Shaping Consumer Acceptance of Alternative Protein: The Impact of Bioengineering and Health Messaging on Mycoprotein Acceptance

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Executive summary

Food security has become an increasingly critical global challenge, there is a need for protein alternatives that are both scalable and sustainable. Alternative proteins show potential, but the sector faces challenges with sales declining, and consumer barriers relating to taste, texture and price. Mycoprotein, a protein made by fungal fermentation, shows potential to overcome common alternative protein barriers with its meat-like texture, complete amino acid profile and high fiber content with minimal processing. Genetic modification can improve nutritional and sensory characteristics, addressing consumer barriers. However, limited research exists on consumer acceptance of genetically modified alternative proteins, especially in the context of the US National Bioengineering Food Disclosure Standard (NBFDS). This research investigated how market communication influences consumer acceptance of genetically modified mycoprotein through a mixed-methods approach.

Three sub questions were addressed, regarding exploration of communication strategies, determining effects of bioengineering disclosure on willingness to try and buy and by exploring mycoprotein nomenclature preferences. Qualitative interviews with four industry and academic experts and a quantitative cross-sectional survey of 165 US consumers were performed to answer the research questions. The survey employed a 2x4 mixed factorial design testing bioengineering logo presence (between-subjects) and four different health/nutrition claims (within-subjects). Thematic analysis was performed to extract themes from the interviews and linear mixed-effects models were used for survey statistical analyses.

Expert interviews identified four primary communication strategies in the alternative protein sector: Respecting consumer routines, evoking familiar associations, emphasizing tangible benefits and employing subtle communication. These communication strategies are responses to the identified main barriers: routine rigidity, food neophobia and trust concerns regarding industry credibility. The interviews indicated a shift from communal benefits, like sustainability, toward tangible health benefits. Contrary to expectations, bioengineering disclosure did not significantly influence willingness to try ($p=.983$) or buy mycoprotein. However, bioengineered logo was found to negatively moderate the influence of perceived trust ($\beta = -0.263$, $p < .01$) and perceived healthiness ($\beta = -0.173$, $p < .05$) on willingness to try mycoprotein, indicating that bioengineering disclosure might shift consumer decision-making dynamics rather than negatively impacting willingness to try. Health benefits were confirmed to be a primary motivator for consumers interested in mycoprotein (61% of respondents). Food neophobia was found to significantly predict willingness to try mycoprotein ($\beta = -0.220$, $p < .01$), but not to buy mycoprotein. In terms of nomenclature, 'Yeast' related naming evoked positive associations in participants, with 'Nutritional yeast' receiving the highest Net Positivity Score (30) followed by 'Yeast protein' (24), 'Mycoprotein' (13), 'Mycelium' (6), and 'Yeast biomass' (1).

This research extends on dual processing theory to genetically modified alternative proteins, showing that identified communication strategies target either System I or System II thinking. The found moderation effect of bioengineering disclosure on decision-making heuristics present a contribution to existing food decision-making literature and the NBFDS. Findings inform industry product development and communication strategy, emphasizing health benefits with fiber emerging as a promising strategy.

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I'm so glad that I've chosen to do my thesis here and I will return to the Netherlands as a more experienced and fulfilled person.

- *Marc*

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1 Introduction

The global population has experienced significant growth in the last years, and the population is predicted to increase by another 2 billion in the coming 30 years (Nations, n.d.). This growth comes with several challenges, specifically on food availability and climate-impact. Because of this growth, demand for meat and seafood are expected to rise by at least 50% in 2050, from 2012 levels (GFI, 2025a). Industrial farming has hit the ceiling of what is possible and climate change, degradation of soil, water scarcity, and land constraints are all on their way to make the current food system unsustainable and incapable of keeping up with the increasing demand (Gilding, 2025). There is a need for food system solutions that are sustainable and scalable. Consumers are becoming more aware on climate issues, causing a shift in focus of the global food industry towards sustainability and innovation efforts. In terms of products, this results in protein sources that serve as conventional (animal) meat alternatives, since conventional meat is known to have a big impact on land usage, water usage and greenhouse gasses. The most abundant and well known type of alternative protein is plant-based protein. Other types of alternative protein can originate from cultured meat, or microbes.

Because of its potential, the alternative protein market has seen a big rise of investments in the last 4 years, up to 2021 globally (Figure 1). This rise was mostly driven by investments in companies like Impossible Foods (US) and Perfect Day (US), with an innovative plant-based meat product and fermentation produced animal protein respectively (AgFunder, 2025). However, recently, investments quickly dropped because of declining US retail sales. US households are buying less plant-based meats than before (Flood, 2024; Watson, 2023). Key barriers that likely played a role in this decline are taste, price, texture, processing concerns and emotional connection to meat (Kirchner and Leet-Otley, 2025a). These barriers cause the industry to keep exploring additional alternative protein solutions, to combat these barriers. Several other factors impacted decline in the plant-based food industry. Industry lobbyists and wellness influencers are promoting carnivore diets to reach protein goals, which the Trump administration has embraced (Milman, 2025). In other parts of the world, similar decline trends were observed, with the UK seeing a 9% decline in sales volume between 2022 and 2023 (GFI, 2024), also reflected by industry signals like Unilever (UK) selling off its 'the Vegetarian Butcher' brand (Unilever, 2025).

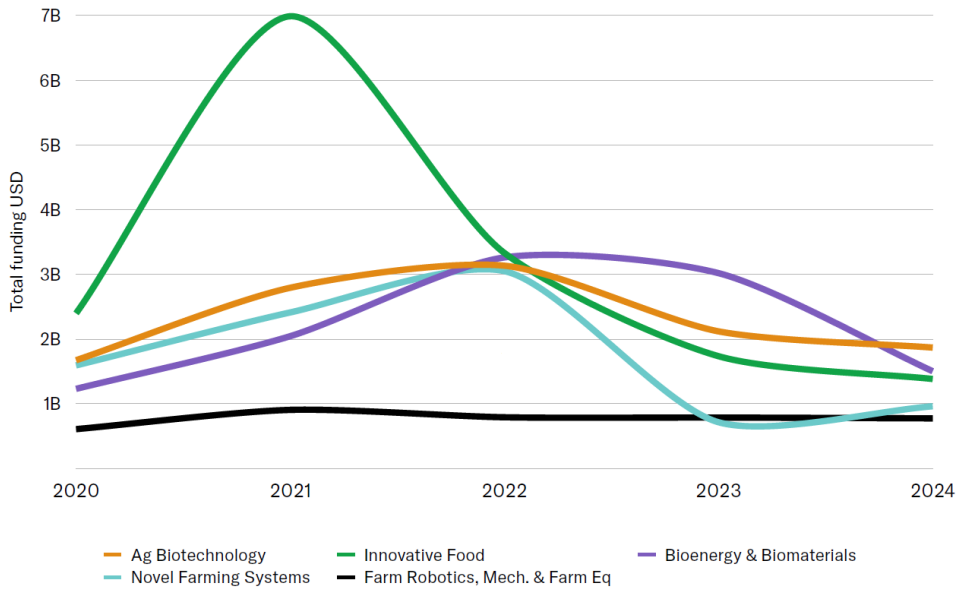

Figure 1: Global Agricultural Technology Investment Trends (2020-2024). Categories are Biotechnology Innovative Food, Bioenergy & Biomaterials, Novel Farming Systems and Fram Robotics, Mech. & Farm Eq from 2020-2024. Figure from (AgFunder, 2025).

Regardless of the declining retail sales, the United States keeps rising as a developed market in terms of total investment in agriculture food technology, with a year-over-year increase of 14% in 2024 compared to 2023, totaling a 6.6B USD investment. Besides key barriers, there are also factors that drive consumers to consume alternative protein. A recent consumer insights study by the Good Food Institute (GFI) in the US showed that the main drivers for consumers to eat plant-based meats are health-related, consumers view plant-based meat as a way of avoiding disease, as a nutritious package or as a source of lean protein, avoiding the health problems sometimes associated with animal based meat. Another main driver, although for a much smaller group, is sustainability and animal suffering issues associated with animal based meat.

While plant-based meats have become popular among early adopters, the sector struggles to attract mainstream consumers. In 2024, GFI published a report on 'household shoppers in the US' and found that only 7% of households purchasing animal-meat made up 82% of all plant-based meat sales, implying that there is still a lot of untapped potential in attracting conventional meat eaters, rather than just focusing on vegan or vegetarian consumers. Impossible foods announced in 2024 that they are changing their marketing communication strategy to put more emphasis on a 'meatier' branding; mainly highlighting the taste aspect, and including 'meatier' branding elements such as red colors and bold fonts to aid in attracting conventional meat eating customers (Impossible Foods, 2024). The struggle to attract mainstream consumers highlights the need for alternative approaches to overcome barriers to adoption.

Because of key barriers, companies are researching other types of alternative protein. Microbial foods is one of the categories that has gained some traction, because of easy industrial production, scaling and nutritional characteristics. In academia, the category is sometimes described as 'Single Cell Protein (SCP)', while in industry more specific terminology is used. Mycoprotein is an example of a microbial food, also referred to as 'mycelium' or 'fungi protein', and is made through fermentation of fungi or yeasts. There are several advantages associated with mycoprotein, compared to plant-based foods. It contains various vitamins, is protein-rich (~50% of the dry weight) and the composition of different proteins is already close to meeting the Food and Agriculture Organization (FAO) standards, all without any processing (Anupama and Ravindra, 2000). This makes 'whole-cut' like food products possible, containing mycoprotein as a main ingredient (> 85%) (Quorn, n.d.). These advantages could lower key barriers to alternative protein consumption. An added benefit is that a lot of micro-organisms are able to form biomass from all kinds of waste ranging from agricultural waste, food waste and plant waste to industrial wastewaters (Koukoumaki et al., 2024; Sekoai et al., 2024). This ability to grow on waste further showcases the sustainability potential of this kind of food specifically. Finally, in contrast to other microbial foods, mycoprotein's key advantage lies in its texture, which very closely resembles the fibrous qualities of meat (Gilani and Lee, 2003). The texture could therefore lift one of the key barriers to consumption.

Mycoprotein has remained a niche market product despite Quorn already introducing it in 1985 (Linder, 2024). New companies in the mycoprotein landscape, such as US start-up Meati, are struggling financially to navigate the landscape (Mridul, 2025). This is partly due to low consumer familiarity in the US, at 12% (Kirchner and Leet-Otley, 2024), and only 33% of total consumers finding it at least somewhat appealing. Therefore, there is a need to educate consumers on the terminology and the associated benefits. Mycoprotein companies tried to build familiarity by associating the product with mushrooms, since both fall under the fungi domain of life. Quorn and Meati called their mycoprotein products 'closely resembling mushrooms' and 'mushroom root' respectively. However, this strategy proved troublesome since they were both sued in the US for false advertising, eventually settling (Poinski, 2017; Watson, 2024). This indicates several challenges in marketing mycoprotein.

Genetic modification technologies can enhance mycoprotein's nutritional and sensory characteristics by modifying the microorganism used in fermentation. Modifications to taste and texture profiles can address key barriers in that regard. In addition, key drivers can be emphasized even more by improving nutritional characteristics, which can be done by including vitamin or protein production pathways into the organism. Combining the technologies of fermentation and genetic modification, the resulting product has potential to be protein rich, fiber and healthy while is also being tasty and highly adaptable. However, the use of genetic modification also includes some consumer adoption challenges. Consumer adoption of GM foods is mostly researched in the US in the context of genetically modified crops. The purpose of genetic modifications in crops is mostly to increase yields, quality and tolerance to stresses or pests (Abdul Aziz et al., 2022). Perceptions on such products in the US are characterized by limited understanding, concerns on health impact and ethical issues (Wunderlich and Gatto, 2015).

To summarize, there is an acute societal need to act regarding our unsustainable food system, both in terms of environmental concerns and practical limitations. Alternative protein is a promising solution to make our food system more sustainable, because of environmental impact of the conventional meat it would displace. However, the alternative protein industry is in decline due to political factors, social media, and key sensory barriers, among other factors. A relatively unknown protein alternative, mycoprotein, demonstrates potential to deliver on barriers of taste and texture hindering plant-based meat's adoption. Especially when applying genetic engineering, key barriers can be lowered and health-based drivers can be even more emphasized. However, limited literature exists on consumer response to genetically modified mycoprotein. This signifies the existence of a knowledge gap on the intricacies of communicating about such as product. Filling this gap would provide insights into the effects of labelling on consumer behavior, which could be useful in deciding how to educate consumers on novel technologies. Furthermore, insights on communication and decision-making dynamics could help inform approaches to introduce such a product in the market.

The primary objective of this research is to investigate consumer acceptance dynamics for genetically modified mycoprotein, by examining how different labelling and positioning strategies influence willingness to try and buy such a product. This research aims to contribute to academic understanding of consumer behavior regarding alternative protein, identifying factors that play a role in complex decision-making processes. It also aims to provide insights that can be used by policy makers, industry and non-governmental organizations on the influence of labelling strategies on the consumer. The focus of this research will be on the US market, since it is considered a developed alternative protein market. Furthermore, the US market has already established regulatory frameworks and some amount of consumer familiarity with genetically modified foods, making it a highly relevant context to research genetically modified mycoprotein acceptance dynamics.

The objective will be reached by answering the main research question and sub questions (Figure 2):
RQ: '*How does market communication influence customer acceptance of healthy and sustainable genetically modified alternative protein*.'

SQ1: '*What communication and branding strategies have been used to market alternative protein products and how did that influence consumer behavior?*'
SQ2: '*How do bioengineering disclosure and nutrition/health claims influence willingness to try/buy mycoprotein products?*'
SQ3: '*What kind of associations do consumers have with familiar and unfamiliar mycoprotein nomenclature?*'

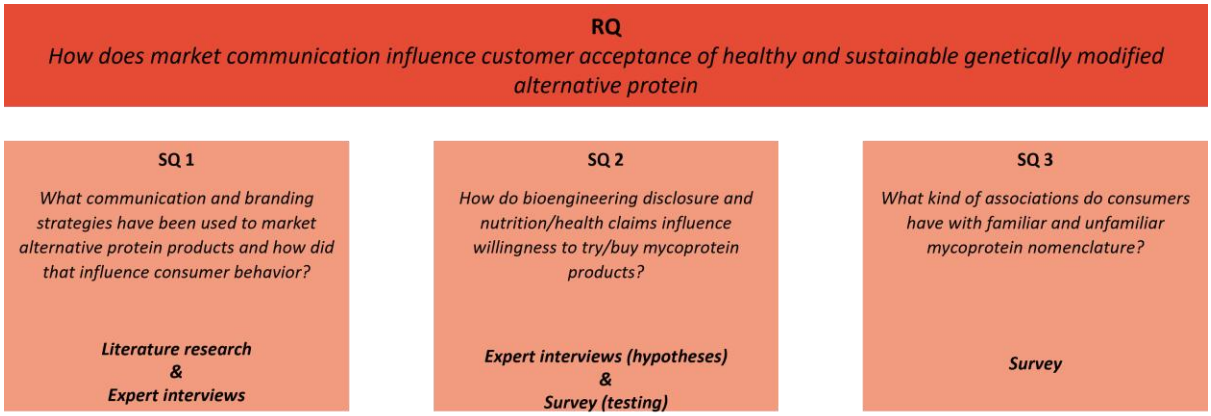

Figure 2: Research questions and subquestions. Visualization of research questions and methods used to answer them.

2 Theoretical Backgrounds

This chapter will provide a conceptual framework for (1) understanding consumer acceptance of genetically modified mycoprotein and (2) investigating how bioengineering disclosure and health claims affect consumer perceptions. Literature on psychological foundations of novel food acceptance, mycoprotein-specific consumer behavior, genetic modification attitudes (GM Attitudes), and nutrition/health claims (NHCs) is critically reviewed. The conceptual framework that is built in this chapter (Figure 6) finds its origin in decision-making literature. Therefore, information processing theory will first be discussed.

2.1 Information processing theory

The internal thought process of making choices is referred to as 'decision-making'. A widely accepted model for decision-making is the theory of Dual Processing, popularized under the terms of System I and System II thinking (Kahneman, 2011). It posits that decision making can go through either one of two modes. System I is fast, automatic and intuitive, it can be experience based, associative in nature and independent of cognitive ability. Heuristics can trigger System I type thinking, which can be described as 'mental shortcuts', mostly used for quick reactions and decisions rather than logic reasoning. System II is a more deliberate type of thinking, it is slower, more controlled and more based on values and cognitive ability (Kannengiesser and Gero, 2019). While initially, it was seen more as an 'either or' type of thinking, research has implied that decision-making can occur based on a combination of the 2 systems, both involving valuation by heuristics and deliberate processing to some extent (Figure 3).

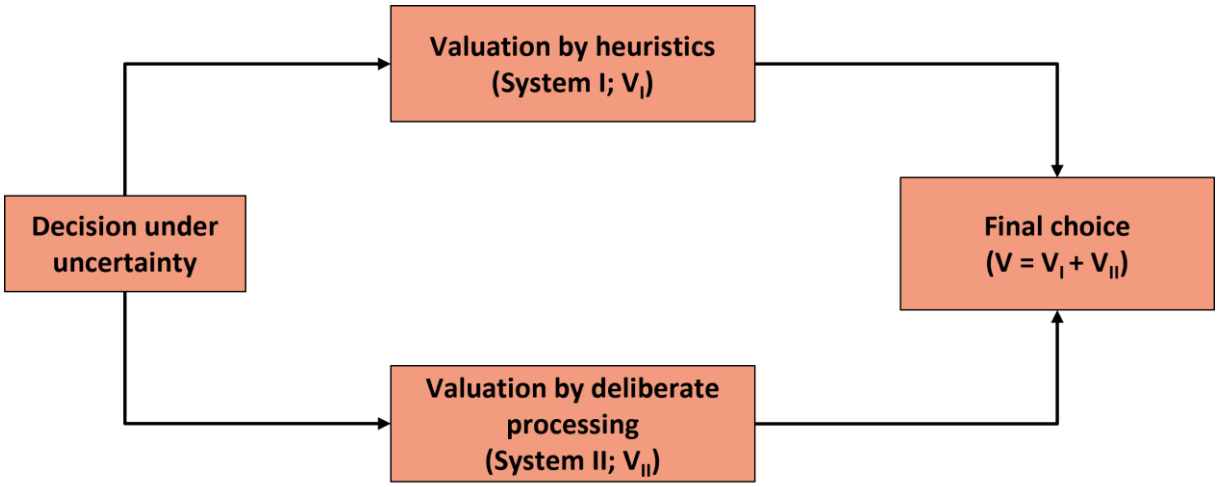

Figure 3: Dual Processing Theory in Consumer Decision-making. Conceptual model showcasing System I and System II processing modes. Picture based on (Djulbegovic et al., 2012; Mukherjee, 2010).

Research on food decision-making specifically also assumes influences by both external information stimuli, and an individual's personal factors like motivations, attitudes, knowledge and expectations (Tønnesen et al., 2022). Stimuli might spark quick heuristic judgements (System I), while previous attitudes might cause more deliberate systematic processing (System II) (Tønnesen et al., 2022). Therefore, information processing theory will serve as a basis for the conceptual framework that is set up in this section. Regarding novel food technologies, most consumers have very little knowledge (Mielby et al., 2013). This can cause System I, valuation by heuristics, to be activated. The most important heuristics that are involved in people judging food technologies are those of affect, trust and naturalness (Siegrist and Hartmann, 2020). The interaction between novel foods and technologies, and dual processing theory will be discussed throughout this chapter. First, mycoprotein specific factors will be discussed.

2.2 Mycoprotein as alternative protein

Mycoprotein is a distinct category within the alternative protein options, separate from cultured meat and plant-based meat. One of the main benefits of mycoprotein, and the use of genetic modification, is regarding its potential to be a very healthy, un-processed alternative protein type. It is produced through fermentation of fungi or yeasts, for instance with fungi *Fusarium venenatum*, used by the company that commercialized mycoprotein in 1985, Quorn. Fungal fermentation leads to a biomass product that is high in protein, rich in fibers and low in fat content (Linder, 2024). It is considered a nutritious alternative to meat, with a complete amino acid profile. It is neutral in taste and mimics the texture of conventional meat quite well (Finnigan et al., 2024). In addition to nutritional value, more research is being done discovering health-related benefits to incorporating mycoprotein in a diet. For instance, eating mycoprotein can possibly reduce risk of cardiovascular diseases and be beneficial in controlling glycemic responses (Hashempour-Baltork et al., 2020).

Consumer awareness and familiarity

Consumer awareness on mycoprotein has remained limited despite being first introduced over 20 years ago, remaining somewhat of a niche market (Finnigan et al., 2019; Linder, 2024). A recent survey by the Good Food Institute (GFI) indicates that only 12% of US consumers claim to have heard about mycoprotein (Kirchner and Leet-Otley, 2024). This contrasts with the plant-based protein category, based on plant-based proteins like soy, pea or beans. In terms of academic literature on mycoprotein, most research focuses on technological or sustainability aspects, rather than on consumer behavior and acceptance (Dean et al., 2022). In contrast, plant-based proteins have received a lot of attention, in industry, marketing and academia (Onwezen et al., 2021).

Key acceptance drivers

In literature, two studies were found specifically researching mycoprotein in the context of consumer behavior. Dean et. al (2022) performed a twelve-country wide survey targeting 4000 consumers to identify key drivers for mycoprotein consumption, and explore willingness to try (WTT), willingness to buy (WTB) and willingness to pay a premium (WTP) for mycoprotein products. Healthiness and nutritional benefits were identified as the main drivers for the overall participant group. Further research into subgroups showed that these drivers were not significantly confirmed for the vegetarian and flexitarian subgroups. The authors hypothesize that this might be due to vegetarians or flexitarians feeling that their current diet is already healthy enough. Sustainability was also identified as a significant driver to try mycoproteins for all subgroups. Other research (Chezan et al., 2022) confirms that sustainability aspects are deemed important in deciding to try the product, but sensory aspects, like taste and texture, determine the product's further success.

Qualitative interviews with survey participants by Chezan et al. revealed that inclusion in a healthy diet, mainly avoidance of sugar, and naturalness were also identified to be important. Practically, this meant avoidance of additives, preservatives and long ingredient lists. Associations with mold came up in these interviews, lowering willingness to try and buy. However, familiarity, often in the form of associations with blue cheese or mushrooms, seemed to have a positive influence on the acceptance of mold. In general, they found that 'reducetarians' were more likely to purchase fungal proteins compared to unrestricted omnivores.

Since the body of literature on mycoprotein consumer behavior is limited, these are the only key acceptance drivers that were identified. When looking at the broader category of alternative protein, plant-based meat is a much more researched category, and likely some of the drivers and challenges apply to mycoprotein as well. The Good Food Institute (GFI) has performed extensive analysis on over 3000 US consumers, and found that health is one of the top drivers of plant-based meat consumption looking at the overall market (Kirchner and Leet-Otley, 2025b). Specifically, consumers value high-protein content, low fat content, being nutritious and being a good source of vitamins and minerals.

