higher education and males are also more likely to choose upcycled foods. Advice for companies intending to produce upcycled products should conside their audience as well the level of processing of their product, and carefully choose which attributes to communicate on thepackaging of their products. Consumer behaviour is complex and performed in a highly stimulating environment and whilst upcycled foods face barriers in normalisation, they entail many positive effects for industrial ecology, food waste and general resilience of our food systems. Therefore, the successful navigation of avoidance-motivated barriers to upcycled foods adoption can drive positive environmental impacts within the food system's sustainability transition.

References

Abbey, J. D., Meloy, M. G., Guide Jr., V. D. R. and Atalay, S. (2015) 'Remanufactured Products in Closed-Loop Supply Chains for Consumer Goods', Production and Operations Management, 24(3), pp. 488-503.

Ahmed, U. S. and Gotoh, K. (2006) Cost-benefit analysis of environmental goods by applying contingent valuation method. Springer.

Alemu, M. H. and Olsen, S. B. (2020) 'An analysis of the impacts of tasting experience and peer effects on consumers' willingness to pay for novel foods', Agribusiness, 36(4), pp. 653-674.

Aschemann-Witzel, J., Asioli, D., Banovic, M., Perito, M. A., Peschel, A. O. and Stancu, V. (2023) 'Defining upcycled food: The dual role of upcycling in reducing food loss and waste', Trends in Food Science & Technology.

Aschemann-Witzel, J. and Stangherlin, I. D. C. (2021) 'Upcycled by-product use in agri-food systems from a consumer perspective: A review of what we know, and what is missing', Technological Forecasting and Social Change, 168, pp. 120749.

Asioli, D. and Grasso, S. (2021) 'Do consumers value food products containing upcycled ingredients? The effect of nutritional and environmental information', Food Quality and Preference, 91, pp. 104194.

Asioli, D. and Grasso, S. (2021) 'Do consumers value food products containing upcycled ingredients? The effect of nutritional and environmental information', Food Quality and Preference, 91, pp. 104194.

Baxter, W., Aurisicchio, M. and Childs, P. (2017) 'Contaminated Interaction: Another Barrier to Circular Material Flows', Journal of Industrial Ecology, 21(3), pp. 507-516.

Bhatt, S., Deutsch, J. and Suri, R. (2021) 'Differentiating Price sensitivity from willingness to pay: Role of pricing in consumer acceptance of upcycled foods', Journal of Food Products Marketing, 27(7), pp. 331-339.

Bhatt, S., Lee, J., Deutsch, J., Ayaz, H., Fulton, B. and Suri, R. (2018) 'From food waste to value-added surplus products (VASP): Consumer acceptance of a novel food product category', Journal of Consumer Behaviour, 17(1), pp. 57-63.

Bhatt, S., Ye, H., Deutsch, J., Ayaz, H. and Suri, R. (2020) 'Consumers' willingness to pay for upcycled foods', Food Quality and Preference, 86, pp. 104035.

Botelho, A., Pinto, L. M., Lourenço-Gomes, L., Valente, M. and Sousa, S. (2016) 'Social sustainability of renewable energy sources in electricity production: An application of the contingent valuation method', Sustainable Cities and Society, 26, pp. 429-437.

Boyle, K. J. (2017) 'Contingent Valuation in Practice', in Champ, P.A., Boyle, K.J. and Brown, T.C. (eds.) A Primer on Nonmarket Valuation. Dordrecht: Springer Netherlands, pp. 83-131.
Bryggerier, S. (2022) Bryggeristatistik. sverigesbryggerier.se. Available at: https://sverigesbryggerier.se/statistik/.
Camacho-Otero, J., Boks, C. and Pettersen, I. N. (2018) 'Consumption in the Circular Economy: A Literature Review', Sustainability, 10(8), pp. 2758.
Carson, R. T. and Hanemann, W. M. (2005) 'Contingent valuation', Handbook of environmental economics, 2, pp. 821-936.
Cembalo, L., Borrello, M., De Luca, A. I., Giannoccaro, G. and D'Amico, M. (2020) 'Transitioning agri-food systems into circular economy trajectories', Aestimum, pp. 199-218.
Chaboud, G. and Daviron, B. (2017) 'Food losses and waste: Navigating the inconsistencies', Global Food Security, 12, pp. 1-7.
Coderoni, S. and Perito, M. A. (2020) 'Sustainable consumption in the circular economy. An analysis of consumers' purchase intentions for waste-to-value food', Journal of Cleaner Production, 252, pp. 119870.
Coderoni, S. and Perito, M. A. (2021) 'Approaches for reducing wastes in the agricultural sector. An analysis of Millennials' willingness to buy food with upcycled ingredients', Waste Management, 126, pp. 283-290.
Corrado, S., Caldeira, C., Eriksson, M., Hanssen, O. J., Hauser, H.-E., van Holsteijn, F., Liu, G., Östergren, K., Parry, A., Secondi, L., Stenmarck, Å. and Sala, S. (2019) 'Food waste accounting methodologies: Challenges, opportunities, and further advancements', Global Food Security, 20, pp. 93-100.
Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F. N. and Leip, A. (2021) 'Food systems are responsible for a third of global anthropogenic GHG emissions', Nature Food, 2(3), pp. 198-209.
Crovetto, M. and Uauy, R. (2012) 'Changes in processed food expenditure in the population of Metropolitan Santiago in the last twenty years', Revista medica de Chile, 140(3), pp. 305-312.
Devnani, B., Moran, G. C. and Grossmann, L. (2023) 'Extraction, Composition, Functionality, and Utilization of Brewer's Spent Grain Protein in Food Formulations', Foods, 12(7), pp. 1543.
EC (2021) Study on the status of new genomic techniques under Union law and in light of the
Court of Justice ruling in Case C-528/16.
EC (2021) The European Commission's Knowledge Centre for Bioeconomy: Breif on food waste in the European Union.
EC (2022) EU platform on food losses and food waste. Available at: https://food.ec.europa.eu/safety/food-waste/eu-actions-against-food-waste/eu-platform-food-losses-and-food-waste_en.
EC (2023) Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2008/98/EC on waste. https://eur-

lex.europa.eu/resource.html?uri=cellar:05b634bd-1b4e-11ee-806b-01aa75ed71a1.0001.02/DOC_1&format=PDF.

Eriksson, M., Bartek, L., Löfkvist, K., Malefors, C. and Olsson, M. E. (2021) 'Environmental assessment of upgrading horticultural side streams—The case of unharvested broccoli leaves', Sustainability, 13(10), pp. 5327.

Eriksson, M., Strid, I. and Hansson, P.-A. (2015) 'Carbon footprint of food waste management options in the waste hierarchy–a Swedish case study', Journal of Cleaner Production, 93, pp. 115-125.

Eş, I., Gavahian, M., Marti-Quijal, F. J., Lorenzo, J. M., Mousavi Khaneghah, A., Tsatsanis, C., Kampranis, S. C. and Barba, F. J. (2019) 'The application of the CRISPR-Cas9 genome editing machinery in food and agricultural science: Current status, future perspectives, and associated challenges', Biotechnology Advances, 37(3), pp. 410-421.

FAO, I., UNICEF, WFP and WHO (2022) The state of food security and nutrition in the world 2022, Rome: FAO.

Fernandez, T., Godwin, A., Doyle, J., Verdin, D., Boone, H., Kirn, A., Benson, L. and Potvin, G. (2016) 'More comprehensive and inclusive approaches to demographic data collection'.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K., West, P. C., Balzer, C., Bennett, E. M., Carpenter, S. R., Hill, J., Monfreda, C., Polasky, S., Rockström, J., Sheehan, J., Siebert, S., Tilman, D. and Zaks, D. P. M. (2011) 'Solutions for a cultivated planet', Nature, 478(7369), pp. 337-342.

Ghazanfar, S., Abdullah, M., Ummar, R., Shabbir, R. and Saqib, S. (2022) 'Effect of Sustainability Claim on Willingness to Pay for Upcycled Food in Digital Era: Differential Effect of Sustainability Claim Between Virtue and Vice Product Category', Frontiers in Environmental Science, 10, pp. 870401.

Ghazanfar, S., Abdullah, M., Ummar, R., Shabbir, R. and Saqib, S. (2022) 'Effect of Sustainability Claim on Willingness to Pay for Upcycled Food in Digital Era: Differential Effect of Sustainability Claim Between Virtue and Vice Product Category', Frontiers in Environmental Science, 10.

Grasso, S. and Asioli, D. (2020) 'Consumer preferences for upcycled ingredients: A case study with biscuits', Food Quality and Preference, 84, pp. 103951.

Gustavsson, C., Sonesson, van Otterdijk and Meybeck (2011) Global food losses and food waste: extent, causes and prevention., Rome: FAO.

Hagman, L. (2023) 'Sustainable side-stream management in Swedish food processing companies using external actors and biogas solutions', Frontiers in Food Science and Technology, 3, pp. 1073663.

Hagman, L. (2023) 'Sustainable side-stream management in Swedish food processing companies using external actors and biogas solutions', Frontiers in Food Science and Technology, 3, pp. 1073663.

Hanley, N. D. (1989) 'VALUING NON-MARKET GOODS USING CONTINGENT VALUATION', Journal of Economic Surveys, 3(3), pp. 235-252.