Heart health is one important aspect why people would choose plant-based meat over conventional meat.

Positioning challenges

Mycoprotein faces unique positioning challenges it must overcome to be successful in the sector. Chezan et al. (2022) emphasize that sensory aspects such as taste and texture are very important to consumers. However, Dean et al. (2022) found that in some subgroups, perceptions on taste can even inhibit willingness to try mycoprotein. This indicates that consumers have negative associations regarding mycoprotein's taste beforehand, negatively impacting WTT. These negative associations could stem from its fungal origin and associations with mold. Implications of negative taste associations are backed by a recent survey by GFI, with consumers indicating that they are not convinced the product would taste good. This while consumers do believe that mycoprotein offers sustainability and nutrition benefits (Kirchner and Leet-Otley, 2024).

Chezan et al. suggest to research the nomenclature used for this type of protein, to find a term to describe the ingredient that is both accurate and appealing. Earlier research on fungal protein terminology (McKinsey, n.d.) showed that labels emphasizing fermentation or the protein source might reduce consumer appeal, as opposed to terminology focusing on benefits. Interestingly, this research found a higher willingness to try mycoprotein among US consumers than the previously mentioned GFI survey. The terminology used in these two surveys differed, which indicates nomenclature indeed can influence consumer appeal.

Dean et al. (2022) discuss that consumers that are especially drawn to conventional meat, who think meat is important to maintain a healthy diet, or like the sensory aspects extremely are not likely to start searching for replacements. Their research showed that the sensory aspects of conventional meat itself do not influence consumers' willingness to try mycoprotein, but do inhibit willingness to buy. This indicates attachment to meat as a large barrier for certain consumer groups to including mycoprotein in their diet. This is also emphasized by literature on plant-based meats, which highlights conventional meat's involvement in social and cultural values (Circus and Robison, 2018). Another study (Michel et al., 2021) showed that associations with meat differ between men and women, with women associating meat with concerns about animal welfare and the environment, while males associated meat with more positive aspects like taste and variety.

2.3 Bioengineering disclosure

Genetically modified crops were introduced in the US in 1996, with adoption rates increasing in the following years (USDA, 2025). Despite increasing adoption, public acceptance of the usage of gene technologies has remained limited, consumers are less willing to pay for genetically modified foods as opposed to conventional foods (Costa-Font et al., 2008; Lusk, 2011) and nearly half of US consumers try to avoid genetically modified foods (IFIC, 2018). Since 2022, the US Department of Agriculture (USDA) implemented the first federal mandatory labelling requirement standard, the National Bioengineered Food disclosure Standard (NBFDS) (USDA, 2019). The standard intends to inform consumers about whether a product contains ingredients that are genetically modified, by labelling them as 'bioengineered' or 'made from bioengineering'.

According to the standard, disclosure of bioengineered ingredients can be done through (1) Text disclosure, (ie. stating 'Bioengineered' on the packaging), (2) Bioengineered symbol (Figure 5), (3) Text message or contact phone number (ie. Stating 'Text [number] for bioengineered food information'), and (4) URL displayed on the packaging, in text or in the form of a QR code (USDA, n.d.). Introduction of the standard has faced criticism, with research indicating that consumers are relatively unfamiliar with 'bioengineered' terminology. A study performed in 2022 found that 60% had heard the term 'genetically modified' before, while only 40% had heard of 'bioengineered' (Caputo et al., 2025).

Allowed methods of disclosure are also criticized, with research indicating that QR-codes and URLs are rarely used by consumers in supermarket shopping contexts (Tallapragada and Hallman, 2018). This could be why another study by (McFadden and Lusk, 2018) found that the disclosure type can influence consumer willingness to pay (WTP), specifically with text labels decreasing WTP compared to QR code disclosure.

Figure 4: Official US Bioengineered Food Disclosure Logos. Different variants of the bioengineered logo; black and white, and in color, 'bioengineered' or 'derived from bioengineering'. Logo's from: ("BE Symbols | Agricultural Marketing Service,".

Terminology used to disclose the use of bioengineering can have an impact on consumer response. Research by (Howell et al., 2025) showed that the currently used scientific and engineering terminology suffers from negative associations, while other terminology such as design-focused labels (ie. 'Bio-designed') can have positive effects for acceptance across various attributes such as safety, nutrition, healthfulness and quality. Recent research after implementation of the standard, showed that most people want to have bioengineered products labelled, and that the bioengineered logo is by far the preferred way of disclosure, as opposed to other disclosure options (Caputo et al., 2025). Therefore, in this research, the black and white version of the 'Bioengineered' logo is used.

The vast body of literature on genetically modified foods, largely focusing on crops, shows that the use of genetic modification in foods can influence consumers' risk perceptions in multiple ways. Mainly dimensions of human health and food safety risks, environmental risks, socio-economic risks and ethical concerns are relevant in this context (Bawa and Anilakumar, 2013; Pakseresht et al., 2021). These studies indicate that because of consumers' perceptions of risk on GM, the disclosure itself can be interpreted as a 'warning signal'. Research by the International Food Information Council (IFIC) also found that disclosure increases health concerns.

In summary, because consumers associate genetic modification with risks, ethical concerns, and a disclosure as a 'warning signal', it seems consumer acceptance of the technology has remained limited. In addition, previous studies found lower willingness to pay for genetically modified products, which can be seen as a measure for consumer acceptance much like willingness to try and buy. This leads to the formulation of the following hypothesis:

H1a: Bioengineering disclosure negatively influences consumers' willingness to try and buy mycoprotein.

The following sections will hypothesize which constructs affect willingness to try and buy mycoprotein, and how they possibly interact with bioengineering disclosure.

2.4 Perceived healthiness

As mentioned before, one of mycoprotein's main value propositions is regarding health. In research on bioengineered crops, benefit communication in general has been indicated to increase willingness to pay for products containing a bioengineered logo (Caputo et al., 2025). Nutrition and Health Claims (NHCs) are often used in marketing of alternative protein products, because of their perceived positive influence on customers. There are regulations in place on NHCs, in both the US and the EU, to prevent consumers from being deceived. There are several types of claims (Figure 5), the most relevant being health claims with or without mentioning any nutrient, or nutrition claims. These type of claims need to be substantiated and approved by either the FDA or the EU to prevent consumer deception.

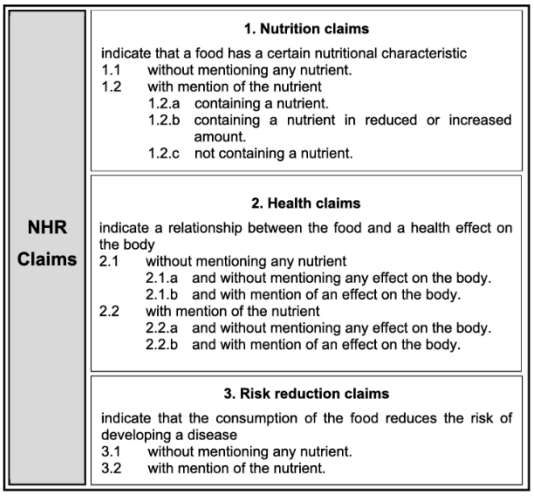

Figure 5: Classification of Nutrition, Health and Reduction Claims. Regulatory framework for categorizing food claims based on EU Regulation No. 1924/2006 (Steinhauser and Hamm, 2018).

Most studies in the field of NHCs found that claims result in an increase of 'perceived healthiness' (Lähteenmäki, 2013; Steinhauser and Hamm, 2018), but some others find no increase or even a decrease (Bialkova et al., 2016; Franco-Arellano et al., 2020). Increased perceived healthiness is viewed by the consumer as a direct benefit, and is shown to be a growing factor in impacting product intentions (Pinto et al., 2021) and acceptance (Siegrist, 2008). Health claims can also impact taste expectations (Raghunathan et al., 2006). It is important to realize that perceived healthiness of the product itself also plays a role in the impact of claims (Lähteenmäki, 2013; Steinhauser and Hamm, 2018). This research leads to formulation of the following hypothesis:

H2c: Perceived healthiness positively influences willingness to try and buy mycoprotein.

It is thought that claims positively influence consumer perceptions because claims activate associations with the benefit. Then, by 'spill over', the perceptions transfer to the actual product, leading the consumer to have a positive association with the product. These effects are described as 'halo effects' (Benson et al., 2018). However, literature results on the influence of NHR claims on consumer preferences, purchase and consumption behavior have been mixed (Kaur et al., 2017; Lähteenmäki, 2013; Steinhauser and Hamm, 2018), which can partly be attributed to different researches using different types of claims and widely different product carriers, ranging from yoghurt, to muesli bars, to dairy products. Indeed, other research by (Tønnesen et al., 2022) found that the effect of NHR claims is dependent on several factors, among which product type, claim type and specific consumer characteristics. They indicate that perceptions of types of claims and products need to be verified case-by-case, because of the influence of the product carrier. Research specifically on different types of claims nutrition/ingredient claims versus health claims is mixed. Some research indicates that ingredient type claims are preferred by consumers (Steinhauser et al., 2019), while other research indicate that consumers do not differentiate between different claim types consciously (Hodgkins et al., 2019). (Rybak et al., 2021) found mediation effects of perceived healthiness between nutrition/health claims and purchase intentions. Because of the described halo effects, it is thought that health claim type might partly mitigate the (in H1a hypothesized) negative effects of bioengineering disclosure on willingness to try and buy mycoprotein. This leads to the formulation of the following hypotheses:

H2a: Health claims directly positively influence willingness to try and buy mycoprotein compared to ingredient claims.

H2b: Health claims positively influence perceived healthiness compared to ingredient claims.
H2bc: Perceived healthiness positively mediates the relation between health type claims and willingness to try and buy

Steinhauser and Hamm (2018) reviewed NHC literature and found health motivation and nutrition knowledge as factors influencing the effect of NHR claims on purchase behavior. Health motivation is often correlated with nutrition knowledge, people who want to eat healthy are often more knowledgeable on nutrition (Grunert et al., 2011; Hung et al., 2017). The influence of nutrition knowledge related to NHCs provided mixed results in most research, with some finding that nutrition knowledge leads to lower preferences or purchase intentions on product with NHR claims. In other research by (Steinhauser et al., 2019), influence of nutrition knowledge and health motivation on purchasing behavior of products containing NHR claims showed that while people with high nutrition knowledge and health motivation did look longer at the nutrition and health claims, it did not show an effect on the purchase decision. This while higher perceived healthiness did increase its likelihood of being purchased. (Tønnesen et al., 2022) found that choosing a product with a claim was related negatively related to subjective nutritional knowledge. This could indicate that nutrition knowledge is a barrier against potential health halos. Because of the increasing interest in nutrition knowledge, it will be included in the study as an exploratory variable.

There is not much research on the combined effects of NHCs and bioengineering disclosure. This is likely because genetic modification has mostly been researched in the US for crops, which are mostly engineered for disease resistance rather than nutritional/health improvements.

2.5 Heuristics

The affect heuristic

The affect heuristic suggests that people rely on an affective meaning that is associated with an object or technology when they think of risk assessment (Finucane et al., 2000). In gene technologies, people might associate genetic modification with monster-like qualities, which might negatively impact their judgment. In the case of mycoprotein, people might associate the fungal and yeast origin with disease or disgust. In research regarding plant-based meats in general, and novel categories like mycoprotein, often negative associations were discovered (Garaus and Garaus, 2023), mostly relating to taste/health/environment.

Perceived trust

One of the heuristics affecting decision-making in food is trust, for instance by assessing whether a product is safe to consume. This heuristic is especially relevant in novel food technologies like genetic modification or mycoprotein production, it can play a role in this context in terms of social trust and institutional trust. Social trust is based on whether people share values with one another, while institutional trust signifies trust in actors partaking in the food industry (Siegrist and Hartmann, 2020). This trust can be influenced by labelling on individual products, but also by actors like government agencies and mass media (Wu et al., 2021). Consumers might lack social trust in the food industry, because they don't believe it has their best interests at heart. Instead, consumers might believe the food industry focuses on maximum profits (Earle and Cvetkovich, 1995; Siegrist and Hartmann, 2020). Indeed, past incidents regarding customer deception were driven by financial profit (Esteki et al., 2019). This has increased consumer interest in transparency in the supply chain of food they buy.

Trust has been identified as a significant predictor of behavioral intentions in several studies on novel food. Specifically in research on alternative protein, (Faber et al., 2024) found that trust in alternative protein directly positively influences behavioral intentions on plant-based meat products. Wu et al. (2021) indicate that visual cues on packaging like food attribute claims or certifications can directly aid in building consumer trust in the product. Faber et al. (2024) also found mediating effects of trust (in

alternative protein), between the relations of Environmental & Ethics food choice motives and behavioral intentions, and between intrinsic quality aspects (taste, texture, healthiness) and behavioral intentions. These studies suggest a possible mediation effect of trust between visual cues like health claims and bioengineering logo's/certifications and willingness to try and buy mycoprotein. This leads to formulation of the following hypotheses:

H1c: Bioengineering disclosure negatively influences consumers' perceived trust in the product
H1d: Perceived trust directly positively influences willingness to try and buy mycoprotein
H1cd: The negative influence of bioengineered disclosure on' willingness to try is mediated by perceived trust

Perceived naturalness
Naturalness heuristics are also involved in the acceptance of novel foods, to assess whether a food is safe to eat. For most consumers, naturalness, as opposed to artificialness, is deemed important in all aspects of food production, from food origin and technical production to the characteristics of the product. Therefore, it can influence consumers' food intake behavior (Román et al., 2017). In the context of GM foods, laypeople tend to see them as dangerous and offering few benefits (Scott et al., 2018). This is often based on moral concerns regarding naturalness. People view nature and naturalness as sacred, and see genetic modification as a violation of that moral value. Research on foods similar to mycoprotein, in this case named 'mycelium', shows that these type of products can be associated with naturalness (Fischer and Hilboesen, 2025). However, apart from terminology specific effects on naturalness associations, (Scott et al., 2018) suggest that perceptions of naturalness and attitudes toward GM food follow the 'law of contagion', meaning only very little intervention (genetic modification) might need to be done for them to consider the food completely unacceptable. Other research further corroborates that acceptance of GM technologies depend on the perceived naturalness of the GM food (Tenbült et al., 2005). Another aspect that is associated with unnaturalness is food processing (Hässig et al., 2023), and it's unclear to which extent consumers view mycoprotein as processed. Next to direct effects of perceived naturalness on buying behavior, research on other novel technologies have shown that perceived naturalness can mediate acceptance of the technology (Siegrist and Sütterlin, 2017). This body of literature suggests that:

H1e: Perceived naturalness directly positively influences willingness to try and buy mycoprotein.
H1c: Bioengineering disclosure negatively influences perceived naturalness.
H1ce: The negative influence of bioengineering disclosure on willingness to try and buy is mediated by perceived naturalness.

Therefore, in contrary to a lot of plant-based foods, it is unclear whether mycoprotein would be able to benefit from a 'natural' positioning, because the combination of relatively unknown nomenclature, use of genetic modification and the mycoprotein production process has not been evaluated in terms of naturalness.

2.6 Individual differences

As dual processing theory prescribes, personal characteristics such motivations, attitudes, knowledge and expectations also influence decision making. Specifically, these personal characteristics might activate deliberate processing in consumers when facing a food-related choice, therefore impacting the resulting choice. There are several personal characteristics known to influence decision-making in general. Some that directly relate to genetically modified novel food choice will be discussed here.

Food neophobia

A key personal characteristic known to be involved in food decision making is neophobia, a tendency to avoid novelty. This concept was applied to food, as a tendency to avoid novel foods, and coined 'food neophobia' (Pliner and Hobden, 1992). It is hypothesized to originate as having a function in evolution, specifically in protecting against dangerous foods in an unknown environment. However, following the 'omnivore's dilemma', living on the brink of starvation, one should also be somewhat open to novel foods to increase chances of survival. Food neophobia is conceptualized as a character trait, and can be measured on a continuum using the 10-item scale, also developed by Pliner and Hobden (1992). The concept of food neophobia is used a lot in research on novel foods, both in academic and industrial contexts. This includes research on genetically modified foods or novel production techniques (Rabadán and Bernabéu, 2021).

The level of food neophobia depends on numerous factors. Demographic factors like age, education and income are thought to play a role (Jezewska-Zychowicz et al., 2021). Food technology concerns and personality traits like neuroticism are also predictors of high food neophobia (Thanasoula, 2025) and parental factors such as feeding style and parental eating habits are also shown to influence food neophobia (del Campo et al., 2024). The role of food neophobia in decision-making is context dependent, as shown by Pliner and Hobden. For instance, college students indicated that they were less likely to try a novel food if it was offered to them by a stranger, compared to a psychologist or a friend at home.

In the context of alternative protein, food neophobia is often mentioned as a barrier to acceptance. A review by (Onwezen et al., 2021) compared different alternative protein types, making a distinction between very innovative types of alternative protein like insects and seaweed, and less innovative alternative protein such as pulses, fish and plant-based proteins. As literature on consumer behavior regarding mycoprotein specifically is limited, the authors did not include it in the review. Nonetheless, food neophobia was identified as an important factor for acceptance regardless of the type of alternative protein, but as playing a more important role in more innovative alternative proteins (Onwezen et al., 2021). Therefore, it seems acceptance of more innovative alternative proteins is more subject to individual characteristics. Since mycoprotein can also be described as a very innovative type of protein, this implies that food neophobia can play an important role in its acceptance. The limited literature on consumer behavior that is available regarding mycoprotein, describing mycoprotein as 'fungi protein', also indicates that constructs relating to food neophobia can negatively influence purchase intentions (Dean et al., 2022). A literature review by (Vermeir and Roose, 2020) on the role of visual cues in food decision-making suggests that food neophobia might act as a moderator of visual cues on choice behavior, while that relation does not seem to have been tested in the context of bioengineering disclosure labels. Given the hypothesis of the negative influence of bioengineering disclosure on willingness to try, it could be that people with high food neophobia rely more on heuristics than people with low food neophobia. Given negative associations with genetic modification, food neophobia is hypothesized to positively moderate the influence of bioengineering disclosure on willingness to try. This leads to formulation of the following hypotheses:

H3a: Food neophobia negatively influences willingness to try mycoprotein
H3b: Food neophobia positively moderates the relationship between bioengineered logo and willingness to try and buy

Attitudes

Research suggests that previous consumer knowledge regarding GM can influence acceptance. A distinction is made between objective knowledge on the technology, and subjective (self-reported) knowledge. People knowledgeable on biotechnology are more willing to accept GM technologies. Consumers with high levels of education, income and food involvement that are often exposed to

negative info on gm tend to overestimate their knowledge level (Hwang and Nam, 2020). Research by (L.J. Frewer et al., 2003) shows that prior attitudes towards GM foods were important predictors to selecting GM foods, and were not influenced by providing external information. They indicate that GM labelling is more likely to activate existing attitudes, than to form completely new ones. Next to the previously formulated hypotheses, previous attitudes towards genetic modification (GM Attitudes) will be incorporated in the research in an exploratory manner.

Food-Related Lifestyle

Consumer segmentation is a tool used to identify and segment a market based on a difference in needs and wants between different groups of buyers. This can be useful in marketing, because product characteristics or framing can be tailored to a specific group of buyers, possibly increasing repeat purchases. Segmentation is useful for industry to identify a group to start targeted marketing towards. In academia, it is often used in research on messaging to different types of groups, for instance to aid communication of governmental policies. Psychographic characteristics are often used in segmentation, relying on personality traits, lifestyle or values (Kotler and Keller, 2016). For food specifically, a popular instrument is the framework of Food-Related Lifestyle (FRL), which is based on a means-end approach to lifestyle (Brunsø et al., 2021, 2004).

The FRL framework assumes people buy products because they believe they align with their life values. Relationship with food is different for everyone. Some people simply view food as a necessity, while for others it can evoke emotions of community and happiness. In the original instrument (Grunert et al., 1997), questions inspired from the Food Neophobia Scale were also included, indicating its value in segmentation. The FRL intends to measure 23 dimensions in five main areas that are linked to food purchases, such as ways of shopping, cooking methods, quality aspects, consumption situations and purchasing motives (Scholderer et al., 2004a). In its basis, it produces five segment types (Brunsø et al., 2021):

- Adventurous: Demand high quality, high involvement in cooking, enjoys new products, motivated by social aspects of food
- Conservative: Does not like innovation in food products, conservative approach to cooking, demand high quality
- Uninvolved: Not caring much about anything, a fan of snacking and convenience food
- Careless: Like uninvolved segment, but interested in new products
- Rational: Moderate scores on most dimensions, above average interest in health and product info

As an exploratory analysis, the difference in product intentions for different FRL segments will be attempted to be verified.

2.7 Research gaps

After analysis of the current body of literature on key aspects of this research, heuristic decision making, mycoprotein products, genetically modified foods, and nutrition/health claims, several gaps are identified that this research aims to address. Despite extensive research on consumer acceptance of alternative proteins and genetically modified foods, intersections between these two fields remain largely unexplored. Mycoprotein has been researched because of its health, taste, texture, and sustainability benefits, but only limited research has been done on factors influencing willingness to try, buy and pay a premium for mycoprotein (Chezan et al., 2022; Dean et al., 2022). To my knowledge, there is no literature including the impact of the official National Bioengineering Disclosure Standard (NBFDS) on mycoproteins' perceptions on perceived naturalness and trust. Existing research on the NBFDS, focuses on crops (Caputo et al., 2025) while consumer response on bioengineered foods can highly depend on the type of food (Lusk, 2011). This signifies the main gap this research tries to

address, the lack of knowledge on consumer decision-making regarding a mycoprotein product that contains a bioengineering disclosure.

In terms of market communication strategies, some research has been done on nutrition and health claims (NHCs), indicating that they could drive willingness to try and buy conventional and bioengineered foods. However, the combination of communicated benefits with bioengineering disclosure in the context of alternative protein is underexplored. For mycoprotein specifically, research on market communication in general is underexplored. This represents the second gap this research will address, exploring combined combination strategies communicating different types of benefits messaging and bioengineering disclosure.

Thirdly, while individual characteristics of food neophobia and attitudes towards genetically modified foods have been established as predictors in novel food acceptance, they have not been applied in the context of genetically modified mycoprotein. Furthermore, segmentation frameworks like Food-Related Lifestyle have been used extensively, both in academia and in industry, to guide targeted marketing in the alternative protein sector, but application to genetically modified foods has only been done in the context of GM crops. That is where the third gap emerges, the influence of lifestyle effects on acceptance of genetically modified alternative protein has been underexplored.

These gaps will be addressed in this research by (1) Exploring communication strategies and their influence on decision-making, (2) Testing the effects of bioengineering disclosure, in the form of logos, on perceived naturalness, trust and willingness to try/buy mycoprotein and examining how claim type (health claim vs ingredient claim) influences perceived healthiness and willingness to try/buy mycoprotein and (3) moderation effects of food neophobia on the (hypothesized) negative relation between bioengineering disclosure and product intentions will be investigated. Finally, the influence of Food-Related Lifestyle dimensions will be explored.

By addressing the identified gaps, this research will enrich knowledge on consumer acceptance dynamics for genetically modified mycoprotein. It will aim to establish the mediating roles of trust and naturalness between the NBFDS and product intentions, therefore elucidating consumer decision-making dynamics when encountering a bioengineered logo. Furthermore, the mediating role of perceived healthiness between claim type and product intentions is aimed to be established. Therefore, this research will be able to inform policy makers, industry and non-governmental organizations on the effects of disclosure and claims on decision-making, so they can optimize labelling and messaging strategies.

2.8 Conceptual framework

Based on the hypothesis formulated from the literature, the conceptual framework in

Figure *6* is proposed. The framework builds on information-processing theory introduced in Figure 3, and adopts a similar approach as (Tønnesen et al., 2022), indicating that both external stimuli (labelling and claims) and personal characteristics (Food neophobia) influence decision-making in food. To summarize, the following hypotheses will be tested in this research:

H1a: Bioengineering disclosure negatively influences consumers' willingness to try and buy mycoprotein.
H1b: Bioengineering disclosure negatively influences consumers' perceived trust in the product
H1d: Perceived trust directly positively influences willingness to try and buy mycoprotein

H1bd: The negative influence of bioengineered disclosure on' willingness to try is mediated by perceived trust
H1ce: The negative influence of bioengineered disclosure on' willingness to try is mediated by perceived naturalness

H2a: Claim type (health claims vs ingredient claims) directly positively influence willingness to try and buy mycoprotein.
H2b: Claim type (health vs ingredient) positively influences perceived healthiness compared to ingredient claims.
H2ab: The positive influence of claim type on willingness to try is mediated by perceived healthiness.

H3a: Food neophobia negatively influences consumers' willingness to try and buy mycoprotein.
H3b: Food neophobia positively moderates the negative relationship between bioengineering disclosure and product intentions.

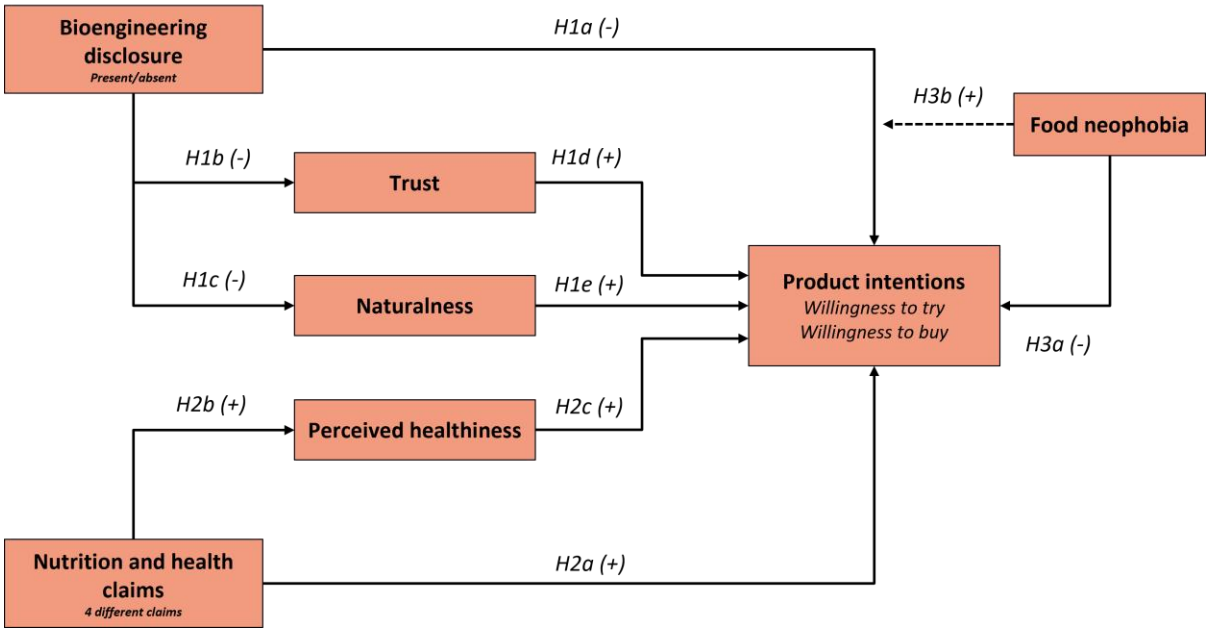

Figure 6: Theoretical Framework for Consumer Acceptance of GM Mycoprotein. Model showing relationships between external stimuli (bioengineering disclosure and Nutrition and Health claims), individual characteristics (Food Neophobia), heuristics (trust, naturalness), and product intentions.

3. Methodology

This research uses a mixed method approach to reach the research goals. Since mycoprotein is a relatively unknown type of food, and not a part of the plant-based foods umbrella, there is not a lot of research on consumer acceptance dynamics on mycoprotein, its origin and the combination with genetic modification. That is why a mixed method approach is relevant, 4 expert interviews were conducted to identify barriers in the alternative protein sector relevant for mycoprotein, and investigate the influence of different communication strategies on consumer decision-making. The quantitative survey design is partly informed by the expert interview insights, aiming to discover the effects of bioengineering disclosure and health claims on consumer willingness to buy and try (genetically modified) mycoprotein.

3.1 Qualitative part: Semi-structured Interviewing & Thematic Analysis

For the qualitative part of this research, semi-structured interviews were chosen as the main research method. The development of the interview guide was done following a five step process as described by Kallio et al. (2016) consisting of five phases: (1) identifying the prerequisites for using this methodology, (2) retrieving and using previous knowledge, (3) formulating the guide, (4) pilot testing the guide, and (5) presenting the final guide. Semi-structured interviews are considered appropriate when studying people's perceptions and opinions of complex or emotionally sensitive issues (Kallio et al., 2016). Consumer psychology on decision-making regarding novel foods is very complex, involving different types of factors including personality traits, personal values, and heuristics. Therefore, this method was deemed appropriate. The combination of this complexity in decision-making and communication, and the influence of the use of novel technologies, like genetic modification and mycoprotein production, make this method appropriate. The interviews focused on opinions of 4 experts in the field, going into depth on different aspects of the protein transition and consumer decision-making processes concerning conventional and alternative protein.

In semi-structured interviews, the expertise of the participant can be emphasized by allowing specific follow-up questions. This results in collection of diverse views and themes from the different interviews (Kallio et al., 2016). In terms of reporting structure, some interpreting is already done in the result section due to the interpretive nature of thematic analysis.

Development of interview protocol

In literature review regarding alternative protein, consumer behavior, genetic modification, and branding strategies a conceptual basis for the interviews was formed. This was done by identifying gaps in knowledge on consumer perceptions on this novel type of food.

The interview guide consisted of 10 main questions across the themes of current state of industry, considerations for mycoprotein specifically, and genetic modification. In some cases, additional questions were added following up a possible answer on the main question. The questions were formulated using the guiding principle that these should direct conversation toward the research topic (Kallio et al., 2016). To promote conversion, rather than just questions and answers, the questions can be asked in a different order allowing for dialogue, which is typical for a semi-structured interview. The questions were designed to be clearly worded, open ended and focused on personal experience of the interviewees. This general interview guide was used as a basis, but some questions were added or removed based on the specific expertise of a participant to obtain richer interview data. A reasoning of why each question was included is also present, including possible follow-up questions to ask regarding the topics. The base interview guide can be found in Appendix I. The interview guide was pilot-tested by using internal testing (Kallio et al., 2016), evaluating the preliminary interview guide with my company supervisor and 1st thesis supervisor.

Sampling strategy

Participants were selected using judgment sampling to increase relevance to the research subject. Participant selection criteria were based on important aspect of the research question. Experience in consumer behavior, marketing experience, familiarity with alternative protein and preferably a presence in the US market were the main criteria. 12 participants were identified and approached through multiple channels, including internet searches, LinkedIn messages, referrals by supervisors and through snowball sampling, resulting in 4 positive responses. The email sent to invite participants is shown in Appendix II. Interviewees were asked to sign an informed consent form (Appendix III), stating how their data would be used. To increase diversity of expert opinions, participants from both academia and industry were included in the sample. A sample of 4 interviewees may be considered a relatively small sample size, which was mainly due to time constraints. Nonetheless, small sample sizes can still hold high information power by making sure the research aims are specific, the interviewee's expertise matches the research aims and the interview dialogue is high quality (Malterud et al., 2016). What should be noted was that only one of the interviewed experts was from the US. Nonetheless, the interviews were insightful as to general messaging, nomenclature and state of industry. Still, it should be taken into account that relevancy of the overall insights to the US market might be limited.

Data handling

The 45-60 minute interviews were conducted using Microsoft Teams, and recorded using the included 'record' and 'transcribe' features. To ensure transcription accuracy, the full transcript was re-reviewed against the full interview recording for all interviews. Data was stored on the TU Delft managed OneDrive. Transcripts were cleaned, anonymized, and further analyzed using ATLAS.TI. When necessary, quotes were translated to English for displaying results.

Thematic analysis

The interview results were analyzed by performing thematic analysis as described by Braun and Clarke (2006). Thematic analysis is used often to extract and analyze themes from extensive qualitative data, and is described as a six-phase process. The first phase consists of 'familiarizing yourself with the data', including transcription. As mentioned before, the Microsoft Teams 'transcribe' feature was used to transcribe the interviews and transcripts were manually reviewed after. During this process the transcripts were also cleaned and anonymized. 'Cleaning' entailed removal of filler words such as 'uhm', 'yes', and other filler words like 'you know' to make the transcripts more readable. Anonymization entailed replacing participant names with identifiers (P1, P2, P3, P4), removing any references to the participants name or place of employment. Furthermore, any other details that could lead to personal identification were either removed or generalized. When requested by the interviewee, names of companies that came up in the interview were removed. During transcription and cleaning of transcripts, familiarization with the data took place, already obtaining some initial ideas on which themes could emerge from the data.

The second phase of thematic analysis consists of 'generating initial codes'. This can be done inductively ('data-driven') or deductively ('theory driven'). Since the aim of the interviews was mostly exploratory in its nature, an inductive approach was followed, letting themes emerge from the data. Following the guidelines by Braun and Clarke, the data was analyzed line by line and as many potential patterns as possible were coded. In ATLAS.TI, codes were supplemented by notes regarding the context, to make sure it was not lost in coding. After some time had passed, a second round of coding took place, verifying accuracy of initial codes and adding more codes when necessary. The obtained codes were placed in a codebook, which was reviewed to reduce redundancy of codes, resulting in 207 codes before moving on the third phase in the process. The codebook, including a short definition of each code, can be found in Appendix V.

The third phase consisted of 'searching for themes'. The 207 codes resulting from the previous phase were categorized in different themes using both ATLAS.TI and Excel for visual aid. In phase 4, the draft themes were compared to the original dataset to verify that the interview transcripts reflect the themes. Themes were also compared to each other, to verify that they were distinct. This process was an iterative process, going back and forth between transcripts, codes and set-up themes multiple times. Finally, after this iterative process, results are presented by explanation of the different themes and the relationship between them using a thematic map (Braun and Clarke, 2006).

3.2 Quantitative part: Cross-Sectional Survey Among US Consumers

The quantitative part of this research aimed to test the influence of labelling on willingness to try and buy (genetically modified) mycoprotein. The influence of bioengineering disclosure on willingness to try and buy is tested, including possible mediation effects by perceived trust and naturalness. Furthermore, the influence of claim type (health vs ingredient type) on willingness to try and buy were tested, including possible mediation effects. This part will provide insights into consumer decision-making dynamics. Additionally, associations with different terminology for mycoprotein will be explored. Regarding genetic modification, the role of explicit benefits was also explored.

Experimental design

A cross-sectional online survey was co-designed with food start-up Yeti Foods, after which data collection was done by Yeti Foods and stored by them. The full survey can be found in Appendix VII. The survey consisted of several experimental parts. Before any experimental part, information was collected regarding informed consent (Appendix III), Prolific IDs, pre-screening questions, Prolific screener validation questions and collection of demographic information (age, gender, household income range, household characteristics, education level, urban/suburban/rural residency). Part I of experimental data collection comprised collection of dispositional variables: Food-Related Lifestyle (FRL), Food Neophobia, attitudes toward genetic modification (GM), and Nutrition Knowledge.

Part II was developed using a 2x4 mixed factorial design (Figure 7), with one between-subjects factor (presence/absence of a bioengineered logo) and one within-subjects factor (4 health/nutrition claims). This design was chosen to investigate both the influence of the bioengineered logo, and the influence of different Nutrition and Health Claims (NHCs) on willingness to try and buy. To this end, 4 different packaging mock-ups were made (for an example, see: Appendix VI), each with a different NHC. Based on investigation of claims used by US plant-based meat companies and interview results, claims used were: (1) 'High in protein', (2) 'High in dietary fiber', (3) 'Feeds your gut – rich in fiber for a healthy microbiome', or (4) 'A healthy choice for your heart'. Information on how these claims were selected is available in Appendix VI. Regarding the between-subjects factor, each of these 4 mock-up versions could be shown to participants either with a bioengineered logo, or without a logo. The design was set up in such a way, that participants either only saw mock-ups with bioengineered logo, or only without logo (N_{Logo} = 86, $N_{No\ logo}$ = 79). Participants in each group were assigned one of 5 different fixed orders of the mock-ups, to minimize order effects. The order was not completely randomized for each participant due to survey software limitations (Microsoft Forms).

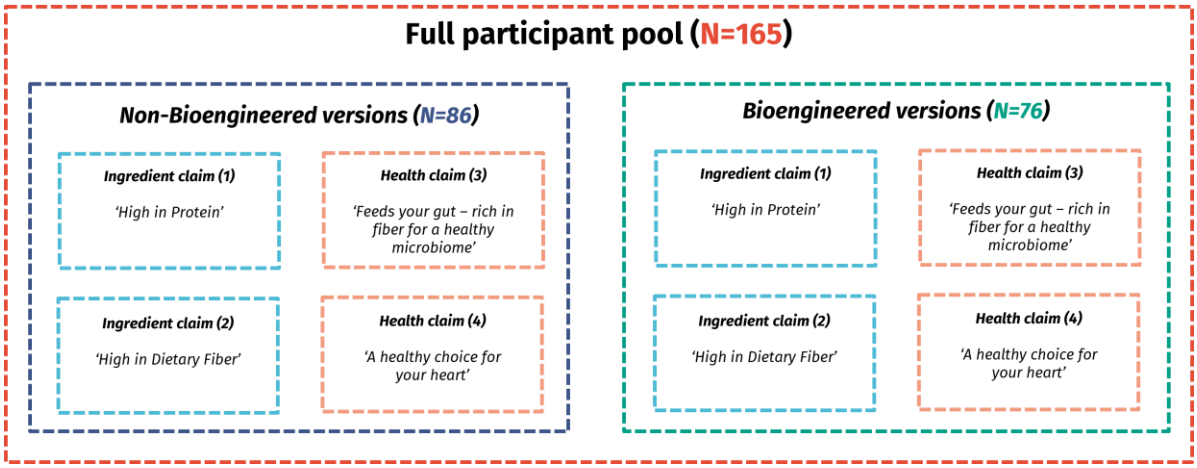

Figure 7: Experimental Design: Mixed Factorial Survey Structure. 2x4 factorial design with between-subjects factor (bioengineered logo) and within-subjects factor (four nutrition/health claims). N=165.

Part III was developed to contain more practical and explorative questions, based on industry nomenclature research in precision fermentation contexts (GFI, 2025b). In the first set of questions, participants could choose from a list which positive or negative associations they had with 6 different terms describing mycoprotein as an ingredient. The next set of questions explore whether specific health-related benefits would make the product more appealing, and which of those benefits could offset a possible negative impact of the use of GM.

Sample recruitment

Participants were recruited in three rounds through crowdsourcing platform Prolific. In the first round, screening criteria were 'US residency', 'Primary Grocery Shopper' and 'Approval rate 95% - 100%' with no additional screening criteria. On review of the first round, the sample appeared biased towards older generations with low income (< $60.000), including some poor quality submissions. Therefore, the second round was started to enrich the sample for millennials with slightly higher income by including criteria of 'Age 28 – 44' and 'Household income > $70.000'. Because of poor quality submissions, approval rate criterium was increased to '99% - 100%', which still comprised of over 85% available participants. In round three the same criteria were used as round two, only changing age '18 – 28' to include Gen Z participants.

In all three rounds, additional prescreening took place based on a question gauging openness to consuming plant-based meat in the future. Participants who indicated they were at least 'somewhat likely' to consume plant-based meat in the future could continue with the survey, while consumers that were 'not at all likely' or 'not so likely' to consume plant-based meat were screened out. This question was inspired by industrial segmentation research (Kirchner and Leet-Otley, 2025b). As per Prolific's recommendations, 3 other questions were included in custom pre-screening on the general topic of food. These 'ghost' questions were meant to prevent participants from guessing which question determines eligibility, which otherwise could have led to participants answering the question dishonestly to be able to continue the survey.

Participants were awarded a 'good' wage following Prolific's recommendations, constituting $4 for the ~20-minute survey. If participants were screened out in additional prescreening, they were still awarded for their time spent in the survey (often ~1 minute). In total, 232 participants started the survey, of which 67 were screened out. Each response was assessed individually in order to do some crude filtering of poor submissions. A submission was viewed as poor if one or multiple of the following was present (1) Failed attention check (random answers) in the specific attention check questions, (2) Presence of conflicting answers, (3) Overly present 'straightlining' in the results. If there was some

amount of uncertainty about the submission really being poor quality, participants were given the benefit of the doubt.

Measures

Dispositional (between subject) measures were obtained once per participant. **Food neophobia** was measured using the Pliner & Hobden 10-item scale, by evaluating on a 5-point Likert scale (Pliner and Hobden, 1992). After reversing items 1, 4, 6, 9 and 10, scores were calculated by averaging the 1 – 5 Likert score of the items. This resulted in a score between 1 – 5 with high values indicating highly food neophobic participants. **General attitude towards genetically modified foods**, further referred to as GM attitude, was measured using the 13 item scale developed by (Bredahl, 2001). After reversing items 4, 7, 9, 10, 11, 12 and 13, scores were calculated similarly to food neophobia scores. **Nutrition knowledge** was measured by 20 true/false items, a scale developed by (Dickson-Spillmann et al., 2011). Item 17 of the original scale was adjusted by changing 'Gruyère cheese' to 'Cheddar' to increase relevance to US consumers. **Food-Related Lifestyle** was measured using 7 dimensions, (1) Importance of product information, (2) Relevance of Price-Quality criterion, (3) Interest in cooking, (4) Use of convenience foods, (5) Social and cultural impact, (6) Importance of taste, and (7) importance of health, selected from the original 23 dimension instrument (Grunert et al., 1997) (Brunsø et al., 2021). Some question wording was altered, to either modernize language or to increase relevance to alternative protein segmentation, drawing inspiration from an industry segmentation report from GFI (Kirchner and Leet-Otley, 2025a). Specific changes and additions can be found in Appendix VIII.

Situational (within subject) measures were evaluated in every scenario, resulting in 4 evaluations per measure. Adapted from (Siegrist and Sütterlin, 2017), **naturalness** was measured by asking the question 'How natural or artificial do you assess this product?' in a 5-point Likert question ranging from 'Very artificial' to 'Very natural'. **Trust** was measured on a 3 item 5-point Likert scale with statements 'I trust that this product is safe to consume', 'I have confidence in how this product was made or engineered' and 'I trust the health benefits', reflecting different trust dimensions uncovered in literature, in the product itself, in the production process and in validity of claimed health benefits (Lynn J. Frewer et al., 2003; Lähteenmäki, 2013). **Perceived healthiness** was evaluated by asking 'How healthy do you assess this product to be?', in a Likert question, based on its usage in similar studies (van Rompay et al., 2016) (d'Astous and Labrecque, 2021). Willingness to try and buy was measured by adapting statements used in previous research (Ares and Gámbaro, 2007), implemented as evaluations on a 5-point Likert scale asking consumers how likely they are to 'Try this product if it was offered to you' or to 'Buy this product'.

Missing values for Likert scale questions were imputed by Multivariate Imputation by Chained Equations (MICE) in R (Sam Wilson, 2021), an algorithm that accounts for correlation between variables to impute.

Statistical analyses

All of the following described statistical analyses were performed using R4.5.1 in RStudio 2025.09.0+387. The location of the data analysis script can be found in Appendix IX.

Hypothesis testing

Hypothesis testing was performed using linear mixed-effects models (LMMs), using the lme4 package in R (Bates et al., 2015). Linear mixed-effects models were used because the situational variables naturalness, trust, perceived healthiness, willingness to try and willingness to buy were evaluated by participants for each of the 4 scenarios, violating the critical assumption of independency used by many other (regression) models. Random intercepts for participants were included to account for a participant's individual baseline in scoring, fixed effects tested the hypothesized relationships. For hypotheses testing a single predictor, LMMs with a single predictor and participant random intercepts

were used to test the direct effects of the predictor. For interaction models, a two-way interaction term tested moderating effects between food neophobia and bioengineered logo. Significant interactions were further investigated using the 'effect' function in R. When applicable, multiple models were tested against each other to determine whether the fit was significantly better by using ANOVA.

Model assumptions were checked using either the 'performance' package in R, with the 'check_model' function, or using VIF (to check for multicollinearity). Together these functions check for residual normality, homoscedasticity, random-effects distributions, and multicollinearity and provides plots to visually assess if assumptions are valid.

Clustering

Initially, a clustering analysis was performed based on the Food-Related Lifestyle (FRL) dimensions. Before clustering, dimensions were verified by Confirmatory Factor Analysis as done previously in research on FRL clustering (Scholderer et al., 2004b). To this end, the 'cfa' function was used (Mair et al., 2025). Based on the Comparative Fit Index (CFI) and Root Mean Square Error Approximation (RMSEA), some items were removed from the questionnaire. Scaled scores from the CFA were used in subsequent clustering, in addition to scaled food neophobia score.