Hellali, W. and Koraï, B. (2023) 'The impact of innovation level and emotional response on upcycled food acceptance', Food Quality and Preference, 107, pp. 104849.
Hellali, W. and Koraï, B. (2023) 'Understanding consumer's acceptability of the technology behind upcycled foods: An application of the technology acceptance model', Food Quality and Preference, 110, pp. 104943.
Hellali, W., Korai, B. and Lambert, R. (2023) 'Food from waste: The effect of information and attitude towards risk on consumers' willingness to pay', Food Quality and Preference, 110, pp. 104945.
Huang, X., Cheng, L., Chien, H., Jiang, H., Yang, X. and Yin, C. (2019) 'Sustainability of returning wheat straw to field in Hebei, Shandong and Jiangsu provinces: A contingent valuation method', Journal of Cleaner Production, 213, pp. 1290-1298.
IPCC (2019) Special report on climate change and land: Chapter 5, https://www.ipcc.ch/srccl/chapter/chapter-5/. Available at: https://www.ipcc.ch/srccl/chapter/chapter-5/.
Ishii, T. and Araki, M. (2016) 'Consumer acceptance of food crops developed by genome editing', Plant cell reports, 35, pp. 1507-1518.
Jain, S. and Gualandris, J. (2023) 'When does upcycling mitigate climate change? The case of wet spent grains and fruit and vegetable residues in Canada', Journal of Industrial Ecology, 27(2), pp. 522-534.
Jin, Q., Yang, L., Poe, N. and Huang, H. (2018) 'Integrated processing of plant-derived waste to produce value-added products based on the biorefinery concept', Trends in Food Science & Technology, 74, pp. 119-131.
Joensuu, K., Hartikainen, H., Karppinen, S., Jaakkonen, A.-K. and Kuoppa-Aho, M. (2021) 'Developing the collection of statistical food waste data on the primary production of fruit and vegetables', Environmental Science and Pollution Research, 28, pp. 24618-24627.
Johansson, K. and Samuelsson, M. (2018) METHOD FOR PREPARING A FOOD GRADE COAGULATED POTATO PROTEIN CONCENTRATE Patent no. US20180042265A1. [Online]. Available at: https://patentimages.storage.googleapis.com/d4/1e/1a/61a604bbe5c606/US20180042265A1.pdf.
Johnson, L. K., Dunning, R. D., Gunter, C. C., Dara Bloom, J., Boyette, M. D. and Creamer, N. G. (2018) 'Field measurement in vegetable crops indicates need for reevaluation of on-farm food loss estimates in North America', Agricultural Systems, 167, pp. 136-142.
Jordbruksverket (2022) Skörd av potatis 2022. Preliminär statistik. Available at: https://jordbruksverket.se/om-jordbruksverket/jordbruksverkets-officiella-statistik/jordbruksverkets-statistikrapporter/statistik/2022-12-07-skord-av-potatis-2022.-preliminar-statistik#h-Kortomstatistiken.
Just, D. R. and Goddard, J. M. (2023) 'Behavioral framing and consumer acceptance of new food technologies: Factors influencing consumer demand for active packaging', Agribusiness, 39(1), pp. 3-27.

Kamleitner, B., Thürridl, C. and Martin, B. A. S. (2019) 'A Cinderella Story: How Past Identity Salience Boosts Demand for Repurposed Products', Journal of Marketing, 83(6), pp. 76-92.

Kardung, M., Cingiz, K., Costenoble, O., Delahaye, R., Heijman, W., Lovrić, M., van Leeuwen, M., M'barek, R., van Meijl, H. and Piotrowski, S. (2021) 'Development of the circular bioeconomy: Drivers and indicators', Sustainability, 13(1), pp. 413.

Kniivilä, M. (2006) 'Users and non-users of conservation areas: Are there differences in WTP, motives and the validity of responses in CVM surveys?', Ecological Economics, 59(4), pp. 530-539.

Knorr, D., Augustin, M. A. and Tiwari, B. (2020) 'Advancing the Role of Food Processing for Improved Integration in Sustainable Food Chains', Frontiers in Nutrition, 7.

Knorr, D. and Sevenich, R. (2023) 'Processed foods: From their emergence to resilient technologies', Comprehensive Reviews in Food Science and Food Safety, 22(5), pp. 3765-3789.

Lawrence, M. (2023) 'Ultra-processed foods: a fit-for-purpose concept for nutrition policy activities to tackle unhealthy and unsustainable diets', British Journal of Nutrition, 129(12), pp. 2195-2198.

Magnusson, T., Andersson, H. and Ottosson, M. (2019) 'Industrial ecology and the boundaries of the manufacturing firm', Journal of Industrial Ecology, 23(5), pp. 1211-1225.

McCarthy, B., Kapetanaki, A. B. and Wang, P. (2020) 'Completing the food waste management loop: Is there market potential for value-added surplus products (VASP)?', Journal of Cleaner Production, 256, pp. 120435.

McFadden, D. (2017) 'Stated preference methods and their applicability to environmental use and non-use valuations', Contingent Valuation of Environmental Goods: A Comprehensive Critique, 153.

Miljömål, Sveriges. (2023) Livsmedelsförlusterna ska minska och mer ska bli mat: En ökad andel av livsmedelsproduktionen ska nå butik och konsument år 2025. https://sverigesmiljomal.se/etappmalen/livsmedelsforlusterna-ska-minska/. Available at: https://sverigesmiljomal.se/etappmalen/livsmedelsforlusterna-ska-minska/.

Mirosa, M. and Bremer, P. (2023) 'Understanding new foods: Upcycling', Sustainable Food Innovation: Springer, pp. 147-156.

Monni, A., Olivier, E., Morin, A. J. S., Olivetti Belardinelli, M., Mulvihill, K. and Scalas, L. F. (2020) 'Approach and avoidance in Gray's, Higgins', and Elliot's perspectives: A theoretical comparison and integration of approach-avoidance in motivated behavior', Personality and Individual Differences, 166, pp. 110163.

Monteiro, C. A., Cannon, G., Lawrence, M., Costa Louzada, M. d. and Pereira Machado, P. (2019) 'Ultra-processed foods, diet quality, and health using the NOVA classification system', Rome: FAO, 48.

Monteiro, C. A., Cannon, G., Levy, R., Moubarac, J.-C., Jaime, P., Martins, A. P., Canella, D., Louzada, M. and Parra, D. (2016) 'NOVA. The star shines bright', World Nutrition, 7(1-3), pp. 28-38.

Monteiro, C. A., Cannon, G., Moubarac, J.-C., Levy, R. B., Louzada, M. L. C. and Jaime, P. C. (2018) 'The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing', Public health nutrition, 21(1), pp. 5-17.

Monteiro, C. A., Levy, R. B., Claro, R. M., Castro, I. R. R. d. and Cannon, G. (2010) 'A new classification of foods based on the extent and purpose of their processing', Cadernos de saude publica, 26, pp. 2039-2049.

Moshtaghian, H., Bolton, K. and Rousta, K. 'Consumer attitudes towards upcycled foods'.

Moshtaghian, H., Bolton, K. and Rousta, K. (2021) 'Challenges for upcycled foods: definition, inclusion in the food waste management hierarchy and public acceptability', Foods, 10(11), pp. 2874.

Moubarac, J.-C., Batal, M., Martins, A. P. B., Claro, R., Levy, R. B., Cannon, G. and Monteiro, C. (2014) 'Processed and ultra-processed food products: consumption trends in Canada from 1938 to 2011', Canadian Journal of Dietetic Practice and Research, 75(1), pp. 15-21.

Muscat, A., de Olde, E. M., Ripoll-Bosch, R., Van Zanten, H. H., Metze, T. A., Termeer, C. J., van Ittersum, M. K. and de Boer, I. J. (2021) 'Principles, drivers and opportunities of a circular bioeconomy', Nature Food, 2(8), pp. 561-566.

Nazzaro, C., Lerro, M., Stanco, M. and Marotta, G. (2019) 'Do consumers like food product innovation? An analysis of willingness to pay for innovative food attributes', British Food Journal, 121(6), pp. 1413-1427.

Nemoto, T. and Beglar, D. 'Likert-scale questionnaires'. JALT 2013 conference proceedings, 1-8.

Nezlek, J. B., Forestell, C. A. and Cypryanska, M. (2021) 'Approach and avoidance motivation and interest in new foods: Introducing a measure of the motivation to eat new foods', Food Quality and Preference, 88, pp. 104111.

Nezlek, J. B., Forestell, C. A. and Cypryanska, M. (2021) 'Approach and avoidance motivation and interest in new foods: Introducing a measure of the motivation to eat new foods', Food Quality and Preference, 88, pp. 104111.

Nitzko, S. and Spiller, A. (2019) 'Comparing “Leaf-to-Root”, “Nose-to-Tail” and Other Efficient Food Utilization Options from a Consumer Perspective', Sustainability, 11(17), pp. 4779.

Onwuegbuzie, A. J. (2000) 'Expanding the framework of internal and external validity in quantitative research'.

Ott, D., Goyal, S., Reuss, R., Gutzeit, H. O., Liebscher, J., Dautz, J., Degieter, M., de Steur, H. and Zannini, E. (2023) 'LCA as decision support tool in the food and feed sector: evidence from R&D case studies', Environment Systems and Decisions, 43(1), pp. 129-141.

Pęksa, A. and Miedzianka, J. (2021) 'Potato Industry By-Products as a Source of Protein with Beneficial Nutritional, Functional, Health-Promoting and Antimicrobial Properties', Applied Sciences, 11(8), pp. 3497.

Perito, M. A., Coderoni, S. and Russo, C. (2020) 'Consumer attitudes towards local and organic food with upcycled ingredients: An italian case study for olive leaves', Foods, 9(9), pp. 1325.

Peschel, A. O. and Aschemann-Witzel, J. (2020) 'Sell more for less or less for more? The role of transparency in consumer response to upcycled food products', Journal of Cleaner Production, 273, pp. 122884.

Petit, G., Korbel, E., Jury, V., Aider, M., Rousselière, S., Audebrand, L. K., Turgeon, S. L. and Mikhaylin, S. (2020) 'Environmental Evaluation of New Brewer's Spent Grain Preservation Pathways for Further Valorization in Human Nutrition', ACS Sustainable Chemistry & Engineering, 8(47), pp. 17335-17344.

Petrus, R. R., do Amaral Sobral, P. J., Tadini, C. C. and Gonçalves, C. B. (2021) 'The NOVA classification system: a critical perspective in food science', Trends in Food Science & Technology, 116, pp. 603-608.