Clustering was performed using the k-means algorithm, resulting clusters were visualized using the factoextra package and silhouette scores were used to determine cluster distinctness. In general in literature, average silhouette width scores of above 0.5 are considered to indicate good clustering, with values between 0.25 and 0.5 indicating some formation of clusters, but not as distinct. In other research including the FRL, sometimes silhouette scores of above 0.25 are also seen as acceptable (Schäufele-Elbers and Janssen, 2023). The choice of the amount of clusters is partly based mainly on the highest silhouette scores and the elbow plot (Kaufman and Rousseeuw, 1990). It should be noted that the limited amount of participants in this study will impact the identification of clusters negatively. Although in general, 20 observations per expected cluster can lead to significant results, at least 50 is recommended (Dalmaijer et al., 2022).

Word association analyses

Associations with different terms describing the mycoprotein ingredient were tested. The terms 'Yeast Biomass', 'Nutritional Yeast', 'Yeast Protein', 'Mycelium', were tested, also including the term 'Mycoprotein' itself. These terms were chosen based on (1) mentions by existing companies in the mycoprotein space (Appendix VI), (2) brainstorm with internship provider. Participants could choose from a previously selected group of association terms, including positive terms ('Healthy',' Natural', 'Sustainable', 'Innovative', 'Ethical'), negative ('Fungal', 'Processed', 'Lab-grown', 'Artificial', 'Unhealthy') and neutral ('Not from plant or animal', 'None of the above', 'Animal-based', 'Plant-based (made from plants) terms. These terms were used following industry research performing research on precision fermentation nomenclature (GFI, 2025b). The same methodology of this research was adopted, calculating a 'Net positive score'. This is a subjective measure for indicating overall positive or negative associations with the different terminology, calculated by subtracting the average percentage of participants with positive associations by the average percentage of participants with negative associations.

4 Qualitative Results (Expert Interviews)

4.1 Overview of Interview Themes

The qualitative phase of this research aimed to gather insights on current communication and branding strategies within the alternative protein sector and to identify marketing-related factors that are especially important for novel product, focusing on genetically modified mycoprotein (SQ1). Semi-structured interviews were conducted with four experts with varying perspectives, from academia, industry, and non-profit organizations. Through thematic analysis, as described by Braun and Clarke (2006), four central themes emerged from the data analysis (Table 1). Each of the themes uncovers different aspects of consumer behavior and market dynamics in the alternative protein sector. The analysis revealed consumer decision-making, industry credibility, product positioning and communication complexity as interconnected themes that highlight considerations regarding drivers and barriers in bringing a novel meat alternative to market.

Table 1: Expert Interview Thematic Framework. Overview of four main themes and associated subthemes that emerged during four expert interviews, analyzed through thematic analysis.

Themes	Subthemes
Consumer Decision-Making Drivers	
	Routine Rigidity
	Food Neophobia
	Social and cultural influences
Trust and Credibility of the Food Industry	
	Process Transparency
	Profit Motives
Positioning and Value Proposition	
	Tangible benefits
	Convenience and routine integration
Communication Strategy Insights	
	Balancing explicit versus subtle communication
	Preventing misunderstanding and misinterpretation
	Cross-industry collaboration
	Targeted marketing

4.2 Theme 1: Consumer Decision-Making Drivers

The theme of consumer decision-making addresses the question of what thought processes and behaviors drive or inhibit consumer adoption of meat alternatives. It is considered a key theme to the research objective, as insights into how consumers come to decisions and what drives that process can provide handles for both industry and governments to base strategies on. Three subthemes were identified within this theme, Routine Rigidity, Social and Cultural Pressures, and Food Neophobia.

Routine Rigidity refers to how difficult it is to change consumer routines and buying behaviors, as identified by multiple participants. They emphasized the importance of habits in people's choice for which foods to buy, even when consumers' values might align with a different type of food product: *'A consumer might say 'I care about the environment', but they're not necessarily making a different choice when they go to the grocery store.' – P1.* This quote showcases the power of routine in consumer

buying behavior, and indicates there might be a lack of deliberate systematic processing in choosing which food to buy. Routines also influence expectations regarding other types of products. If products are branded as a replacement for an existing product in their routine, like a 'burger' or 'schnitzel', there are immediate expectations in terms of taste, preparation methods and integration into recipes: *'For the end-consumer, if they are eating something called a 'schnitzel', then it must at least look/taste/feel like the conventional meat product it tries to imitate' – P2.*

Food Neophobia also emerged as a barrier to alternative protein adoption. Consumers that are highly food neophobic are more likely to reject alternative protein, as informed by other research (Amoneit et al., 2025). Food neophobia is a character trait, but it's also context dependent as illustrated by participants: *'I think neophobia is often instigated by having a new and scary appearance, or a negative experience with the product' – P2 and* '*Some consumers will be extremely hard to turn, but for most rejectors some of that is driven by lack of understanding or information' – P1.* These quotes suggests that while Food Neophobia is a character trait, its effects can be moderated by certain aspects such as visual clues, familiarity and knowledge on the product. Another participant acted on this, suggesting that: *'Different framings and product types can touch on different already existing thought frameworks, and associations. Some might fit better for certain kinds of people, it is a trick that is used in industry for new product communication.' – P3*.

Social and cultural influences, like traditional social norms associated with meat consumption and cultural traditions, have also been identified by participants as important factors. Especially within the segment that is not open to meat alternatives: *'Even if people are generally willing to try new foods in this category, they can be resistant because of cultural and emotional connection to conventional meat, also connected to politicization of the category' – P1*. Still, there seems to be a positive shift towards openness of meat alternatives: *'The idea that one should eat meat every day is fading, resulting in a rise of flexitarianism' – P3.* This quote was followed by the side note that the definition of flexitarianism has changed as well. While it used to mean 'avoiding conventional meat four to five days a week', now people use the term when avoiding conventional meat one to two days a week. In addition to social and cultural norms, demographics also play a role. In general, younger consumers are less likely to reject protein alternatives, and families with children might struggle more having their children eating certain kinds of foods.

4.3 Theme 2: Trust and Credibility of the Food Industry

The theme of consumer trust in the food industry emerged as a concern across all interviews, reflecting consumer skepticism towards intentions of large companies, governmental food regulation and lack of transparency. In this context, Non-Governmental Organizations (NGOs) were also mentioned, as they play a role in communicating potential issues to the public. This theme is important for genetically modified products especially, since there has been some controversy in the past with the category. Three sub-themes were identified related to this category: Process Transparency and Profit Motives.

Process Transparency, or more specifically its lack thereof, is viewed by participants as an important aspect shaping consumer distrust in the food industry. Part of consumer distrust in food industry is sparked by previous incidents, such as by the Monsanto example in Europe: '*It [consumer trust in genetic modification] went wrong when Monsanto, a chemical company known from cancer causing chemicals, tried to push a genetically modified crop on the market without labelling it, because it was not mandatory.' – P3.* The choice of not labelling their caused significant consumer backlash, with European consumers feeling that the company was trying to hide something from them (Council on Foreign Relations, n.d.). The problem is that companies and regulatory bodies don't know what consumers need transparency about: *'At some point, someone was publicly ridiculed for not wanting genes in their tomatoes. However, we have been eating tomatoes for hundreds of years without knowing the existence of genes. That is not important information for a consumer in choosing*

tomatoes, unlike the fact that an American multinational has patented the technology and wants to push the product on the market.' – P3. Regarding the US market, distrust of the food industry was mentioned less, except in the context of blended meats.

Profit Motives are another aspect influencing consumer trust in industry according to participants. Mainly the focus of industry on chasing such profits, and focusing less on ethical aspects. Aggressively patenting and protecting patents was mentioned by participant P3 as industry behavior that is frowned upon by consumers, as it indicates that companies do not have consumers' best interests at heart. In this context, the topic of 'ultra-processing' came up with multiple participants. Participants agreed that there is a general tendency of consumers to classify 'processed' foods as dangerous, either because of distrust in the food industry or its association with being unhealthy. These views stem from the fact that '*One can use ultra-processing to make healthy products, but one can also abuse the technology to make cheaper products with an addictive aspect. In the latter case, all 'benefits' go to the industry in the form of quick profits rather than to consumers.' – P3.* Processing technology is not seen as inherently good or bad by the participants, what is important is how it is used by companies. The problem is that a marginal group of companies abusing the technology, play a big role in forming consumer opinions: *'That's a common issue in the food industry. Most companies operate honestly, but a small minority chase quick profits. That's when problems arise and people feel deceived. The majority of companies then has to repair the damage. It's always been this way and always will be' – P2*.

Interestingly, not all consumers assess a product's degree of processing in the same way. Some consumers look at the amount of ingredients on the packaging, while others look at whether the named ingredients are familiar to them. Most do not assess a product with an existing framework, like NOVA (Monteiro et al., 2018). One of the interviewees mentioned falafel as an interesting case, since it is often not viewed as processed by consumers, while most meat alternatives are. There seems to be an 'authenticity' factor at play. If people perceive a product as natural, they are less likely to view it as processed.

4.4 Theme 3: Positioning & Value Proposition

The third main theme that emerged comprises expert opinions on how novel food products, including both mycoprotein and hybrid forms such as blended meats, should be positioned in the market to resonate with consumers. In contrast to the first theme, this theme focuses on product framings and which aspects of a product are important to consumers. Two sub-themes were identified, the first one unveiling a shift in consumer preferences towards messaging on tangible benefits.

Tangible benefits, a direct (health) benefit from consuming food, came up in talks with participant as an emerging requirement for people, reflecting a societal shift. While previous messaging efforts mostly focused on animal welfare and sustainability, broader communal benefits, it seems that these factors have become less salient in decision-making in the US and in Europe. Instead, messaging focus has shifted from broader communal benefit messaging to messaging conveying 'instant effect' benefits. The 'Protein Hype', the trend that people are actively buying foods high in protein or with a protein amount advertised, is an example of this shift: *'What we can really learn from the protein hype is that society is changing. An increasing number of people is sensitive towards those possible instant effects.' – P4.* People associate protein with 'instant effect' benefits such as building muscle, improved athletic performance, boosting energy and staying full. It is very interesting to note that such tangible benefits seem to be able to make people overcome routine rigidity mentioned in theme 1.

Participants indicated that while protein is necessary and good in general, people are overconsuming protein. Fiber emerged as a promising new positioning angle for a few reasons. Firstly, most people do not get enough fiber from their diets. Secondly, research has shown that fiber can give 'instant effects',

such as positive gut health, skin, and fullness effects. Links are even made between fiber intake and mental health improvement, a subject that is also becoming increasingly relevant to the public. Thirdly, various organizations, such as institutes, academia and industry are aligning on these benefits. From the interviews, a conclusion was that collaboration between different food relevant actors is very important. This is mostly to build credibility for these kinds of statements, an important factor for consumers.

Convenience foods, particularly their rising popularity and ***integration into existing routines***, emerged in the context of attracting the 'early majority'. This possible route for alternative protein taps into the increasing demand in ready-to-eat foods, such as pre-made sandwiches, wraps, salads, by replacing the conventional protein they currently contain with alternative protein. That way, consumers are still consuming 'the same product' and *'You make it easy to switch for consumers, by respecting their routines and habits' – P4.* Another example of a similar strategy is the case of blended meats. By taking an existing burger and changing the formula to include plant-based protein, the barrier can be lowered to try the product. This route comes with some communication challenges, which will be discussed in theme 4. Another way to minimize consumer effort, is to optimize shelving of alternative protein products in the supermarket. By placing meat alternatives directly next to conventional meat products, rather than in a separate isle, you make it easier for the target group you're trying to reach to buy an alternative product.

4.5 Theme 4: Strategic Communication

The fourth theme addresses the nuance required to devise a communication strategy for an alternative protein product. The theme reveals complexity in balancing communication with consumer acceptance, also incorporating how different groups of customers might react to different messaging.

Balancing explicit versus subtle communication, of product ingredients and benefits, is a theme that emerged from multiple interviews. Explicitly communicating in this context refers to communication on the front packaging, or otherwise communicating through brochures or websites. Subtle communication refers to only adhering to labeling requirements, stating the ingredient on the ingredient list, and not focusing on any other communication regarding the ingredient. Participants have observed a shift away from explicit communication of ingredient type: *'The origin of the protein is becoming less important, which is good. We should go to a protein world where it doesn't matter if it's chicken or soy, as long as it tastes good.' – P2.* On the other hand, whether consumers should be informed explicitly on the ingredient type could depend on the type of consumer: *'Some consumers are very informed about food, they probably want to know and knowing would probably convey some benefits that the ingredient might have.' – P1.*

In the case of blended meats, the opinion on the best type of communication strategy is mixed. One interviewee is an advocate of 'subtle communication' regarding this category. By 'plantifying' conventional meat products, adding plant-based meat to the original products, people can be helped in reducing their meat consumption. This type of subtle messaging does not evoke resistance or raise questions, while 'overcommunicating' could deter people from buying the product. However, consumers should not be or feel deceived as a result of the communication strategy. That would pose a problem in the US in the blended meat category, one interviewee suggested: '*There's been some history of unfavorable ingredients used as fillers in meat to make them cheaper. So I think consumers are skeptical of that and if that became the norm, I think that would significantly reduce consumer's interest.' – P1.* Industry in the Netherlands reflects this mixed opinion between experts, with two big supermarket choosing opposing strategies. Explicit communication is done based on sustainability aspects, which multiple interviewees indicate is becoming less of a factor in consumer decision-making. Critique from academia in this regard is that by 'subtly' communicating, we are not making a behavioral shift towards alternative protein at all, as most people will not even realize that they are

consuming alternative protein. They describe it as a 'transition without really changing' (Wittebrood, 2025).

There is a nuance on when to use a type of communication another participant indicates. When introducing a new category with multiple products, explicit communication is in order. However, when starting to introduce a product, like one mycoprotein product, explicit communication would only raise questions and reduce demand for the product.

Preventing misunderstanding and misinterpretation, was stressed as important in communication by multiple interviewees. Communication regarding ingredient origin should carefully balance between accuracy, attractiveness, and understandability: *'Consumers should understand what it is, but it should not get so scientific/technical that it raises questions or detracts from the appeal of the product' – P1.* This is also exemplified by mycoprotein companies Quorn and Meati exploring different names and explanations for their product, both (Poinski, 2017; Watson, 2024). Another subject that has come back in all interviews is the increasing role of social media in influencing customer views, for instance with influencers: '*An enormous amount of misinformation is available about the food industry and products. The subject of genetic modification would definitely also be affected by that I think' – P2.* P1 indicates that social media also brings a factor of uncertainty with it, in terms of predicting future trends, which has become even more difficult because of those dynamics.

Cross-industry collaboration, between companies, but also NGOs, research institutes, and health foundations, were mentioned by an interviewee as important in communication. P4 indicated that this is especially important in conveying tangible benefits, to build trust in claims and to educate consumers on the benefits of alternative proteins. P1 also mentioned industry collaboration as important, specifically in deciding on nomenclature and explanations to use. P2 stressed the importance of NGOs, stating that industry should stay in close contact with them to ensure transparency and prevent consumers from feeling deceived by a company's marketing strategy.

Target marketing, has been identified as an emerging trend in the last 2/3 years in the alternative protein sector. Companies are trying to find their ideal target customer, and adjusting messaging based on that. Interviewees look at this difference in messaging for different customers in a different way. One interviewee talks about segmentation on a very specific level, targeting people based on their life values, and what they want to obtain from foods, similar to the Food Related Lifestyle framework. Another talks about it on a more generic level, dividing people in groups based on Rogers' innovation model of diffusion. In the US, plant-based meat companies tends to segment based on 'ideal target customers' that best fit the product value proposition, to increase adoption of their product, but also to increase revenue.

4.6 Interconnections

The four themes identified show interconnectedness that amplify barriers, but also show opportunities for strategies addressing these barriers.

Theme 2 exemplifies that consumers are skeptical of the food industry because of industrial focus on quick profits, and a lack of transparency. This skepticism mainly comes from past experiences, examples of companies chasing quick profits by using processing technologies, and the Monsanto case in genetically modified foods. This lack of trust in industry stemming from previous experiences directly influences consumer decision-making. If consumers are skeptical about the food industry, they are less likely to try something new, therefore triggering already existing food neophobia in people. That way, routine rigidity becomes even more difficult to overcome, because next to relying on familiar habits, consumers have active 'deliberate processing' reasons to avoid novel foods.

A societal shift was observed of consumers wanting instant, tangible benefits from food. This new 'want' from consumers opens up opportunities to position and frame products in such a way to reduce barriers mentioned in theme 1. Even though many people rely on habits to guide their buying decisions, a very important direct benefit (for instance in health) has the potential to break routine. This also affects industrial credibility identified in theme 2, since health benefits that are supported by various (non-industrial) actors can improve trust in the product.

Finding nomenclature for mycoprotein might prove to be difficult, as it should address food neophobia (theme 1), for instance in the form of nomenclature that sparks familiarity without being deceiving. This can be difficult as exemplified by the examples of Quorn and Meati being sued for false advertising. However, nomenclature should also support industry credibility, by not being associated with processing for instance, and should not raise too many questions (themes 2, 4). Finally, nomenclature should be associated with tangible benefits (theme 3), to increase the chance of consumers breaking routine and trying the product.

5 Quantitative Results

To test the influence of labelling and communication strategies on consumer willingness to try and buy (genetically modified) mycoprotein, a cross-sectional survey was distributed among 165 US consumers. The effects of bioengineering disclosure (bioengineered logo vs no logo) and nutrition/health claims (NHCs) on purchase intentions were investigated, including possible mediating factors like perceived trust, naturalness and healthiness. Direct and moderating effects of personal characteristics like food neophobia were also investigated. These tests were meant to provide insight into the 'mental shortcuts' consumers take in decision-making, in the specific context of genetically modified mycoprotein.

A mixed-factorial design, 2 (logo vs no logo) x 4 (different NHCs), was employed. All participants were showed 4 different mock-ups with different NHCs, with 86 participants seeing versions including a bioengineered logo, and 76 participants seeing versions without a bioengineered logo (Appendix VI). While showing each mock-up, data on perceived naturalness, healthiness, trust in the product and willingness to try/buy were collected.

5.1 Survey Demographics

Participants were recruited between the 28th of August and the 11th of September 2025 using crowdsourcing platform 'Prolific'. Participants were screened for being the primary grocery shopper of the household. After removal of 10 poor quality submissions, a total of 232 participants completed the pre-screening survey. Of these participants, 29% of participants were excluded for not meeting study criteria, as they were not at least somewhat likely to consume plant-based meat (PBM) in the future (Figure 8). The remaining 165 participants were either somewhat likely to eat PBM in the future (28%), very likely (22%), or extremely likely to (22%).

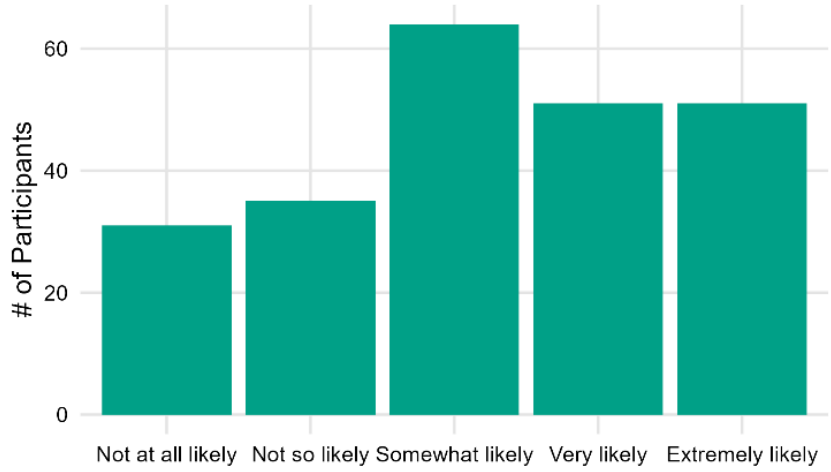

Figure 8: Consumer Openness to Plant-based Meat Consumption. Distribution of future plant-based meat consumption likelihood used as pre-screener for the survey.

A total of 165 participants completed the full survey, 86 participants were shown mock-ups without a bioengineered logo and 79 were shown mock-ups with bioengineered logo. Demographics were collected to ensure the sample representativeness and to be able to assess whether groups were over or underrepresented (Table 2). Initially, these variables were also collected to be used as covariates in subsequent statistical analyses. The total sample consisted of 55% female and 43% male respondents, with 2% indicating 'Non-binary' or 'Prefer not to say' as an option. The distribution in terms of generation was 19% Generation Z, 57% Millennial, 16% Generation X and 7% Baby boomer, meaning the sample is overrepresented by Millennials. Level of education was categorized into 18% 'Low' (high school diploma), 54% 'Medium' (Technical/Community college, Bachelor's degree) and 27% 'High'

(Master's or Doctorate degree). In terms of dietary preferences, 72% followed no special diet, 10% was vegan or vegetarian, 3% pescetarian, and 13% other.

Table 2: Demographic Characteristics of Survey Participants (N = 165). Descriptive statistics including generation, gender, education level and diet. 'Bioengineering disclosure' indicates whether participants viewed mock-up versions including or excluding the 'bioengineered' logo.

Demographic	**Category**	*Bioengineering disclosure*		**Percentage**
		No logo (N = 86)	***Logo (N = 79)***	***Average***
Generation	Gen Z (18 – 28)	20%	19%	19%
	Millennials (29 – 44)	56%	58%	57%
	Gen X (44 – 60)	17%	15%	16%
	Boomer (61 – 79)	7%	8%	7%
Gender	Female	52%	57%	55%
	Male	45%	41%	43%
	Other / Prefer not to say	2%	3%	2%
Education Level	Low	21%	15%	18%
	Medium	53%	56%	54%
	High	26%	29%	27%
Diet	Unrestricted diet	76%	68%	72%
	Vegetarian/Vegan	6%	15%	10%
	Pescetarian	6%	0%	3%

The sample characteristics in terms of demographics were similar between the *No logo* and the *Logo* group (Table 2), ensuring that effects of demographics in group comparisons in the follow-up sections were minimized. The only difference is in terms of diet, there are more vegetarians and vegans among participants who saw the versions including bioengineered logo

5.2 Descriptive statistics and Initial Correlations

Both dispositional variables and situational variables were measured using 1-5 scale Likert questions. Several constructs were calculated based on multiple items, by averaging the values of the items unless stated otherwise. If a construct was calculated from multiple items, reliability coefficients were determined (Cronbach's Alpha). Table 3 shows all dispositional variables including means, standard deviations, and reliability coefficients. All constructs except nutrition knowledge are displayed between a range of 1-5. **Food neophobia** showed a very good internal consistency (α = .86, M = 2.08, SD = 0.60). **Attitude toward genetic modification** showed excellent internal consistency (α = .90, M = 2.89, SD = 0.66). **Nutrition knowledge** (M = 67.55, SD = 20.9) was assessed by percentage correct answers on 20 nutrition-related True/False statements, and therefore has no internal consistency constant**. Food related lifestyle** was measured across eight different dimensions, with varying internal consistencies. **Importance of product information** (3 items) showed good internal consistency (α = .80, M = 4.13, SD = 0.61). **The importance of price–quality criterion** (3 items) had acceptable reliability (α = .69, M = 4.25, SD = 0.52), like **interest in cooking** (2 items) (α = .69, M = 2.29, SD = 0.84), **convenience** (2 items) (α = .70, M = 2.75, SD = 0.94), **cultural/social involvement** (4 items; α = .71, M = 3.84, SD = 0.68), **taste** (3 items) (α = .74, M = 4.52, SD = 0.47). **Product health attributes** (4 items) demonstrated good reliability (α = .79, M = 3.99, SD = 0.61). Finally, the **Nutrition and exercise** dimension (2 items) had acceptable consistency (α = .70, M = 3.96, SD = 0.81).

Table 3: Descriptive Statistics for key psychological constructs. Mean scores, standard deviations (Sd) and Cronsbach's alpha values for food neophobia, attitude toward genetic modification, nutrition knowledge and food-related lifestyle dimensions.

Construct	Items	Cronbach's α	Mean	SD
Food Neophobia	10	0.86	2.08	0.60
Attitude toward Genetic Modification	13	0.90	2.89	0.66
Nutrition Knowledge (% correct)	20	-	67.55	20.9
Food-Related Lifestyle (FRL)				
Importance of product information	3	0.80	4.13	0.61
Price-quality criterion	3	0.69	4.25	0.52
Interest in Cooking	2	0.69	2.29	0.84
Convenience	2	0.70	2.75	0.94
Cultural and social	4	0.71	3.84	0.68
Taste	3	0.74	4.52	0.47
Product health attributes	4	0.79	3.99	0.61
Importance of nutrition for exercise	2	0.70	3.96	0.81

Table 4 shows means, standard deviations, and reliability coefficients (when applicable) for situational variables measured after showing each mock-up. Trust was the only variable that was assessed with multiple items, so it is the only one with a Cronbach α coefficient. In some mock-up versions, a small difference can be observed between means. Notable is that the trust scale shows excellent consistency (α = 0.90 – 0.93).

Table 4: Product Evaluation Scores by Experimental Condition. Mean ratings for naturalness, healthiness, trust, willingness to try and willingness to buy across different claims and logo conditions.

Variable	Version	No Label Mean (SD) *(N = 86)*	Label Present Mean (SD) *(N = 79)*
Naturalness	1	2.98 (1.13)	2.92 (1.19)
	2	2.93 (1.13)	3.05 (1.08)
	3	2.95 (1.14)	2.94 (1.07)
	4	2.95 (1.07)	3.04 (1.11)
Health Perception	1	3.87 (0.96)	3.87 (0.82)
	2	3.83 (0.94)	3.87 (0.88)
	3	3.97 (0.91)	3.91 (0.82)
	4	3.91 (0.97)	3.90 (0.78)
Trust	1	3.62 (0.93) (α=0.93)	3.59 (0.81) (α=0.90)
	2	3.61 (0.88) (α=0.92)	3.65 (0.84) (α=0.90)
	3	3.59 (0.91) (α=0.93)	3.64 (0.86) (α=0.92)
	4	3.60 (0.91) (α=0.92)	3.64 (0.87) (α=0.92)
Willingness to Try	1	3.81 (0.99)	3.84 (0.93)
	2	3.80 (0.99)	3.84 (0.93)
	3	3.86 (1.03)	3.80 (0.97)
	4	3.81 (1.00)	3.81 (0.96)
Willingness to Buy	1	3.32 (1.14)	3.39 (1.08)
	2	3.31 (1.09)	3.39 (0.99)
	3	3.34 (1.14)	3.42 (1.05)
	4	3.33 (1.13)	3.39 (1.01)

Correlation analysis between variables was performed to identify interesting targets for further analysis, and to identify possible issues (Table 5). Dispositional variables food neophobia, attitude towards genetic modification, nutrition knowledge and all dimensions of the Food-Related Lifestyle instrument were included, together with situational variables of trust, naturalness health perceptions, and willingness to try/buy. Situational variables for each mock-up violate the core regression

assumption of independency. Therefore, to be able to include situational variables, averaged values across the 4 different situations were used. This does not pose a problem in this step, as this initial correlation analysis is only a guide aiming to identify which correlations to investigate more in depth. The created correlation table omits FRL dimensions for readability, the complete table can be found in Appendix XI. Some noteworthy correlations, or lack thereof, will be discussed in the following paragraphs:

Food neophobia is significantly negatively correlated with attitude towards genetic modification (R=-.16, $p < 0.05$) and nutrition knowledge (R=-.19, $p < 0.05$). Food neophobia is negatively correlated with purchasing intentions (R=-.18, $p < 0.05$) while showing no significant correlation with perceived healthiness, naturalness and trust. Food neophobia is also correlated with several FRL dimensions, positively with interest in cooking (R=.34, $p < 0.01$) and convenience (R=.18, $p < 0.05$), while negative with social and cultural influences (R=-.30, $p < 0.01$) and taste (R=-0.32, $p < 0.01$). **Nutrition knowledge** seems to have no significant correlation with any other variables, except for food neophobia. There was also no significant correlation between nutrition knowledge and any of the FRL dimensions. There were also no correlations observed between perceived naturalness and any of the FRL dimensions. **Attitude towards GM** showed correlation with trust, perceived naturalness, perceived healthiness and willingness to buy/try the product. **Situational variables** showed correlation between all variables. A very high correlation between trust and perceived healthiness (R=0.83, $p < 0.01$) and trust and product intentions (R=0.78, $p < 0.01$) might indicate multicollinearity, which should be further investigated when performing regression analyses.

*Table 5: Correlation Table of Primary Study Variables. Including study variables: (1) food neophobia, (2) attitude towards genetic modification, (3) nutrition knowledge, (4) trust, (5) perceived naturalness, (6) perceived healthiness and (7) product intentions. Note that values of trust, perceived naturalness, perceived healthiness and product intentions are averaged across all mock-ups and presence/absence of a bioengineered logo. N=165. *p < 0.05. **p < 0.01. N=165.*

Variable	M	SD	1	2	3	4	5	6	7
1. Food Neophobia	2.08	0.60	—						
2. Attitude towards genetic modification	2.89	0.66	–.16*	—					
3. Nutrition Knowledge	67.55	20.88	–.19*	.11	—				
4. Trust (product, process, claim)	3.62	0.85	–.12	.48**	–.04	—			
5. Perceived naturalness	2.96	1.05	.07	.24**	–.03	.49**	—		
6. Perceived healthiness	3.88	0.82	–.08	.37**	.04	.83**	.47**	—	
7. Product intentions (WTT + WTB)	3.59	0.92	–.18*	.33**	–.01	.78**	.44**	.73**	—

All variables were also plotted to inspect distribution and spread (Appendix I). Notably, for food neophobia, the maximum observed score was 3.8, indicating the absence of highly food neophobic participants. The distribution of nutrition knowledge is right skewed. Furthermore, for healthiness, naturalness, trust, willingness to try and willingness to buy, there is a sharp peak because of many participants answering similarly on the Likert questions. These distributions also do not seem to be normally distributed. This should be taken into account, depending on the assumptions of to be used statistic models.

5.3 Main Statistical Analyses

Initial correlation analysis (Table 5) showed that almost all dispositional and situational variables correlate with product intentions, providing incentive to investigate them further. Nutrition knowledge showed no correlation with any of the other variables except food neophobia, so it was excluded from main-effects analyses. As indicated before, the correlations shown in the correlation table are only indications. Hypotheses on main effects were set up, rooted in the theoretical backgrounds chapter. Hypothesis testing included fitting linear mixed-effects regression models (LMMs) to account for participants viewing multiple scenarios, violating other regression models' assumption of independency. Model fit was compared between different models with ANOVA testing.

5.3.1 Direct effects on willingness to try and willingness to buy mycoprotein

The variables bioengineered labeling (H1a; -), Claim type (H2a; +), Food Neophobia (H3a; -), Perceived trust (H1d; +), Perceived naturalness (H1e; +) and perceived healthiness (H2c) were hypothesized to affect consumer willingness to try and willingness to buy mycoprotein. To test these hypotheses, 6 LMMs were fit predicting willingness to try, and 6 LMMs were fit predicting willingness to buy. Random intercepts for participant IDs were included to account for individual scoring behavior. Predictors were bioengineered logo (logo vs no logo), claim type (health claim vs nutritional claim), food neophobia, perceived trust, perceived naturalness and perceived healthiness (Table 6; Table 7).

Across all participants, the average willingness to try was 3.82 (SD=0.073) indicating above moderate willingness to try the product. Willingness to try was not significantly predicted by bioengineered logo (β = -0.003, p = .983) and claim type (β = 0.000, p = 1.000), but was significantly positively predicted by perceived healthiness (β = 0.241, p < 0.001), perceived naturalness (β = 0.149, p < 0.001) and perceived trust (β = 0.481, p < 0.001), while significant negative influence of food neophobia (β = -0.220, p = 1.000) was observed. The average willingness to buy was 3.36 (SD=0.08), slightly above moderate willingness to buy the product. Willingness to buy was not significantly predicted by bioengineered logo (β = 0.079, p = .623), claim type (β = -0.018, p = .544) and food neophobia (β = -0.116, p = 0.147), but was significantly positively predicted by perceived healthiness (β = 0.378, p < 0.001), perceived naturalness (β = 0.302, p < 0.001) and perceived trust (β = 0.663, p < 0.001).

To summarize, hypotheses H1a and H2a were completely rejected, hypothesis H3a was accepted for willingness to try, but rejected for willingness to buy. Hypotheses H1d, H1e and H2c were accepted for both willingness to try and willingness to buy mycoprotein.

*Table 6: Linear mixed-effects regression models predicting willingness to try. Regression results testing direct effects of bioengineered logo (no logo vs logo), claim type (nutritional or health claim), perceived healthiness (z), perceived naturalness (z), perceived trust (z) and food neophobia score (z) on willingness to try. All participants saw all claims (N=165), either with bioengineered logo present (N=76) or without logo (N=86). Degrees of freedom (df) from Satterthwaite's approximation. *p < 0.05, **p < 0.01, ***p < 0.001.*

Predictor	Estimate	SE	t (df)	p
Model 1: Random intercept				
(Intercept)	3.821	0.073	52.66 (164)	<.001***
Model 2: Model 1 + Bioengineered				
(Intercept)	3.823	0.101	37.92 (163)	<.001***
Bioengineered logo	–0.003	0.146	–0.02 (163)	.983
Model 3: Model 1 + Claim type				
(Intercept)	3.821	0.074	51.93 (173)	<.001***
Claim type (Ingredient)	0.000	0.025	0.00 (494)	1.000
Model 4: Model 1 + Perceived healthiness (z)				
(Intercept)	3.821	0.063	60.74 (151)	<.001***
Healthiness (z)	0.241	0.029	8.34 (640)	<.001***

Model 5: Model 1 + Perceived naturalness (z)				
(Intercept)	3.821	0.069	55.01 (161)	<.001***
Naturalness (z)	0.149	0.035	4.27 (657)	<.001***
Model 6: Model 1 + Perceived trust (z)				
(Intercept)	3.821	0.056	68.55 (159)	<.001***
Trust (z)	0.481	0.034	14.29 (631)	<.001***
Model 7: Model 1 + Food Neohpobia Score (z)				
(Intercept)	3.821	0.071	54.04 (163)	<.001***
FNS (Z)	–0.220	0.071	–3.12 (163)	.002**

*Table 7: Linear mixed-effects regression models predicting willingness to buy. Regression results testing direct effects of bioengineered logo (no logo vs logo), claim type (nutritional or health claim), perceived healthiness (z), perceived naturalness (z), perceived trust (z) and food neophobia score (z) on willingness to buy. All participants saw all claims (N=165), either with bioengineered logo present (N=76) or without logo (N=86). Degrees of freedom (df) from Satterthwaite's approximation. *p < 0.05, **p < 0.01, ***p < 0.001.*

Predictor	Estimate	SE	t (df)	p
Model 1: Random intercept				
(Intercept)	3.358	0.080	42.03 (164)	<.001***
Model 2: Model 1 + Bioengineered				
(Intercept)	3.320	0.111	29.94 (163)	<.001***
Bioengineered logo	0.079	0.160	0.49 (163)	.623
Model 3: Model 1 + Claim type				
(Intercept)	3.367	0.081	41.43 (176)	<.001***
Claim type (Ingredient)	–0.018	0.030	–0.61 (494)	.544
Model 4: Model 1 + Perceived healthiness (z)				
(Intercept)	3.358	0.063	52.95 (146)	<.001***
Healthiness (z)	0.378	0.034	11.27 (658)	<.001***
Model 5: Model 1 + Perceived naturalness (z)				
(Intercept)	3.358	0.071	47.04 (158)	<.001***
Naturalness (z)	0.302	0.041	7.44 (651)	<.001***
Model 6: Model 1 + Perceived trust (z)				
(Intercept)	3.358	0.052	65.08 (155)	<.001***
Trust (z)	0.663	0.037	18.10 (518)	<.001***
Model 7: Model 1 + Food Neohpobia Score (z)				
(Intercept)	3.358	0.080	42.18 (163)	<.001***
FNS (Z)	–0.116	0.080	–1.46 (163)	.147

5.3.2 Moderating effects of food neophobia

Food neophobia was hypothesized to positively moderate the relationship between bioengineering disclosure and purchase intentions (H3b). To test these hypotheses, LMMs were fit predicting either WTT or WTB, with food neophobia score (FNS; z) and bioengineered logo as predictors. For testing moderation effects, an interaction term (Logo x FNS (z)) is included (Table 8). Moderation effects were not observed on the effects of bioengineering disclosure on willingness to try (β = -0.0685, p = 0.634) or willingness to buy (β = -0.041, p = 0.799). Therefore, hypothesis H3b is rejected.

Table 8: Food Neophobia Moderation Analysis Results. Testing moderation effects of food neophobia on relationship between bioengineered logo and willingness to try and willingness to buy.

Predicting	Predictor	Estimate	SE	t (df)	p
Willingness to try	**Model 1:**				
	(Intercept)	3.821	0.073	52.66 (164)	<.001***
	Model 2: + Logo + FNS				

	(Intercept)	3.805	0.100	38.68 (162)	<.001***
	Bioengineered logo (vs no logo)	0.033	0.142	0.234 (162)	.815
	Food neophobia (z)	-0.222	0.071	-3.115 (162)	<.001***
	Model 3: Model 2 + Interaction (+ Logo × FNS)				
	(Intercept)	3.808	0.098	39.676 (161)	<.001***
	Bioengineered logo (vs no logo)	–0.034	0.143	0.234 (161)	.812
	Food neophobia (z)	-0.191	0.096	-1.979 (161)	.05*
	Logo x FNS (z)	-0.0685	0.143	-0.477 (161)	0.634
Willingness to buy	**Model 1:**				
	(Intercept)	3.358	0.080	42.03 (164)	<.001***
	Model 2: + Logo + FNS				
	(Intercept)	3.31	0.111	29.916 (162)	<.001***
	Bioengineered logo (vs no logo)	0.099	0.160	0.616 (162)	0.539
	Food neophobia (z)	-0.120	0.080	-1.499 (162)	0.136
	Model 3: Model 2 + Interaction (+ Logo × FNS)				
	(Intercept)	3.312	0.111	29.8 (161)	<.001***
	Bioengineered logo (vs no logo)	0.991	0.161	0.617 (161)	0.538
	Food neophobia (z)	-0.101	0.109	-0.935 (161)	0.351
	Logo x FNS (z)	-0.041	0.161	-0.255 (161)	0.799

5.3.3 Lack of mediating effects by perceived trust and perceived naturalness

It was hypothesized that bioengineering disclosure, would negatively influence perceived trust in the product (H1b), and perceived naturalness of the product (H1c). LMMs were fit predicting perceived trust and naturalness, with bioengineering disclosure as a predictor (Table 9). Across all participants perceived naturalness was moderate at 3.00 (SD = 0.083), perceived trust was moderately higher at 3.62 (SD = 0.065). Bioengineering disclosure was not found to significantly predict perceived naturalness (β = 0.010, p = .953) or perceived trust (β = 0.027, p = .835). Therefore, hypotheses H1b and H1c cannot be accepted, thus will be rejected. Initially it was hypothesized that perceived trust and naturalness would positively mediate the relationship between bioengineering disclosure and purchase intentions. However, since no evidence was found of either a relationship between bioengineering disclosure and purchase intentions, or between bioengineering disclosure and perceived naturalness or perceived trust, a mediating relationship is ruled out, therefore also rejecting hypotheses H1bd and H1ce.

*Table 9: Effects of bioengineered logo on trust and naturalness perceptions. Linear mixed-effects regression models showing non-significant effects of logo on perceived naturalness and trust. Degrees of freedom (df) from Satterthwaite's approximation. *p < 0.05, **p < 0.01, ***p < 0.001.*

Predicting	Predictor	Estimate	SE	t (df)	p
Perceived naturalness					
	Model 1:				
	(Intercept)	3.00	0.083	35.98 (164)	<.001***
	Model 2: + Bioengineering disclosure				
	(Intercept)	2.968	0.066	59.65 (182)	<.001***
	Bioengineered logo (vs no logo)	0.010	0.166	0.059	0.953
Perceived trust					

	Model 1:				
	(Intercept)	3.62	0.065	55.45	<.001***
	Model 2: + Bioengineering disclosure				
	(intercept)	3.61	0.09	39.77 (163)	<.001***
	Bioengineered logo (vs no logo)	0.027	0.13	0.208 (163)	0.835

5.3.4 Effect of claim type on perceived healthiness

It was hypothesized that claim type, specifically health claims, would positively influence perceived healthiness (H2b), and that claim type influences willingness to try through perceived healthiness as a mediator (H2b + H2c). LMMs were fit predicting perceived healthiness, with claim type as a predictor, and predicting willingness to try, with perceived healthiness and claim type as predictors (Table 10). Across all participants perceived healthiness was 3.89 (SD = 0.064), indicating above moderate perception. Claim type was found to significantly predict perceived healthiness, with health claims predicting slightly higher healthiness (β = 0.067, p = .027). This finding was confirmed by ANOVA, model 2 was a significant better predictor of perceived healthiness than model 1 (X^2 = 4.930, df = 1, p = 0.26). Therefore, hypothesis H2a can be accepted.

To test hypothesis H2bc, mediation analysis was performed (Table 11). The effect of perceived healthiness (scaled) on willingness to try (H2c) was found to be significantly positive (β = 0.244, p <0.001). Since claim type positively influences perceived healthiness, and perceived healthiness positively influences willingness to try, a causal mediation analysis was performed to identify exact indirect effects. Ingredient type claims (as opposed to health claims) lowered willingness to try through reduced health perceptions (ACME = -0.0185, p = 0.024). However, the total effect was not significant (TE = -0.00034, p=0.988) indicating inconsistent mediation.

*Table 10: Linear mixed-effects regression models predicting perceived healthiness, examining the direct effects claim type (nutritional or health claim). All participants saw all claims (N=165), either with bioengineered logo present (N=76) or without logo (N=86). Degrees of freedom (df) from Satterthwaite's approximation. *p < 0.05, **p < 0.01, ***p < 0.001.*

Predicting	Predictor	Estimate	SE	t (df)	p
Perceived healthiness					
	Model 1:				
	(Intercept)	3.891	0.064	60.74 (164)	<.001***
	Model 2: + Claim type				
	(Intercept)	3.924	0.066	59.65 (182)	<.001***
	Claim type (Ingredient vs Health)	–0.067	0.030	–2.22 (494)	.027*
Willingness to try					
	Model 3: Claim type + perceived healthiness				
	(Intercept)	3.812	0.064	59.57	<.001***
	Claim type (Ingredient vs Health)	0.018	0.024	0.76	0.451
	Perceived Healthiness (z)	0.244	0.039	8.38	<.001***

*Table 11: Mediation analysis: Claim Type → Perceived Healthiness → Willingness to try. Causal mediation analysis revealing inconsistent mediation with significant indirect but non-significant total effects. ACME: Average Causal Mediation Effect, ADE: Average Direct Effect. *p < 0.05, **p < 0.01, ***p < 0.001.*

Effect	Estimate	95% CI Lower	95% CI Upper	p
ACME (average)	–0.0185	–0.0359	–0.0023	.024*
ADE (average)	0.0182	–0.0301	0.0656	.440
Total effect	–0.00034	–0.0524	0.0483	.988
Proportion mediated (average)	0.027	–14.816	8.106	.996

5.3.5 Exploring moderating effects of bioengineering disclosure on the relation between trust and willingness to try

Initially, bioengineering disclosure was hypothesized to influence willingness to try through trust (H1bd) or perceived naturalness (H1ce) as a mediator. However, no significant relation was found between bioengineering disclosure and either trust, perceived naturalness or product intentions. Still, literature indicates some relation between bioengineering disclosure and perceived trust, naturalness and healthiness. In addition, direct effects of perceived trust, naturalness and healthiness on purchase intentions was observed (Table 6; Table 7). Therefore, as a more exploratory part of this research, moderation effects of bioengineering disclosure were investigated. To investigate possible moderation effects, an interaction term was added to the LMM (Table 12). This resulted in a significant effect (β = -0.263, p < .001), indicating that the logo negatively moderates the positive relationship between trust and willingness to try. For perceived healthiness, a significant effect of logo x healthiness is also found (β = -0.263, p < .001), negatively moderating the positive relationship between perceived healthiness and willingness to try. Because these hypotheses were tested in an exploratory way, possibly inflating the chance of false positives, Bonferroni correction is applied to the p-values. Regarding this correction, these moderation analyses are seen as a family of tests (m=3). Adjusted p-values (Table 12) of interaction logo x healthiness and logo x trust were below the threshold (p < 0.05), while logo x naturalness was already not below the threshold before Bonferroni correction.