Poore, J. and Nemecek, T. (2018) 'Reducing food's environmental impacts through producers and consumers', Science, 360(6392), pp. 987-992.

Ramu Ganesan, A., Hoellrigl, P., Mayr, H., Martini Loesch, D., Tocci, N., Venir, E. and Conterno, L. (2023) 'The Rheology and Textural Properties of Bakery Products Upcycling Brewers’ Spent Grain', Foods, 12(19), pp. 3524.

Schiffman, L. and Wisenblit, J. 2015. Consumer Behavior (11th, glob ed.). Pearson Australia.

Schmidt, J. and Bijmolt, T. H. A. (2020) 'Accurately measuring willingness to pay for consumer goods: a meta-analysis of the hypothetical bias', Journal of the Academy of Marketing Science, 48(3), pp. 499-518.

Slevitch, L. (2011) 'Qualitative and Quantitative Methodologies Compared: Ontological and Epistemological Perspectives', Journal of Quality Assurance in Hospitality & Tourism, 12(1), pp. 73-81.

SOU (2023:15) Förnybart i tanken: Ett styrmedelsförslag för en stärkt bioekonomi.

Sousa, P. M., Moreira, M. J., de Moura, A. P., Lima, R. C. and Cunha, L. M. (2021) 'Consumer Perception of the Circular Economy Concept Applied to the Food Domain: An Exploratory Approach', Sustainability, 13(20), pp. 11340.

Spratt, O., Suri, R. and Deutsch, J. (2021) 'Defining upcycled food products', Journal of Culinary Science & Technology, 19(6), pp. 485-496.

Teigiserova, D. A., Hamelin, L. and Thomsen, M. (2020) 'Towards transparent valorization of food surplus, waste and loss: Clarifying definitions, food waste hierarchy, and role in the circular economy', Science of The Total Environment, 706, pp. 136033.

Verbeek, M. and Nijman, T. (1996) 'Incomplete Panels and Selection Bias', in Mátyás, L. and Sevestre, P. (eds.) The Econometrics of Panel Data: A Handbook of the Theory with Applications. Dordrecht: Springer Netherlands, pp. 449-490.

Wang, J., Wang, J. and Gao, J. (2020) 'Effect of Green Consumption Value on Consumption Intention in a Pro-Environmental Setting: The Mediating Role of Approach and Avoidance Motivation', SAGE Open, 10(1), pp. 2158244020902074.

Westerman, P. and Bicudo, J. (2005) 'Management considerations for organic waste use in agriculture', Bioresource technology, 96(2), pp. 215-221.
Wikström, F., Williams, H., Verghese, K. and Clune, S. (2014) 'The influence of packaging attributes on consumer behaviour in food-packaging life cycle assessment studies - a neglected topic', Journal of Cleaner Production, 73, pp. 100-108.
Yang, X., Huang, Y., Cai, X., Song, Y., Jiang, H., Chen, Q. and Chen, Q. (2021) 'Using imagination to overcome fear: how mental simulation nudges consumers' purchase intentions for upcycled food', Sustainability, 13(3), pp. 1130.
Yilmaz, E. and Kahveci, D. (2022) 'Consumers' purchase intention for upcycled foods: Insights from Turkey', Future Foods, 6, pp. 100172.

Popular science summary

Today, a lot of our food commodities are made at industrial scales. Processing has become an essential part of how we transform fresh produce into products with longer shelf lives. However, when these products are made, more than often there is also a byproduct, a part of the plant or animal produce that is not used. Using these byproducts as ingredients in other, often novel, processed foods has the potential to reduce waste and let a larger part of the raw produce that is produced by our food systems go to human consumption. These new products are called upcycled foods.

To further explain, imagine that you are looking to buy oat cookies at the supermarket and you come across a promising looking product but notice that the packaging states that these are upcycled, using pressed oats that are a byproduct resulting from the production of oat milk. Are you inclined to buy this item? Would you prefer to buy them rather than the oat cookies that you usually buy? Questions such as these were posed to Swedish participants in a survey in order to understand if upcycled products are desireable, and if so, does the ways in which the products are processed make a difference?

When we make decisions about what to purchase we are influenced by several internal factors; there are things about products that attract us to them, and things that make us avoid them. Upcycled foods, though individually variable, can have a lower environmental impact and they also hint at a greater system of collaboration in industrial production of foods behind the curtain. They are also, however, new and unfamiliar and they may not be perceived as ‘natural’ or even safe.

Results from the study suggest that there is a barrier for the acceptance of upcycled foods generally, that is to say, that for all the products included in the survey, the conventional alternatives were more popular than the upcycled versions. Nonetheless, responses varied, suggesting that upcycled foods that are less processed (i.e., a green juice) are more attractive to the Swedish consumer panel than the more processed products (i.e., vegan nuggets).

Upcycled foods face an uphill battle in normalisation. There are nonetheless certain consumer segments that are more likely to adapt to purchasing upcycled foods, such as environmentally concious individuals. Ultimately, consumers seem to require lower prices to be able to approach the perceived risk of buying such a product. Can you see yourself purchasing an upcycled food, and is there anything in particular that would make you more likely to?

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I am sincerely gald to have arrived at the end of this project, and to be able to see it in its entirety. This, I know, would never have been possible without the people in my life that have given their time and unyielding to help me, for which I am deeply greatful. I would like to thank my supervisor Anna Kristina Edenbrandt for her unwavering support and patience, helping me in more ways than I ever could have known I needed. Big thanks to my examiner Mattias Eriksson, for allowing me to dream big, and also for killing my darlings when it was most needed. I would also like to extend a thanks to Louise Bartek who truly taught me so much about LCA, even though none of it ended up featuring in this thesis. Finally, thanks to Harry and Alice who witnessed the slough first-hand, and somehow still never doubted in me. I am immensely greatful to cross this finish line, I could never have done it alone.

Appendix 1: Survey

Thesis survey

Start of Block: Introduction

Introduktionstext Hej och välkommen!

I denna undersökning vill vi veta mer om dina attityder till, och val av, olika livsmedel. Studien är en del av ett forskningsprojekt vid Sveriges Lantbruksuniversitet. Resultaten av studien kommer att bidra till den offentliga debatten och ligga till grund för beslutsfattandet för offentliga organisationer och aktörer i livsmedelssektorn.

Vi ber dig aldrig uppge några personuppgifter, alla svar är anonyma. Svaren från enkäten kommer att användas för forskningssyften, och analyseras på gruppnivå, där det inte är möjligt att identifiera dig som respondent.

Enkäten förväntas ta ca 12 minuter att slutföra. Du kan när som helst avsluta undersökningen genom att stänga fönstret.

Om du har frågor eller vill ta del av resultat är du välkommen att höra av dig till anna.edenbrandt@slu.se.

Det finns inga rätt eller fel svar, och vi hoppas att du svarar så uppriktigt som möjligt.

Samtycke **Samtycke**
Jag bekräftar härmed att jag har läst och förstått informationen ovan. Jag är 18 år eller äldre, och ger mitt samtycke till att delta i denna forskningsstudie.

- ○ Jag har läst och förstått vad som ingår i deltagandet i studien, och jag samtycker till att delta. (1)
- ○ Jag samtycker inte, eller vill inte delta i denna studie. (2)

End of Block: Introduction

Start of Block: Screening

Gender Jag är:

- ○ Kvinna (1)
- ○ Man (2)
- ○ Icke binär (3)
- ○ Vill ej ange (4)

Age Ange din ålder i siffror:

_____

End of Block: Screening

Start of Block: Food Values

Q13 Hur viktiga är följande aspekter när du handlar mat?

	(1) Inte alls viktigt (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	(7) Väldigt viktigt (7)
Naturlighet (1)	○	○	○	○	○	○	○
Smak (2)	○	○	○	○	○	○	○
Pris (3)	○	○	○	○	○	○	○
Välj "2" för att visa att du är uppmärksam (6)	○	○	○	○	○	○	○
Livsmedelssäkerhet (4)	○	○	○	○	○	○	○
Lätt att tillaga (5)	○	○	○	○	○	○	○

Page Break

Q81 Hur viktiga är följande aspekter när du handlar mat?

	(1) Inte alls viktigt (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	(7) Väldigt viktigt (7)
Näringsinnehåll (1)	○	○	○	○	○	○	○
Traditioner (2)	○	○	○	○	○	○	○
Matens ursprung (3)	○	○	○	○	○	○	○
Social rättvisa (4)	○	○	○	○	○	○	○
Utseende (5)	○	○	○	○	○	○	○
Miljöpåverkan (6)	○	○	○	○	○	○	○

End of Block: Food Values

Start of Block: Screenout

Matansvar Hur mycket ansvarar du för matinköp i ditt hushåll?

- ○ Jag har allt ansvar för matinköp (1)
- ○ Jag delar ansvaret för matinköp (2)
- ○ Det är någon annan som ansvarar för matinköpen (3)

End of Block: Screenout

Start of Block: Choice tasks JOSEPHINE

Q57 I följande del av enkäten kommer du få välja mellan varianter av olika vardagliga matprodukter.

Några av dessa produkter innehåller ingredienser som är restprodukter ur olika matproduktionssystem. Detta benämns ofta med termen 'upcycled'. Dessa restprodukter används vanligtvis inte till mänsklig konsumtion.

Här visas ett exempel på varifrån en 'upcycled' ingrediens kan komma ifrån. I detta exempel är den nya ingrediensen gjord på en restprodukt från tillverkning av havremjölk:

Varje matprodukt som innehåller en restprodukt får du information om:
1. Vad den innehåller för restprodukt.
2. Vad restprodukten har för ursprung.
3. Process eller teknik som använts för att kunna använda restprodukten

---

Q92 Har du tidigare hört talats om 'upcycled' mat?