*Table 12: Moderation Effects of Bioengineered Logo on Trust and Health Relationships with Willingness to try. *p < 0.05, **p < 0.01, ***p < 0.001.*

Predicting	Predictor	Estimate	SE	t (df)	p	Bonferroni adjusted p (when applicable)
Willingness to try	**Model 1:**					
	(Intercept)	3.823	0.101	37.92 (163)	<.001***	
	Model 2: + Logo					
	(Intercept)	3.823	0.101	37.92 (163)	<.001***	
	Bioengineered logo (vs no logo)	–0.003	0.146	–0.02 (163)	.983	
	Model 3: Model 2 + Trust					
	(Intercept)	3.830	0.077	157.80	<.001***	
	Bioengineered logo (vs no logo)	–0.018	0.112	–0.16 (158)	.872	
	Trust (standardized)	0.480	0.034	629.94	<.001***	
	Model 4: Model 3 + Interaction (Logo × Trust)					
	(Intercept)	3.831	0.077	155.75	<.001***	
	Bioengineered logo (vs no logo)	–0.017	0.112	–0.15 (156)	.880	
	Trust (standardized)	0.578	0.042	648.86	<.001***	
	Logo × Trust	**–0.263**	0.069	614.88	<.001***	0.000435
	Model 5: Model 2 + Perceived Healthiness					
	(Intercept)	3.823	0.087	43.73 (150)	<.001***	

	Bioengineered logo (vs no logo)	–0.004	0.126	–0.03 (150)	.976	
	Perceived Healthiness (standardized)	0.241	0.029	8.32 (639)	<.001***	
	Model 6: Model 5 + Interaction (Logo × Healthiness)					
	(Intercept)	3.823	0.087	43.74 (150)	<.001***	
	Bioengineered logo (vs no logo)	–0.004	0.126	–0.03 (150)	.976	
	Perceived Healthiness (standardized)	0.308	0.037	8.32 (634)	<.001***	
	Logo × Healthiness	**–0.173**	0.059	–2.94 (639)	.003**	0.0106
	Model 7: Model 2 + Perceived Naturalness					
	(Intercept)	3.823	0.097	39.61 (160)	<.001***	
	Bioengineered logo (vs no logo)	–0.004	0.139	–0.03 (160)	.975	
	Perceived Naturalness (standardized)	0.149	0.035	4.26 (656)	<.001***	
	Model 8: Model 7 + Interaction (Logo × Naturalness)					
	(Intercept)	3.824	0.097	39.47 (159)	<.001***	
	Bioengineered logo (vs no logo)	–0.004	0.140	–0.03 (159)	.976	
	Perceived Naturalness (standardized)	0.207	0.048	4.32 (653)	<.001***	
	Logo × Naturalness	–0.125	0.070	–1.78 (655)	.076⁺	0.227

Significant negative moderation of the bioengineered logo on the positive relation between trust and perceived healthiness on willingness to try was further explored by visualizing the moderating effects, plotting the predictor against willingness to try in the two scenarios (logo vs no logo) (Figure 9). These plots show a decrease in slope when the bioengineered logo is present.

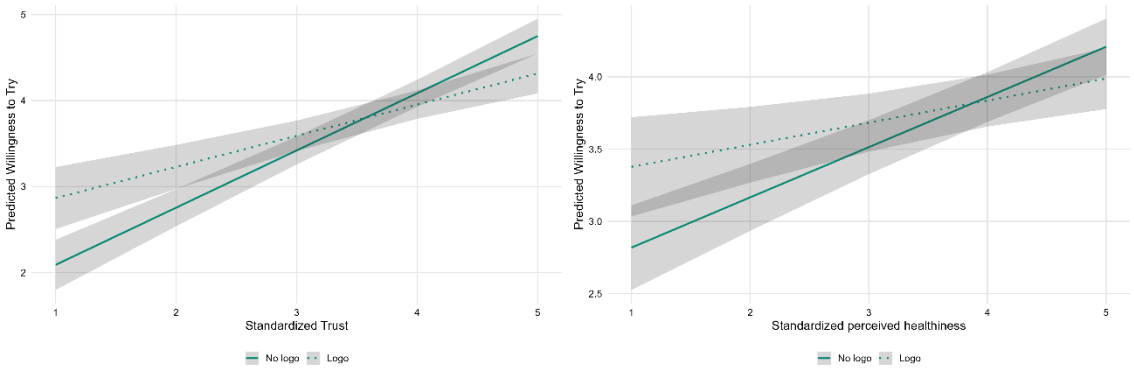

Figure 9: Moderation Effects of Bioengineered Logo on Trust and Health Perceptions → Willingness to try. Visualization of negative moderation effects of bioengineered logo.

5.3.6 Summary of hypothesis tests

Table 13 summarized the hypotheses tested in this research.

*Table 13: Summary of Hypothesis Testing Results.*Mediation effect accepted, but overall insignificant effect (incomplete mediation).*

#	Hypothesis	Accepted?
H1a	*Bioengineered disclosure negatively influences willingness to try and buy mycoprotein.*	*Rejected*
H1b	*Bioengineered disclosure negatively influences trust perceptions regarding mycoprotein*	*Rejected*
H1c	*Bioengineered disclosure negatively influences naturalness perceptions of mycoprotein*	*Rejected*
H1d	*Perceived trust in a mycoprotein product directly influences willingness to try and buy*	*Supported*
H1e	*Perceived naturalness of mycoprotein directly influences willingness to try and buy*	*Supported*
H1bd	*The negative influence of bioengineered disclosure on' willingness to try is mediated by perceived trust*	*Rejected*
H1ce	*The negative influence of bioengineered disclosure on' willingness to try is mediated by perceived naturalness*	*Rejected*
H2a	*Claim type (health claim vs ingredient claim) positively influences willingness to try and buy mycoprotein compared to ingredient claims.*	*Rejected*
H2b	*Claim type (health claim vs ingredient claim) positively influences perceived healthiness of the product, compared to ingredient claim.*	*Supported*
H2c	*Perceived healthiness of a mycoprotein product directly influences willingness to try and buy.*	*Supported*
H2bc	*The positive influence of claim type on willingness to try is mediated by perceived naturalness*	*Supported **
H3a	*Food neophobia negatively influences willingness to try and buy mycoprotein*	
	(i) Willingness to try	*Supported*
	(ii) Willingness to buy	*Rejected*
H3b	*Food neophobia positively moderates the relation between bioengineering disclosure and willingness to try and buy mycoprotein*	*Rejected*

5.4 Food-Related Lifestyle segmentation

Confirmatory Factor Analyses (CFAs) were conducted individually for four FRL domains: Ways of Shopping, Quality Aspects, Cooking Methods, and Purchasing Motives to verify the expected factorial structure as seen in FRL literature (Grunert et al., 1997). The 'Consumption Situation' domain was not included, as it was not included in data collection. Model fit was evaluation with χ^2 (preferred not significant), the Root Meat Squared Error of Approximation (RMSEA; preferably < 0.08), Comparative Fit Indices (CFI > 0.95), Tucker-Lewis Index (TLI > 0.95).

Fit statistics of these models (Table 14) show that the model regarding ways of shopping fit reasonably well (χ^2 = 4.88, n.s; RMSEA=0.093, CFI=0.982, TLI=0.946), with only the RMSEA slightly above the

recommended threshold of 0.08. Quality aspects fit well with all fit statistics being within recommended boundaries (χ^2 = 40.30, n.s; RMSEA=0.040, CFI=0.992, TLI=0.988). Cooking Methods fit quite poorly (χ^2 = 18.58, p < 0.01); RMSEA=0.149, CFI=0.905, TLI=0.764) indicating some problems with the underlying factors and items. Purchasing motives fit reasonably well (χ^2 = 16.32, p < 0.05); RMSEA=0.079, CFI=0.911, TLI=0.911), with only the χ^2 being slightly below threshold and the TLI as well.

Table 14: Confirmatory Factor Analysis for Food-Related Lifestyle dimensions: Fit Metrics.

Domain	χ^2 (df)	p-value	RMSEA	TLI	CFI	SRMR
Ways of Shopping	4.88 (2)	.087	.093	.946	.982	.031
Quality Aspects	40.30 (32)	.149	.040	.988	.992	.029
Cooking Methods	18.58 (4)	.001	.149	.764	.905	.036
Purchasing Motives	16.32 (8)	.037	.079	.911	.953	.046

To investigate these results further, standardized factor loadings were inspected (Table 15). Most indicators show strong loading on the intended dimensions, with Std.all above 0.6, with some indicators showing acceptable loading (>0.4). Somewhat problematic is item FRL17 loading below 0.4, indicating poor predicting of the factor. Therefore, it was removed before cluster analysis, resulting in better fit statistics.

Table 15: Confirmatory Factor Analysis for Food-Related Lifestyle dimensions. Standardized Factor Loadings and R2 values validating predicted structures.

Domain	Factor	Indicator	Std. Loading
Ways of Shopping	Product Characteristics	FRL1	0.614
		FRL8	0.737
		FRL20	0.917
	Price	FRL4	0.997
Quality Aspects	Price/Quality criteria	FRL7	0.755
		FRL13	0.733
		FRL15	0.516
	Taste criteria	FRL12	0.643
		FRL19	0.760
		FRL18	0.716
	Health attributes	FRLH1	0.741
		FRLH6	0.605
		FRLH8	0.881
		FRLH4	0.624
Cooking Methods	Enjoyment in Cooking	FRL2	0.603
		FRL9	0.909
		FRL17	**0.374**
	Convenience	FRL11	0.977
		FRL6	0.552
Purchasing Motives	Social and Cultural motives	FRL14	0.608
		FRL5	0.662
		FRL16	0.454
	Health / fitness motives	FRLH5	0.816
		FRLH7	0.640
		FRLH3	0.490

K-means clustering was performed using the CFA model output, including food neophobia scores. To determine the amount of clusters, silhouette scores were calculated for different amounts of clusters

and an elbow plot was made (Figure 10). Silhouette score indicates distinctiveness of clusters from other clusters. To indicate good clustering, it should be above 0.5, for weak clustering it will be between 0.25 and 0.5, and below 0.25 no compact clusters can be assumed. Figure 10 shows relatively low silhouette scores (< 0.28). Both the silhouette plot and the elbow plot suggest that using these variables, only 2 clusters can be identified with at least some certainty, limiting the applicability of clustering in this scenario. Therefore, it was decided to discontinue clustering attempts.

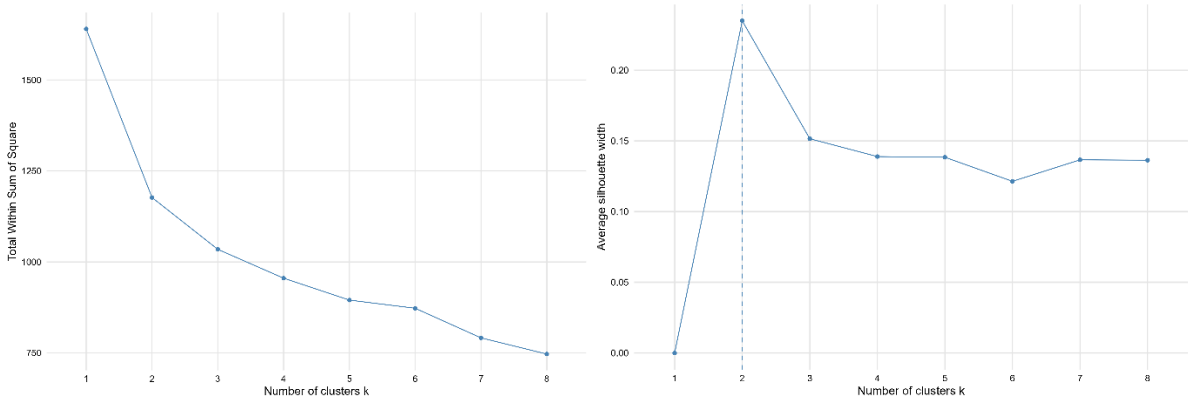

Figure 10: Cluster Analysis Validation: Elbow and Silhouette plots. Plots indicating poor clustering performance.

5.5 Nomenclature & Benefit preferences

In addition to the hypotheses testing analyses performed in the pervious section, exploratory analyses covering benefits messaging, risk/benefit regarding genetic modification, and terminology for mycoprotein were performed.

Overall, health benefits and curiosity were main reasons for wanting to try mycoprotein

Participants were asked to indicate possible reasons for trying mycoprotein (Figure 11). 61% of participants willing to try the product would do so because of health benefits, 57% would do so because of curiosity or novelty, 39% because of environmental reasons, 27% because they think they would like the taste, 26% because of low cholesterol, 19.4% because of lack of antibiotics or hormones and 8% because the product would be lactose-free. 15% of participants was not interested in trying the product. Across different food neophobia scores (FNS), health benefits remained the main reason for participants to try mycoprotein, followed curiosity.

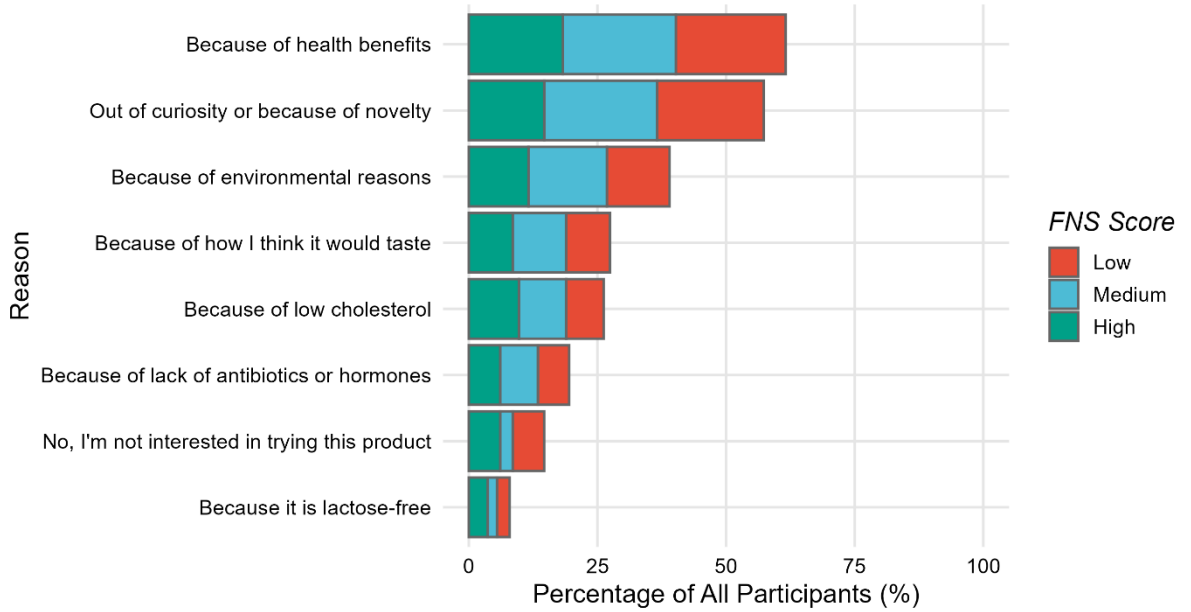

Figure 11: Motivations for Trying Mycoprotein. Ranking of reasons for trying mycoprotein among all participants (N=165).

Nutritional yeast is viewed most positively as a term for mycoprotein

Associations with different terms describing mycoprotein were tested (Figure 12). The terms 'Yeast Biomass', 'Nutritional Yeast', 'Yeast Protein', 'Mycelium', were tested, also including the term 'Mycoprotein' itself. Participants could choose from a previously selected group of terms, including positive, negative and neutral terms. Most participants associate 'Nutritional Yeast' positively, with healthy, sustainable and natural. Yeast Biomass is associated with lab-grown, processed, artificial, and much less with being healthy. Yeast protein scores similarly high on association with healthy, sustainable, and natural, with similar levels to Nutritional Yeast. Mycoprotein shows high association with 'innovative', 'healthy', but also higher on aspects like 'lab-grown', and 'processed'. Mycelium scores high on association with 'fungal', 'natural', 'lab-grown', and much less on health and sustainability.

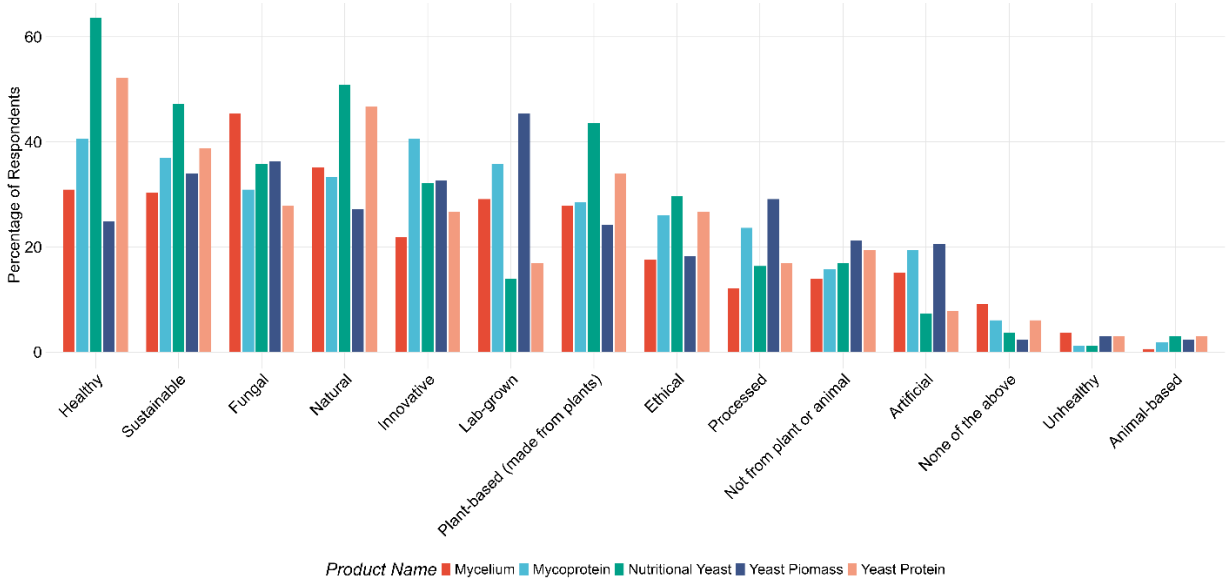

Figure 12: Consumer Associations with Mycoprotein Terminology. Associations for five terms describing mycoprotein, across positive negative and neutral terms..

From the data on associations, a Net Positivity Score (NPS) is calculated. NPS is a subjective score, indicating whether a term is mostly associated with positive or negative aspects (Figure 13). Nutritional yeast has the highest score (30%) Followed by Yeast Protein (24%), Mycoprotein (13%), Mycelium (6%) and finally Yeast Biomass with the lowest score (1%).

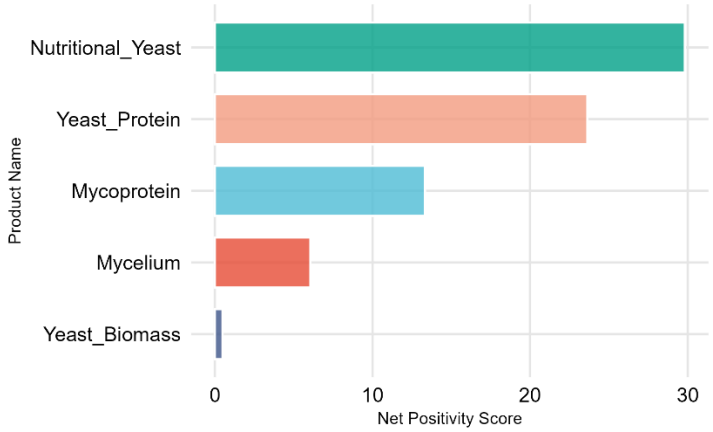

Figure 13: Net Positivity Scores for Mycoprotein Nomenclature. Calculated index for mycoprotein terminology positivity.

6 Discussion

The rising world population and climate change issues are making our current food system unsustainable. Alternative protein has great potential to change our food system to make it future proof, but the sector is plagued by consumer barriers and the market has stagnated. Mycoprotein is a type of alternative protein that shows extra potential for overcoming main consumer barriers, with a texture that is closer to meat, a neutral taste, health advantages and minimally processed. Bioengineering technologies can be used to further increase potential by improving nutritional and sensory characteristics. Consumer behavior research on both mycoprotein, and the official US bioengineering disclosure standard is limited, and the combination is largely unexplored. This presents a critical knowledge gap both in both academic literature and in industry. This thesis bridges that gap by investigating the role of labelling and positioning strategies in shaping consumer acceptance in the US market, in the form of willingness to try and buy. The research explored current communication strategies and their underlying in the alternative protein landscape, quantifies the effects of bioengineering disclosure on consumer decision making and examines associations with different mycoprotein nomenclature. This section will discuss the combined qualitative and quantitative results in guided sections, and will discuss theoretical and practical applications.

6.1 Barriers influencing decision-making regarding alternative protein

Habit formation and novelty

Multiple experts described routine rigidity as a barrier to adoption of novel foods. Despite people's values aligning with a different food choice, the majority of people does not seem to make a different decision in the supermarket because they choose what they are used to rather than buying something new. Related to routine rigidity, the subject of food neophobia came up in the interviews, described as a tendency to avoid novel foods. The interviews suggested that specific factors can trigger food neophobia, examples given were: a scary product appearance, bad previous experiences with the product, a lack of understanding or a lack of information about the product. This finding is in accordance with (Pliner and Hobden, 1992), who indicate that food neophobia can be highly context dependent and influenced by many factors.

Indeed, survey results showed that food neophobia was a significant negative predictor for willingness to try mycoprotein ($\beta = -0.220$, $p < .01$), implying that a high food neophobia score lowers a consumers' willingness to try mycoprotein. This means that consumers who are unlikely to try new foods in general, are also less likely to try mycoprotein compared to people who do like to try new foods. This finding is in accordance to expectations, since the concept of mycoprotein is novel to many people. Interestingly, a similar relation was not observed between food neophobia and willingness to buy mycoprotein. This while in multiple other studies regarding novel foods, this relation is shown (Chen et al., 2025; Franco Lucas and Brunner, 2024). While survey results showed that 57% of consumers mention wanting to try mycoprotein out of curiosity, research on mycoprotein specifically indicates that committing to buying the product could be more dependent on sensory aspects (Chezan et al., 2022). For most consumers, there might not be any expectations for sensory aspects because they had not tried mycoprotein before. Furthermore, people might also be willing to try mycoprotein, but not willing to replace conventional meat with mycoprotein, which is something that 'buying' an alternative protein product like mycoprotein could imply to consumers.

Trust and industry credibility

Across expert interviews, the importance of trust and industry credibility was emphasized. Previous examples of company secrecy, like Monsanto's GM crops, emphasize the importance of not just following rules, but knowing on which aspects consumers are lacking information to make informed decisions. Furthermore, consumers might not believe that these actors have their best interests at heart because of profit motives. This finding is in accordance to research by (Macready et al., 2020), who also indicate that consumers' trust is determined by rational beliefs consumers have about these

actors. Their research also found that openness is one of the most important factors that can create an amount of trust in the food chain, also highlighting the fact that company quick profits can erode trust. P2's quote regarding a minority of companies shaping consumer view of the entire industry is also supported by literature, stating that food actors are seen as a whole by consumers, with each actor balancing weakness of the other actors (Macready et al., 2020).

Consumer trust in the product and production process as measured in the survey, based on packaging and description, averages 3.8 on a Likert-scale between 1-5. This means that most people have above average trust in the product and the production process. Trust significantly predicts willingness to try ($\beta = 0.480$, $p < .001$), and willingness to buy mycoprotein ($\beta = 0.663$, $p < .001$) indicating that it plays a significant role in consumer decision making.

Perceived naturalness

The concept of perceived naturalness only came up a few times during the interviews. This is interesting, as literature generally seems to agree that perceived naturalness is important for novel food technology acceptance (Siegrist and Hartmann, 2020). However, perceptions on processing of foods were discussed in multiple interviews, which is something that can have an effect on perceived naturalness (Hässig et al., 2023). Survey results show that perceived naturalness averages around 3.0 on a Likert-scale between 1-5. Notably, it is one of the lowest average ranked metrics in the survey, while significantly predicting willingness to try ($\beta = 0.149$, $p < .001$), and willingness to buy mycoprotein ($\beta = 0.302$, $p < .001$), This, on average, low rating for mycoprotein might be due to the terminology or description used to describe mycoprotein. The results section on nomenclature indeed indicates that naturalness is associated less with the term mycoprotein than with other terms describing the ingredient. More on that in the section on nomenclature.

6.2 Effects of framing and positioning on barriers

Respecting routines

Several factors were discussed in the interviews that interplay with the barriers mentioned in the previous paragraphs. One of the strategies mentioned to avoid routine rigidity and food neophobia barriers is regarding 'respecting routines'. In the context of blended meats, adding plant-based protein ingredients to existing conventional meat products was mentioned as an example. Furthermore, replacing the protein used in convenience foods, like salads and other ready-to-eat foods, was mentioned. By employing this strategy, existing routines are respected and therefore adoption of alternative products does not evoke as much resistance. Especially the blended meat strategy has been employed recently in the Netherlands, by supermarket Jumbo providing these kinds of products under their private label. They employ what experts call 'subtle communication' strategies, only communicating the use of alternative protein on the ingredient list. According to Jumbo themselves, the main challenge in communicating this way is to convince the large group of people unmotivated to reduce conventional meat consumption, while not giving them the feeling that restrictions are being imposed on them (Wittebrood, 2025). In the same article by Wittebrood, consumer researcher Hans Dagevos argued that strategy does not evoke real change at all, but merely taps into existing routines.

I think there is a valid point there, in that employing this strategy does not immediately lead to higher alternative protein acceptance. However, from a practical point of view, it can certainly speed up the adoption of alternative protein. However, experts from the interviews are divided about whether this strategy is the way to go, one interviewee indicated that in the US consumers might feel deceived if this strategy would be used.

Evoking associations

A closely related strategy is to try and evoke existing positive associations with a new product by framing. For example, by calling an alternative protein product a 'burger', consumers know in what

situation to use it and how to prepare it. Another example of this strategy is of Meati and Quorn stating that their mycoprotein products are 'Mushroom root' or 'Similar to mushroom' respectively, trying to spark an association with mushrooms. However, like in this case, this strategy could evoke resistance if companies settle on accuracy to increase associations consumers can have with the product. In this case, while the association might have helped some consumers, others felt deceived because the used descriptors are not entirely accurate.

Benefit messaging and perceived healthiness

Finally, a strategy that arose across interviews was the use of benefit messaging. Experts noted the increasing role of tangible benefits in consumer decision-making, specifically on health benefits. Indeed, survey results that the most indicated reason for trying mycoprotein was because of health benefits (61% of participants), and perceived healthiness was shown to significantly predict willingness to try ($\beta = 0.308$, $p < .001$) and buy ($\beta = 0.378$, $p < .001$) mycoprotein. Multiple interviews exemplified this shift towards wanting tangible benefits with the 'protein hype'. Not only do they mean that consumers are willing to pay more for products that claim they are high in protein, but mostly that consumers are willing and able to completely change their food-related habits because of the perceived benefits. One interviewee added that simultaneously, sustainability messaging on products has been dialed down as it has become less salient in decision making. A possible reason for this shift can be found outside of food, in the current increased need for instant gratification and convenience, especially since the Covid19 pandemic, which lead to a rise in individualism ("Individualism & Expression Consumer Trends," 2025; McKinsey, n.d.).

In the survey, the influence of health claims, regarding gut or heart health, was compared to the influence of ingredient type claims, stating the high presence of protein or fiber. No direct effects of claim type on willingness to try or buy mycoprotein were observed, which is in accordance with (Hodgkins et al., 2019). It might be that the presence of a claim in general does influence willingness to try or buy, but that the average consumer does not differentiate between ingredient or health type claims. Despite having no direct influence on willingness to try, claim type does influence perceived healthiness of the product. Overall, perceived healthiness of a mycoprotein containing any claim was already moderately high (3.9). Perceived healthiness of mock-ups containing health claims was shown to be slightly but significantly higher than those containing ingredient claims, ($\beta = 0.064$, $p < 0.05$). Moderately high perceived healthiness was expected, since positive 'halos' surrounding nutrition and health claims might spillover to the total product. Mediation analysis showed that there was a significant effect observed, with ingredient claims slightly reducing willingness to try through perceived healthiness (ACME = -0.0185, $p = 0.024$). However, the overall effect on willingness to try, through mediation and direct influence, could not be statistically confirmed. It is possible that this type of mediation is inconsistent mediation, which can occur if direct effects go in opposite directions of mediation effects. Since the initial effect on perceived healthiness was already quite small, these conclusions should be taken lightly, repeated experiments will show whether it is actually significant.

6.3 Effects of bioengineering disclosure

Most experts did not have any specific experience with genetically modified foods. Nonetheless, continuing on their opinions regarding ingredient communication, most mentioned that subtle communication would also be the best way of communicating usage of genetic modification. In the US the most 'subtle' disclosure of bioengineering is likely either a QR code or through a text message. However, (Caputo et al., 2025) found that the bioengineered logo is the preferred way by most consumers. Quantitative results showed that bioengineering disclosure had no direct influence on willingness to try or buy mycoprotein. This finding was somewhat surprising, as recent research regarding the disclosure indicated that, on average, consumers would still choose conventional food products over bioengineered ones (Caputo et al., 2025). Still, that same research showed that willingness to pay for bioengineered foods could be higher among information-seeking consumers. It

is possible that in pre-selecting participants that are at least somewhat open to trying plant-based foods, the study is biased to consumers that have less strong opinions on bioengineering.

In contrary to expectations, bioengineering disclosure also did not have any direct effects on trust or perceived naturalness. A possible explanation is that most research previously done on disclosure of the usage of genetic engineering was done before there was an official US standard. However, since 2022 the National Bioengineered Disclosure Standard has been implemented in the US, so perhaps there is some aspect of familiarity by now. Since the label is an official mandatory government standard controlled by the USDA, it is also possible that consumers view the label as a sign of transparency, therefore increasing trust (Truong et al., 2021). Another possibility is that the bioengineered label does not spark negative associations, because of the label design. The label design and terminology has been shown to influence positive or negative associations (Howell et al., 2025). In general, distrust in the food sector was mentioned less in the geographical context of the United States, compared to the European Union.

Initially, positive mediation effects of trust and perceived naturalness between bioengineering disclosure and willingness to try and buy mycoprotein were hypothesized, but not further tested since there was no direct effects between bioengineering disclosure and either trust or perceived naturalness. As an exploratory part of the research, moderation effects were analyzed instead. These analyses indicated a role of bioengineering disclosure in negatively moderating the positive effects between trust and willingness to try, and between perceived healthiness and willingness to try. No evidence was found of a moderating effect between perceived naturalness and willingness to try. Research on visual cues in food identified many factors influencing and moderating decision-making. Trustworthiness of the product has been identified to interact with product packaging aspects to influence purchasing behavior (Vermeir and Roose, 2020). While these relations have not been explicitly described as visual cues moderating trustworthiness, they do indicate a relationship. Indeed, negative moderation effects were found to be significant ($\beta = -0.263$, $p < 0.01$). This means while bioengineering disclosure does not directly influence willingness to try, it seems to reduce the importance of trust and perceived healthiness in consumer decision-making, as illustrated in Figure 9.

Terminology

Among the different terms investigated, nutritional yeast overall was most positively assessed. It had the highest associations out of all with ‘healthy’, ‘sustainable’, ‘natural’, and ‘plant-based’. The term yeast biomass scored the worst out of all terms. It seems like the word ‘biomass’ is highly associated with lab-grown. Likely there is some positive contamination, or ‘halo’, associated with the word ‘nutritional’, which makes people associate it with healthy and natural foremost. Likewise, the word ‘biomass’ seems to be strongly associated with the lab, as it scored the highest associations with ‘lab-grown’. It is then automatically also associated with artificial, and processed. Mycoprotein scored the highest in association with ‘innovative’. This might be because people are not familiar with the term. Yeast protein is a close follow-up of nutritional yeast, scoring high is natural and sustainable. Mycelium is highly associated with ‘fungal’. This association could be the reason it is also associated less with healthy and innovative. This association was also partly found by Chezan et al. (2022), however they found that people who associated food with fungal, but also had knowledge on other fungal products, such as blue cheese, had a higher likeliness of positive associations. None of the terms were often associated with unhealthy. Overall it seems that the term ‘yeast’ is viewed quite positively, unless combined with ‘biomass’. It should be noted however, that not all mycoprotein would be allowed to be called yeast as not all fungi are yeasts.

6.4 Theoretical Implications

This research builds on the concept of Dual Processing theory, many findings, both in terms of barriers and communication strategies, supports and extend this theory in application to genetically modified

alternative protein foods. The routine rigidity barrier identified in the expert interviews has been conceptualized in previous literature as a 'habit' heuristic in food decision-making (Fischer and Reinders, 2022). The conceptualization of routine rigidity as a heuristic can partly explain why changing behavior in food decision-making is so difficult, as heuristics promote decision-making through quick and biased System I processing. On the other hand, food neophobia is a personality trait, promoting decision-making through deliberate, slow cognitive processing, System II. Perhaps unsurprisingly, the communication strategies identified in the interviews all appear to aim to change the (distribution of) flow of decision-making, guiding consumers to make either System I or System II based choices.

The strategy regarding 'Respecting Routines', makes use of the already existing strong habit heuristic and tries to avoid triggering system II thinking by not explicitly communicating regarding product ingredients. The strategy of 'evoking associations' tries to tap into the 'affect' heuristic explained in the theoretical backgrounds. By connecting to an already existing, preferably positive, association, or to activate feelings of familiarity, the aim is to activate System I in decision-making therefore reducing System II related barriers such as food neophobia. The 'tangible benefit' strategy works a bit differently, trying to act on System II processing so that after deliberate processing, consumers decide that they want to use the product due to personal tangible benefits. It appears that with tangible benefits, exemplified by the protein hype, the perceived benefits are so great that System II processing can overcome habit barriers

Using dual processing theory in marketing is not something that is new. The concept of 'Nudging', defined as 'behavioral intentions that guide choices without restricting options' (Mertens et al., 2022) has been used for a long time in marketing and other aspects to subtly guide decision making towards healthy or sustainable options (Bruns et al., 2018). Therefore, nudging shows potential to convince consumers to change their buying behavior towards options that aid in solving global problems. However, nudging always requires ethical considerations. By actively trying to activate System I thinking, consumers might not make decisions based on their values or personal characteristics anymore. The question is, especially when using a novel technology like genetic modification, if it is deemed ethical to 'exploit' this System I thinking to bypass consumer concerns regarding genetic modification. In a way, this could threaten truly informed decision-making and should be treated with care. In general, nudges can be deemed ethical if they can aid in solving societal problems or promote healthy behavior. There is literature available on ethical frameworks to decide whether nudging is considered ethical in a specific usecase, such as the FORGOOD framework (Lades and Delaney, 2022). However, the usage of these nudges in combination with genetic modification is up for debate. Especially when used by a company, it should be considered who is gaining the most benefit by nudging. On the other hand, the tangible benefit messaging strategy is more likely to activate deliberate thinking rather than System I processing, suffering less from these concerns.

What this research adds to existing literature is embedding both the official National Bioengineering Disclosure Standard and nutrition/health claims in dual processing theory, in the context of alternative protein. To my knowledge, no studies have been conducted on the use of the official bioengineering disclosure statement and alternative protein. This research indicates that most communication strategies try to target System I or System II thinking in different ways to convince consumers to make a different food choice. While 'respecting routines', by sparking the habit heuristic, might lead to the highest change in adoption of alternative protein, more research should be performed on how consumers feel regarding this strategy in different geographical contexts.

This research adds to the National Bioengineering Food Disclosure framework, in observing that the presence of the bioengineered logo shifts decision-making dynamics away from factors like perceived trust and healthiness. It would be interesting to investigate the moderating influence of the bioengineered logo on other factors important in decision-making. Bioengineered labelling was not

found to be a significant predictor for willingness to try in this study, which is partly in contrast to existing literature on customer acceptance of novel foods (Caputo et al., 2025). However, all mock-ups shown to participant showed either an ingredient or health claim. It could be possible that the presence of a tangible benefit mitigated a negative direct effect (Siegrist, 2008).

6.5 Practical Applications

What becomes clear from the interviews is that in product development and positioning, industry should focus on providing tangible benefits rather than focusing on sustainability messaging. The interviews indicate that focusing on fiber content and associated health benefits, such as gut health, fullness, and even mental health connections could prove a promising strategy. Industry should collaborate with other industrial and academic partners to demonstrate tangible benefits and make them trustworthy for consumers. To address other industry trust issues, companies should aim to be transparent in their production process and usage of technologies. How open communication should be on the protein origin depends on which customers companies want to target. In that regard, nomenclature on ingredient types should be investigated by the industry to find a fitting term. This research suggests some terminology, indicating that overall 'yeast' is viewed relatively positive. The downside of using this term is that it must be scientifically correct to use it, not all mycoprotein is yeast. By educating consumers on product benefits in combination with a fitting term, consumers can associate the new category of mycoprotein with tangible benefits. Collaboration of industry with NGOs can also help build credibility, and will ensure consumers will not be deceived by a certain type of messaging.

The emphasis on convenience and routine integration from the interviews is an interesting finding, suggesting that mycoprotein can be introduced through products that are familiar to the majority of people, lifting along with the rise in convenience food. Mycoprotein could be incorporated directly as a product, because of its similar structure to chicken, or be incorporated in blended meat. This strategy is useful in evading high adoption barriers, and could aid as a starting point in making consumers familiar with the ingredient. However, this strategy should be used with caution. Especially when the food product involves technologies that consumers might be skeptical about, the risk of employing this type of strategy is that consumers feel deceived by the food industry, decreasing overall trust in the industry.

The survey results implicate that bioengineering disclosure does not directly influence willingness to try and buy mycoprotein with health benefits. However, decision-making dynamics were shown to shift when the bioengineered logo was present. This research provides the practical insight that the logo can reduce the importance of trust and health perceptions in decision-making, but further research is needed to investigate whether the disclosure increases the importance of other heuristics in decision-making.

6.6 Limitations

A limitation of the qualitative research part is the low sample size. Due to time constraints and difficulty finding willing participants, only 4 participants were interviewed. Regarding bioengineering disclosure, it should be noted that most of the experts were not specialized in consumer behavior regarding genetic modification, nor with the technology itself. This is mostly because the combination of experience in alternative protein and genetic modification is not common. Low sample size and limited knowledge regarding bioengineering could result in potential bias, not reflecting overall expert opinions and therefore limiting generalizability. Furthermore, there are some limitations regarding generalization of results to different geographical or cultural contexts. Out of 4 participants, only 1 was from the US, therefore limiting relevancy to US contexts. The negative effects of these limitations were partly mitigated by designing the quantitative research part not only on the expert interviews, but also on literature on the subject and communication strategies used by US companies. Specifically for

thematic analysis there is always a risk of researcher bias. All stages from coding, theme generation and interpretation are possibly subject to research bias, because of the interpretative nature of thematic analysis.

Participant recruitment bias is one of the limitations of the quantitative part. Pre-screeners used might limit generalizability of the results. Pre-screening based on openness to plant-based meats might have resulted in the limited spread of food neophobia in the sample, therefore lowering the chance of finding moderation effects should there have been any. Furthermore, caution should be taken when trying to generalize the findings outside the geographical context of the US. There will be some generalizability to other Western markets, but cultural backgrounds have been known to greatly influence perception and acceptance of foods (Jeong and Lee, 2021). Another screener that was used screened for participants being the main grocery shopper of the household. This is a criterium that is often applied in the context of consumer purchasing behavior or product choice (Van Hove, 2022; van Ittersum et al., 2024) and will ensure highly practically relevant results. However, generalizability might still be limited somewhat, which will influence relevance to policy applications. The amount of participants was deemed enough to perform the statistical tests, but for more generalizability and higher statistical power for tests that would benefit, like moderation analysis, a larger sample size would be beneficial. That could uncover trends that would not be significant in this small sample size.

In terms of research design, the inclusion of 4 mock-ups per participant was done to maximize the amount of data that could be obtained with 4 different claims. However, still evaluating 4 scenarios per participant could lead to participant fatigue, which could influence the results. Furthermore, no 'control' mock-up was included, excluding any claim. This was also done to maximize the data that could be obtained, by using 4 instead of 3 claims. However, in hindsight, a control would have been a large added benefit in determining significances, not just for claim type, but also for presence of claims in general. Which would have made the results somewhat more insightful for academic literature focusing on nutrition and health claims.

If sample size was larger, an additional label could have been added to some scenarios, a 'non-GMO' label for instance. These labels are widespread in the US, with also companies in the alternative protein sector (Beyond) using them (Non-GMO Project, 2022)

6.7 Management of Technology Programme Integration

This master's thesis was conducted within TU Delft's Management of Technology programme (MoT), which emphasizes technology as a corporate resource and focuses on organizational, commercial and economical aspects of innovation. The research was performed with a corporate perspective in mind, increasing its relevance to alternative protein firms, and can inform policy and add to scientific literature in the contexts of addressing food security and climate change. Research directions were partly informed by [internship provider], a mycoprotein start-up. The project embraces mycoprotein and genetic modification technologies as corporate resources, used to enhance product characteristics and offer unique value propositions to the alternative protein market. These value propositions, mainly health benefits, were explored in the context of personal consumer characteristics, also identifying possible issues in market communication. The research is rooted in academic constructs and involves methodologies taught in the MoT programme such as thematic analysis, regression analysis and descriptive statistics, to systematically answer the research question and provide insights to industry, academia, and policy.

7 Conclusion

This research aimed to understand how market communication influences customer acceptance of alternative protein that is healthy, sustainable, and genetically modified. A mixed-methods approach was employed combining expert interviews and a cross-sectional survey of 165 US consumers. To provide an answer to the main research question 'How does market communication influence customer acceptance of healthy and sustainable genetically modified alternative protein?', three sub questions were addressed regarding exploration of communication strategies, determining effects of bioengineering disclosure on willingness to try and buy, and by exploring mycoprotein nomenclature preferences.

The first subquestion was 'What communication and branding strategies have been used to market alternative protein products and how did that influence consumer behavior?'. Through thematic analysis of four expert interviews, four main communication strategies in the alternative protein sector were defined: Respecting consumer routines, evoking familiar associations, emphasizing tangible benefits and using subtle communication. These communication strategies were responses to the identified main barriers: routine rigidity, food neophobia and trust concerns regarding industry credibility. The way these strategies mitigate barriers are through guiding the decision-making process through either System I, or System II processing. Respecting consumer routines, evoking familiar associations and using subtle communications strategies all aim to guide the consumer to rely on their System I thinking. Respecting consumer routines relies on the existing habit heuristic. If nothing appears to change for the consumer, for instance in the case of blended meat, consumers will continue to rely on this habit heuristic and buy the product. The strategy of evoking familiar associations tries to 'attach' to an existing association in a consumers mind, for instance the 'mushroom root' example mentioned earlier. Subtle communication tries to prevent activation of deliberate processing, for instance on an unfamiliar ingredient, therefore preventing the raising of questions. Emphasizing tangible benefits on the other hand, might activate different systems depending on the individual. The interviews indicated a shift in benefits messaging from communal benefits, like sustainability, to tangible health benefits. This finding suggests that consumers deliberately assess if they see a benefit on the packaging whether it's of use to them, indicating System II processing. The importance of health benefits was also validated by the survey results, showing that most participants (61%) were willing to try mycoprotein because of the health benefits.

To answer the second subquestion 'How do bioengineering disclosure and nutrition/health claims influence willingness to try/buy mycoprotein products?' a mixed factorial survey was performed among 165 US consumers. Contrary to expectations, bioengineering disclosure did not significantly influence willingness to try ($p=.983$) or buy mycoprotein, and neither did claim type. However, a negative moderating effect of bioengineered logo on the influence of perceived trust ($\beta = -0.263$, $p < .01$) and perceived healthiness ($\beta = -0.173$, $p < .05$) on willingness to try mycoprotein was observed. This finding indicates that bioengineering disclosure might shift how consumers evaluate products rather than negatively influencing willingness to try. Regarding the NHCs, health claims significantly increased perceived healthiness compared to ingredient claims ($\beta = 0.067$, $p < .05$), which indirectly influenced willingness to try through perceived healthiness. However, the indirect was very low, and the total effect was non-significant. Food neophobia was expected to moderate response to bioengineering disclosure, but no significant effect was found. This while it did significantly predict willingness to try mycoprotein ($\beta = -0.220$, $p < .01$), but not willingness to buy.

The final subquestion 'What kind of associations do consumers have with familiar and unfamiliar mycoprotein nomenclature?' was answered by asking survey participants which associations came to mind with five different names for mycoprotein. Associations with different terminology varied. Out of the tested terms, 'nutritional yeast' received the highest Net Positivity Score (30), followed by 'Yeast protein' (24), 'Mycoprotein' (13), 'Mycelium' (6), and 'Yeast biomass' (1). Biomass was mostly

associated with artificial and lab-grown terms. Mycoprotein scored relatively high associations with innovativeness, but in general yeast received positive associations with health, sustainability and naturalness.

The answer to the main research question 'How does market communication influence customer acceptance of healthy and sustainable genetically modified alternative protein?' is that bioengineering labelling appears to reshape decision-making dynamics through moderation instead of through direct effects. Most communication strategies influence acceptance or buying behavior by trying to guide decision-making through System I processing, by either acting on the habit heuristic or on familiarity, or try to activate deliberate processing regarding positive health benefits. These findings contribute to research on alternative protein adoption by revealing that labeling strategies influence more than just willingness to try and buy, but can also influence what internal or external factors weigh into consumer decision-making. Therefore, it adds valuable information to the NBFDS framework in identifying influences on decision-making that might not be intended for such a standard. Furthermore, this research incorporates dual processing theory into novel food decision making.

Furthermore, findings can inform industry product development and communication strategies, mainly by emphasizing health benefits, using routine integration strategies to introduce mycoprotein in convenience food or as a blended meat ingredient. In terms of nomenclature, 'yeast' ingredient naming can be employed, should that be applicable to the type of mycoprotein.