- ○ Ja, jag visste exakt vad det var sedan innan (1)
- ○ Ja, jag har hört termen men var inte helt säker på vad det är (2)
- ○ Nej, jag har aldrig hört talats om det (3)

End of Block: Choice tasks JOSEPHINE

Start of Block: Choice Tasks JOSEPHINE Block 1

JC_01 Anta att du vill köpa ett paket bröd och att det finns följande två sorter tillgängliga. Om pris och smakprofil är identiska, vilket bröd skulle du välja?

- ○ **Surdegsbröd Upcycled 700g Innehåller restprodukten:** Förbrukade spannmål **Från:** Ölbryggerier **Process:** Spannmålen torkas och mals till ett mjöl (1)
- ○ **Surdegsbröd 700g - - -** (2)

Page Break

JC_01_mer Anta nu att brödet med restprodukt från öltillverkning kostar mer än det konventionella brödet. Vad är det mesta du skulle vara villig att betala för detta brödet?

- Jag skulle inte betala mer för brödet med restprodukt från öltillverkning (1)
- 5 % mer än det konventionella brödet (2)
- 10 % mer än det konventionella brödet (3)
- 15 % mer än det konventionella brödet (4)
- 20 % mer än det konventionella brödet (5)
- Mer än 20 % mer än det konventionella brödet (6)

Page Break

JC_01_mindre Anta nu att brödet med restprodukt från öltillverkning kostar mindre än det konventionella brödet. Vad är det mesta du skulle vara villig att betala för detta brödet?

- 5 % mindre än det konventionella brödet (1)
- 10 % mindre än det konventionella brödet (2)
- 15 % mindre än det konventionella brödet (3)
- 20 % mindre än det konventionella brödet (4)
- 50 % mindre än det konventionella brödet (5)
- 75 % mindre än det konventionella brödet (6)
- Jag skulle inte köpa brödet med restprodukt från ölproduktion till vilket pris som helst (7)

Page Break

JC_02 Anta att du vill köpa ett paket bröd och att det finns följande två sorter tillgängliga. Om pris och smakprofil är identiska, vilket bröd skulle du välja?

- **Surdegsbröd Upcycled 700g Innehåller restprodukten:** Broccoliblad **Från:** Oskördad broccoli **Process:** Bladen torkas och mals till ett pulver (1)
- **Surdegsbröd 700g - - -** (2)

Page Break

JC_02_mer Anta nu att brödet med restprodukt från broccoliskörd kostar mer än det konventionella brödet. Vad är det mesta du skulle vara villig att betala för detta brödet?

- Jag skulle inte betala mer för brödet med restprodukt från broccoliskörd (1)
- 5 % mer än det konventionella brödet (2)
- 10 % mer än det konventionella brödet (3)
- 15 % mer än det konventionella brödet (4)
- 20 % mer än det konventionella brödet (5)
- Mer än 20 % mer än det konventionella brödet (6)

Page Break

JC_02_mindre Anta nu att brödet med restprodukt från broccoliskörd kostar mindre än det konventionella brödet. Vad är det mesta du skulle vara villig att betala för detta brödet?

- ○ 5 % mindre än det konventionella brödet (1)
- ○ 10 % mindre än det konventionella brödet (2)
- ○ 15 % mindre än det konventionella brödet (3)
- ○ 20 % mindre än det konventionella brödet (4)
- ○ 50 % mindre än det konventionella brödet (5)
- ○ 75 % mindre än det konventionella brödet (6)
- ○ Jag skulle inte köpa brödet med restprodukt från broccoliskörd till vilket pris som helst (7)

Page Break

JC_03 Anta att du vill köpa ett paket bröd och att det finns följande två sorter tillgängliga. Om pris och smakprofil är identiska, vilket bröd skulle du välja?

- ○ **Surdegsbröd Upcycled 700g Innehåller restprodukten:** Potatisprotein **Från:** Restprodukt vid utvinning av potatisstärkelse **Process:** Gen-editering av stärkelsepotatisen (1)
- ○ **Surdegsbröd 700g - - -** (2)

Page Break

JC_03_mer Anta nu att brödet med restprodukt från produktionen av potatisstärkelse kostar mer än det konventionella brödet. Vad är det mesta du skulle vara villig att betala för detta brödet?

- ○ Jag skulle inte betala mer för brödet med restprodukt från produktionen av potatisstärkelse öltillverkning (1)
- ○ 5 % mer än det konventionella brödet (2)
- ○ 10 % mer än det konventionella brödet (3)
- ○ 15 % mer än det konventionella brödet (4)
- ○ 20 % mer än det konventionella brödet (5)
- ○ Mer än 20 % mer än det konventionella brödet (6)

Page Break

JC_03_mindre Anta nu att brödet med restprodukt från utvinningen av potatisstärkelse kostar mindre än den konventionella produkten. Vad är det mesta du skulle vara villig att betala för detta brödet?

- ○ 5 % mindre än det konventionella brödet (1)
- ○ 10 % mindre än det konventionella brödet (2)
- ○ 15 % mindre än det konventionella brödet (3)
- ○ 20 % mindre än det konventionella brödet (4)
- ○ 50 % mindre än det konventionella brödet (5)
- ○ 75 % mindre än det konventionella brödet (6)
- ○ Jag skulle inte köpa brödet med restprodukt från utvinningen av potatisstärkelse till vilket pris som helst (7)

Page Break

JC_04 Anta att du vill köpa en juice och att det finns följande två sorter tillgängliga. Om pris och smakprofil är identiska, vilken juice skulle du välja?

- ○ **Grön Juice Upcycled 350ml Innehåller restprodukten:** Broccoliblad **Från:** Oskördad broccoli **Process:** Bladen torkas och mals till ett pulver (1)
- ○ **Grön Juice 350ml - - -** (2)

Page Break

JC_04_mer Anta nu att juicen med restprodukt från broccoliskörd kostar mer än den konventionella Juicen. Vad är det mesta du skulle vara villig att betala för denna Juicen?

- ○ Jag skulle inte betala mer för Juicen med restprodukt från restprodukt från broccoliskörd (1)
- ○ 5 % mer än den konventionella Juicen (2)
- ○ 10 % mer än den konventionella Juicen (3)
- ○ 15 % mer än den konventionella Juicen (4)
- ○ 20 % mer än den konventionella Juicen (5)
- ○ Mer än 20 % mer än den konventionella Juicen (6)

Page Break

JC_04_mindre Anta nu att Juicen med restprodukt från broccoliskörd kostar mindre än den konventionella produkten. Vad är det mesta du skulle vara villig att betala för denna Juicen?

- ○ 5 % mindre än den konventionella Juicen (1)
- ○ 10 % mindre än den konventionella Juicen (2)
- ○ 15 % mindre än den konventionella Juicen (3)
- ○ 20 % mindre än den konventionella Juicen (4)
- ○ 50 % mindre än den konventionella Juicen (5)
- ○ 75 % mindre än den konventionella Juicen (6)
- ○ Jag skulle inte köpa Juicen med restprodukt från broccoliskörd till vilket pris som helst (7)

Page Break

JC_05 Anta att du vill köpa ett paket vego nuggets och att det finns följande två sorter tillgängliga. Om pris och smakprofil är identiska, vilka vego nuggets skulle du välja?

- ○ **Vego Nuggets Upcycled 650g Innehåller restprodukten:** Potatisprotein **Från:** Restprodukt vid utvinning av potatisstärkelse **Process:** Gen-editering av stärkelsepotatisen (1)
- ○ **Vego Nuggets 650g - - -** (2)

Page Break

JC_05_mer Anta nu att Vego Nuggets med restprodukt från utvinningen av potatisstärkelse kostar mer än den konventionella produkten. Vad är det mesta du skulle vara villig att betala för dessa Vego Nuggets?

- ○ Jag skulle inte betala mer för Vego Nuggets med restprodukt från utvinningen av potatisstärkelse (1)
- ○ 5 % mer än de konventionella Vego Nuggets (2)
- ○ 10 % mer än de konventionella Vego Nuggets (3)
- ○ 15 % mer än de konventionella Vego Nuggets (4)
- ○ 20 % mer än de konventionella Vego Nuggets (5)
- ○ Mer än 20 % mer än de konventionella Vego Nuggets (6)

Page Break

JC_05_mindre Anta nu att Vego Nuggets med restprodukt från utvinningen av potatisstärkelse kostar mindre än den konventionella produkten. Vad är det mesta du skulle vara villig att betala för dessa Vego Nuggets?

- ○ 5 % mindre än de konventionella Vego Nuggets (1)
- ○ 10 % mindre än de konventionella Vego Nuggets (2)
- ○ 15 % mindre än de konventionella Vego Nuggets (3)
- ○ 20 % mindre än de konventionella Vego Nuggets (4)
- ○ 50 % mindre än de konventionella Vego Nuggets (5)
- ○ 75 % mindre än de konventionella Vego Nuggets (6)
- ○ Jag skulle inte köpa Vego Nuggets med restprodukt från utvinningen av potatisstärkelse till vilket pris som helst (7)

End of Block: Choice Tasks JOSEPHINE Block 1

Q15 Ange hur många det bor i ditt hushåll

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- Fler: (6) _____

Q16 Bor det barn under 12 i ditt hushåll?

- Ja (1)
- Nej (2)

Q19 Hushållets gemensamma disponibla inkomst (månadslön efter skatt + eventuella bidrag efter pension)

- 0 - 10,000kr/mån (1)
- 10,001 - 30,000kr/mån (2)
- 30,001 - 50,000kr/mån (3)
- 50,001 - 100,000kr/mån (4)
- > 100,000kr/mån (5)
- Vill ej ange (6)

Q18 Högsta avslutade utbildning

- ○ Ingen avslutad utbildning (1)
- ○ Grundskola (2)
- ○ Gymnasieutbildning (3)
- ○ Eftergymnasial utbildning max. 3 år (4)
- ○ Eftergymnasial utbildning mer än 3 år (5)
- ○ Vill ej ange (6)

End of Block: Follow-up Questions JOSEPHINE

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