Future research should integrate additional measures that could capture whether bioengineering logo positively moderates other heuristics. Mediation analyses should be performed linking trust and perceived healthiness with willingness to try. Larger, more representative samples and consumer research of the disclosure standard in other cultural contexts, such as the EU, would greatly add to generalizability. Furthermore, to investigate whether people observe the logo and how long they look at it eye-tracking studies can be used. By improving our understanding of how bioengineering other visual packaging cues shape consumer perceptions, this report can aid in development of communication strategies that accelerate adoption of a product that has the potential to greatly improve our perspectives on food security and climate change issues.

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Appendices

Appendix I: Interview guide

Topic 1: Current state of Business to Consumer (B2C) industry

Question 1.1

'What are the main challenges in developing and positioning alternative protein products for consumers?

Why: To see expert viewpoint on industry; To verify that (apart from typical indicators like price) investments, high competition and customer acceptance are indeed main challenges, to identify challenges I've missed in literature review.

Question 1.2

'What kind of communication strategies* are used by companies in the current alternative protein section?'

**For instance in terms of message framings (health-related, sustainability focused, ethically focused, etc.) & Product descriptors (vegetarian, vegan, plant-based)*

- ➔ **'What elements of the communication strategy do you think are important? What have you seen work and fail in the past, and why?'**
- ➔ **'How have you seen the marketing strategies of alternative protein change over time?'**

Why: To obtain details on which elements have been effective/ineffective lately and to see trends in the industry.

Question 1.3

'Do you see any emerging trends in how companies are positioning their products to different types of consumers?'

Why: To obtain open up discussion on segmentation-based marketing.

(depending on expertise) Question 1.4

'Do you see differences in alternative protein marketing in different EU countries?'

Why: To get an idea of differences between countries and what drives those differences.

Topic 2: Mycoprotein specific questions

Question 2.1

'What challenges or opportunities do you see in explaining mycoprotein to consumers?'

Context: Multiple companies have tried different ways to explain its microbial origin, but it seems difficult to find a way that appeals to customers while also being factually accurate (as shown by Quorn; Meati)

- **(depending on expertise) Why do you think a lot of consumers don't know mycoprotein?**
- **'What – according to you – will be the main reasons for consumers to either embrace or reject mycoprotein based foods?'**
- **'Are there any communication risks or misconceptions that you expect, considering that mycoprotein is not plant-based?'**
- **(depending on expertise) What kind of demographics, like age, urban/suburban, income, etc. in mind when choosing a communication strategy?**

Why: To get experts opinion on mycoprotein specific challenges.

Question 2.2
'How do you think different terms describing mycoprotein as an ingredient influence customer acceptance?'

- *Scientific terms (mycoprotein) vs more metaphorical descriptors (fermented protein, mushroom root).*
- *What have we learned from previous naming attempts used by Quorn and meati?*
- 'What kind of terms have you seen work and fail?'

Why: To get experts opinion on mycoprotein specific naming challenges.

(depending on expertise) Question 2.3
'What do you think of 'functional food' like statements, like 'lowers risk of heart disease', or 'increases focus' etc, as opposed to only mentioning nutritional characteristics like '0mg cholesterol' and 'high in fibre''

(depending on expertise) Question 2.4
'Where do you see most potential for mycoprotein, or alternative protein products in general? As a separate product meant to replace meat, as an ingredient in a partly animal-based product or as an ingredient used in other plant-based products?'

Why: Based on earlier interview; to see expert thoughts on mycoprotein applications.

Topic 3: Genetic modification questions
Question 3.1
'Do you see a role for genetic modification in helping improve the quality and acceptance of alternative protein products, for instance by improving sensory (taste, texture) and health/nutrition (fiber, vitamins, protein) aspects?'

Why: To see the expert's viewpoint on using genetically modified products; to (partly) put into perspective the answers to the next questions.

Question 3.2
'What implications, if any, do you think the use of genetic modification will have on the communication strategy used?'

1. **'What kind of messages or phrases do you think might make GM food feel more acceptable to customers?**
2. **Do you think different types of customers would respond differently to GMO messaging? Can you provide examples?**
3. **In you experience, can communication actually change people's acceptance of GM foods, or are their attitudes mostly fixed?**

Why: To get expert view on what they think is important in communication regarding the genetic modification aspect.

Question 3.3
'To what extend do you think consumers will 'care' about the genetic modification techniques if these techniques lead to significant sensory and nutritional benefits?'

Why: To get expert view on what kind of risk-benefit consideration most consumers will make.

Question 3.4

'How transparent do you think companies should be when communicating the use of genetic modification? Should they go beyond the mandatory 'bioengineered' label?

Topic 4: Food neophobia

Question 4.1

'Have you noticed whether certain customer groups are less likely to try new food products because of unfamiliar ingredients and technologies?'

Question 4.2

'Are there any communication strategies that you've seen in the alternative protein industry that helped reduce this tendency to avoid novelty?'

Appendix II: Interview invitation email

Dear [Interviewee],

My name is Marc van der Toorn, and I'm currently working on my master's thesis at Delft University of Technology (The Netherlands) on how market communication strategies can influence consumer acceptance of mycoprotein foods, in collaboration with Danish start-up company.

[Relevance of interviewee to thesis subject]. Given your extensive experience in [XXX], would you be open to speaking with me in a 45-minute interview at your convenience? Your insights would greatly contribute to understanding how market communication can aid in acceptance of novel foods produced involving gene technologies.

Would you happen to be available on [Date, Time]? If that timeframe doesn't work, I'm happy to adjust to a time that suits your schedule. I understand that your time is very valuable, so if a shorter conversation would be preferable, I'd of course be happy to adapt.

I look forward to the possibility of speaking with you.

Best,
Marc

Appendix III: Informed consent forms

Interviews

You are being invited to participate in a research study titled 'The influence of market communication on customer acceptance of alternative protein that is healthy and sustainable and genetically modified'. This study is being done by [My name] (Master student) from Delft University of Technology (The Netherlands), in collaboration with [internship provider].

The purpose of this study is to gather expert input on possible marketing communication strategies for genetically modified mycoprotein foods and get an overview of the alternative protein landscape. The interview will take a maximum of 45 minutes. The anonymized input data will be used for academic research purposes (master thesis), including to formulate hypotheses on the influence of communication strategies on consumer acceptance of genetically modified alternative proteins. Anonymous quotes (paraphrases) will be used in the thesis document, which will be openly made available at the end of the project.

For transcription purposes, this interview will be recorded. This recording will strictly be stored at TU Delft servers, according to GDPR regulations, and not be shared with any third parties, including [internship provider]. You will have the opportunity to review the full transcript of the interview before anonymization and usage in the thesis. You may request edits or removal of any part of the transcript. Given the small number of interviewees partaking in the research (N<5) additional care will be taken to minimise risk of reidentification. An anonymous technical summary of the transcript will be made from this data, omitting or generalising any personal, professional or contextual identifiers. You will also have the opportunity to review this summary. This document will then be combined with the summaries from the other interview participants for subsequent analysis. Only the final thesis, including the aggregated, anonymised insights, will be shared publicly and with [internship provider]. [internship provider] will not have access to the raw interview recording, transcript or individual summary. At the end of the project (October 2025), all recordings and transcripts will be deleted, retaining only the anonymised technical summary used in the thesis.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by (1) Generating an anonymous technical summary and only using that data for the research, (2) Storing the obtained data on secure TU Delft storage complying with the GDPR, and (3) Deleting any personally identifiable data after the research has ended.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to indicate with any question whether you want to skip answering.
I have read and understood the information stated in this document, and I consent to participate in this study and the data processing as described above.

Survey
You are being invited to participate in a marketing study regarding a novel food called *mycoprotein*.

This study is being done by food company [internship provider]. The purpose of this study is to investigate customer views on different terms describing mycoprotein, its associated benefits and its production process.

This survey will take you approximately 20 minutes to complete. We'll ask you how well products with different characteristics resonate with you and what you think is important when buying food. We will also ask you some questions regarding demographics, such as age in years, level of education, household income-range and household composition.

All survey data will be collected and owned by [internship provider], and will be used for the development of marketing strategies for a novel food product. [internship provider] will have access to all individual-level survey responses. **After aggregation and analysis**, **the individual-level survey responses will be deleted**. **No names, email addresses or other directly identifiable personal information will be collected**. A subset of the data will be anonymised and shared with Delft University of Technology (The Netherlands) for usage in academic research. This research aims to discover overall associations with food perceptions and the effect of different types of communication on food acceptance. The anonymised results of this academic research will be aggregated, and the insights will be incorporated in the thesis document which will be publicly available.

As with any online activity the risk of a breach is always possible. **To the best of our ability your answers in this study will remain confidential.** We will minimize any risks by (1) Not collecting your name/email for this research, (2) Storing the obtained data on secure company storage complying with relevant data protection regulations, and (3) Anonymising the subset of results needed by academic research, before sharing the data, therefore also ensuring all published data will be anonymous and aggregated.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions.

By selecting 'I agree', you confirm that you have read and understood the study information and consent to participate and for your data to be used as described.

Appendix IV: Ethics Approval

The letter of Ethics Approval can be found in ‘Ethics Approval.pdf’

Appendix V: Codebook

Codebook including definitions can be found in document ‘05-09-2025 – Codebook.xlsx’

Appendix VI: Product Packaging Mock-up Design Process

This appendix will provide more information about the design of the product packaging mock-up

The mock-up design part of the survey is structured as follows. First, the survey part is introduced and a description is provided on what this new type of food product is. It is important that this description is short, factual, not too scientific and not 'trying to convince'. Various definitions for mycoprotein were compared (Table 16): Eat Meati's explanation on 'Mycelium' (Eat Meati, n.d.), Quorn's explanation (Quorn, n.d.) and descriptions used in (industrial) research by GFI (Kirchner and Leet-Otley, 2024) and McKinsey (McKinsey, n.d.) resulting in the inclusion of the following part:

About Mycoprotein:

- *It is a type of food made by fermenting a naturally occurring yeast (like the one used in beer brewing and bread making).*
- *It has a texture similar to meat and can be used to make animal-free products like burger patties, nuggets and cutlets that are minimally processed.*
- *It is high in protein and fiber, low in saturated fat, and seen as a healthy and environmentally friendly alternative to meat.*

After showing consumers the mock-up and description, they were requested to take a moment to look at the full packaging before answering the questions. They were alerted that the 'Nutrition Facts' and ingredient list do not differ per scenario.

Table 16. Industry Analysis of Mycoprotein Descriptors and Benefits. Summary of research investigating mycoprotein descriptors and mentioned benefits in various organizations.

Organization	Mycoprotein descriptors; description	Mentioned benefits (front-pack)	Source
GFI	'Companies have been making meat-like products from mushrooms and fungi for decades. These ingredients are used to create products like steaks, patties, and nuggets with meat-like texture that are minimally processed. Some examples include brands like Quorn and Meati.	-	(Kirchner and Leet-Otley, 2024)
McKinsey			(McKinsey, n.d.)
Quorn	Ingredient name: Mycoprotein Quorn mycoprotein is a source of protein that is high in fiber and low in saturated fat. To make Quorn mycoprotein, we don't start with livestock, we take a natural, nutritious fungus that grows in the soil. This fungus is known as Fusarium venenatum. We then use the age-old process of fermentation – the same process used to create bread, beer and yogurt – to grow Quorn mycoprotein. And because producing Quorn mycoprotein takes 95% less CO^2, than typical ground beef1, it is a great example of a more sustainable and nutritious protein source for a growing global population.	- 'Meatless' - 9G protein - Soy free - 5g fiber	(Quorn, n.d.)

Eat Meati	Ingredient name: Mycelium (N. crassa) Meati is an animal-free, whole-cut complete protein that is as delicious as it is nourishing, and made from mushroom root. Chef-tested, Mother Nature-approved, and grown to make you feel good about the food you are choosing to eat. Now that's Good Energy™ Avoid if sensitive to fungi such as mushroom, mold or yeast 'WHAT IS MYCELIUM?: Mycelium is the amazing root-like structure of fungi. Its fiberous nature is how meati™ gets that delicious, meati-like texture.' 'Made from nutrient-rich mycelium – aka the energy source mother nature intended. Now that's Good Energy. More scientific explanation on the website	- 'Made from mushroom root' / '95% mushroom root protein' - Delicious whole-food protein made from mushroom root - 'Mycelium' - Animal-free - 17g complete protein per serving - 8g fiber per serving - Good source of fiber - 0g cholesterol - Free from gluten, soy and wheat - 'Complete protein that includes all nine essential amino acids' - 'Fiber 25% DV. This helps you feel full longer and supports healthy digestion' - B9/folate 100% DV. Folate supports healthy energy production and helps keep your cells in top shape - Zinc 40% DV: a mineral important for immune function and metabolic support	(Vegan Supply, n.d.) (Eat Meati, n.d.)
Beyond Meat	-	- Labels: Clean label project, American diabetes association, non gmo project, american heart association - Avocado oil - 75% less saturated fat - 21g of protein per serving	(Beyond Meat, n.d.)
Impossible meat	-	- 19g protein - 0mg cholesterol - 33% less saturated fat - No animal antibiotics - Nutrient-rich - Good source of vitamins & minerals - No cholesterol	(Impossible Foods, n.d.)

The mock-ups used in this research are meant to contain most aspects present on packaging in the supermarket, with the exception of bright colors and branding elements. See Figure 14 for an example. All mock-ups contain:

- **Product name (Generic descriptive name 'Cutlets')**
- **Nutrition/health claim.** Chosen based on (1) Possible claim types (**Fout! Verwijzingsbron niet gevonden.**), (2) Comparison between benefits currently communicated by companies in the alternative protein landscape (Beyond, Impossible, Morningstar Farms, Quorn, Eat Meati), (3) Input from the expert interviews on future trends.
- **Product image: An appetizing picture of the product.**
- **The term 'Animal-free'.** Since the product is not plant-based, another term had to be used. This term was chosen because of its use by another brand (Vegan Supply, n.d.), combined with research from the precision fermentation sector indicating it could be a good term to name products that are neither animal nor plant-based (GFI, 2025b).
- **US Nutrition Facts label**. To make the choice feel more realistic; nutrition facts are realistic for a mycoprotein product.
- **Ingredient list**. To make the choice feel more realistic.
- Depending on survey version: **the bioengineered logo**. This logo was used, as research by Caputo et al. (2025) showed that it is the preferred way of GM disclosure by the average consumer. The black-and-white logo was chosen instead of the colorful one to maintain the 'neutral' aesthetic, and because a colorful logo might (positively) impact perceptions.

After showing the mock-up, participants had to answer a question on 'What elements do you see on the packaging?'. This question was originally included to ensure participants looked at all the elements of the front and back packaging, but it could also be used to screen for poor quality submissions (for instance if a participants gives inconsistent answers to this question in the 4 different scenarios). An alternative option would have been to highlight the health claim and the bioengineered label, but that could have created bias.

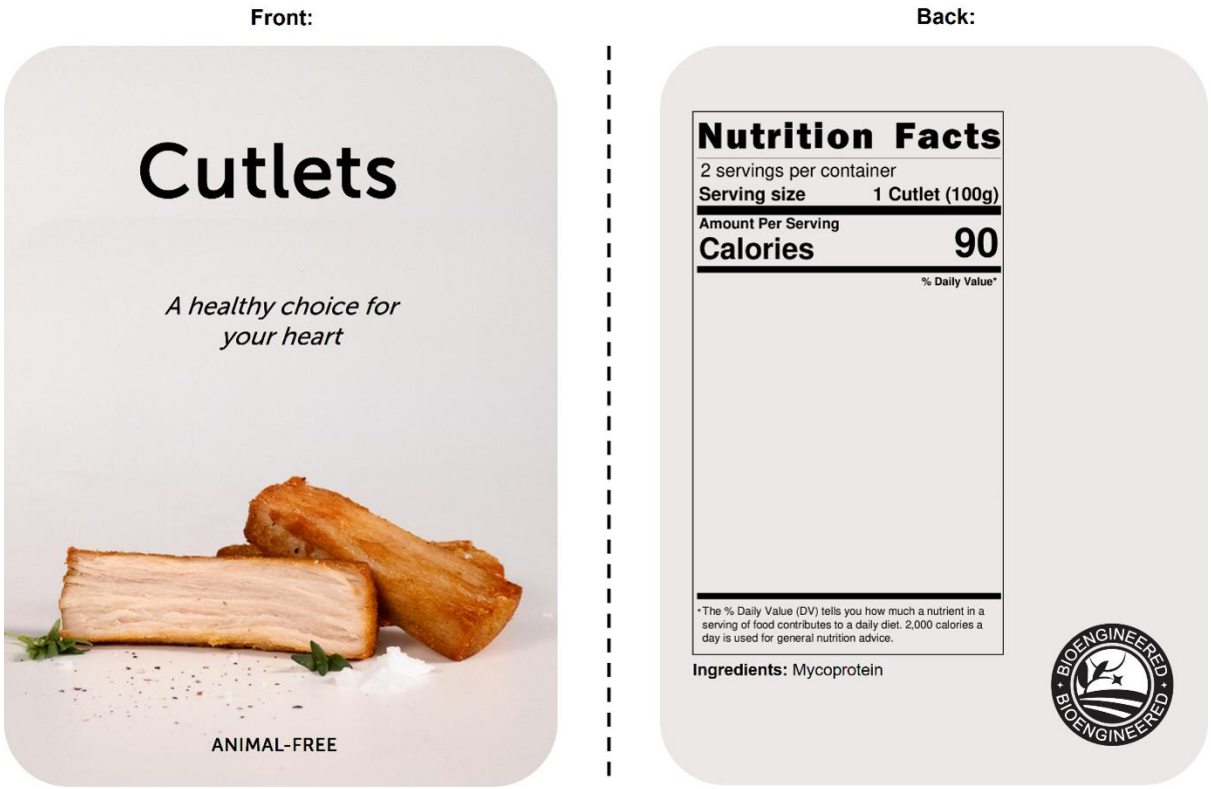

Figure 14: Product Packaging Mock-Up Design Example. Example product packaging scenario, containing the claims ('A healthy choice for your heart') and the bioengineered logo (lower right), besides showing a picture of the product, the term 'Animal-free', Nutrition facts (Food and Drug Administration style) and the ingredient list were added.

Appendix VII: Survey questions

Survey questions can be found in document ‘Survey V1.8.pdf’

Appendix VIII: Adaption of food-related lifestyle instrument

As mentioned in the methodology section, the food-related lifestyle by (Brunsø et al., 2021; Grunert et al., 1997) was adapted to alternative protein context. To this end, a selective set of questions was chosen from the instrument (Table 17). Specifically the dimensions of 'Importance of product info' was included unaltered, much like dimensions of 'Price-quality criterion', 'Interest in Cooking' and 'Taste'. Additionally, selective questions on 'Price Criteria', 'Convenience' and 'Cultural/social' were included. The health dimension was included, with slight changes in wording (including more American terms like 'processed foods'). An additional health dimension was added, with several questions originating from the GFI segmentation report (Kirchner and Leet-Otley, 2025a).

*Table 17: Adapted Food-related Lifestyle Instrument Items. Partly modified survey items from the original FRL instrument (Brunsø et al., 2021; Grunert et al., 1997). *GFI = Good Food Institute segmentation summary (Kirchner and Leet-Otley, 2025a).*

Original number	Original cat	Question # in survey	**Importance of product info (Shopping scripts; unaltered) (SC1)**
V1	SC1	1	To me product information is of high importance. I need to know what the product contains.
V11	SC1	20	I compare product information labels to decide which brand to buy.
V29	SC1	8	I compare labels to select the most nutritious food.
			Price criteria (SC5)
V28 (price criteria)	SC5	4	I look for ads in the newspaper for store specials and plan to take advantage of them when I go shopping.
			Price-quality criterion (Higher order product attributes; unaltered) (APA2)
V13	APA2	15	I compare prices between product variants in order to get the best value for money.
V64	APA2	7	I always try to get the best quality for the best price.
V7	APA2	13	It is important for me to know that I get quality for all my money.
			Interest in cooking (Unaltered) (CS1)
V18 (rev)	CS1	2	I do not like spending too much time on cooking.
V43	CS1	9	I like to have ample time in the kitchen (for cooking/preparing meals).
V62	CS1	17	Cooking is a task that is best over and done with.
			Convenience (CS3)
V14	CS3	11	We use a lot of ready-to-eat foods in our household.
V52	CS3	6	Frozen food accounts for a large part of the food products I use in our household.
GFI	SC6	3	When grocery shopping, I only buy things on my list (SC6)
			Cultural / social
V63 (self-fulfillment in food)	CO1	14	Eating is to me a matter of touching, smelling, tasting and seeing, all the senses are involved. It is a very exciting sensation. (CO1)
V17 (social relationships)	CO3	5	I find that dining with friends is an important part of my social life. (CO3)
V38 (social relationships)	CO3	16	Over a meal one may have a lovely chat. (CO3)
K6 (Social event)	US2	10	We often get together with friends to enjoy an easy-to-cook, casual dinner. (US2)
			Taste (APA5)
Q13 (variation of V5)	APA5	12	Enjoying the taste of food products is important to me when I am eating.
Q14	APA5	19	It is important to me to be able to eat delicious food on weekdays as well as weekends.

Q15	APA5	18	I enjoy a good meal.
			Health (Higher order product attributes; slightly altered (1,2), Q10 added (instead of under category organic products) (APA1/4)
V35	APA1	1	To me the naturalness of the food that I buy is an important quality.
V49 (adapted)	APA1	6	I try to avoid processed foods
V56 (adapted)	APA1	8	I prefer to buy natural products, i.e. products without artificial ingredients.
V9 (organic products)	APA4	4	I make a point of using natural or ecological (*changed to organic)* food products.
			Additional health questions
V50 (Taste)	APA5	2	It is more important to choose food products for their nutritional value rather than for their taste
GFI		5	I eat high-protein foods to help build or maintain muscle
GFI		3	I read nutrition labels to track fat, salt, or additives
GFI		7	I exercise regularly to stay fit

Appendix IX: Statistical analysis script

Statistical analysis script can be found in document 'MoT Thesis Marc.Rmd'

Appendix X: Dispositional and Situational Variables Plots

Figure 15: Spread of Dispositional and Situational Variables. Frequency distribution plots showing spread and (lack of) normality patterns for key variables.

Appendix XI: Full correlation table between key constructs

Table 18: Complete Correlation Matrix for All Study Variables. Full correlation table between all dispositional and situational variables, including food-related lifestyle dimensions (N= 165).

Variable	M	SD	1	2	3	4	5	6	7	8a	8b	8c	8d	8e	8f	8g	8h
1. Food Neophobia	2.08	0.60	—														
2. Attitude towards genetic modification	2.89	0.66	−.16* [−.31, −.01]	—													
3. Nutrition Knowledge	67.55	20.88	−.19* [−.33, −.04]	.11 [−.04, .26]	—												
4. Trust (product, process, claim)	3.62	0.85	−.12 [−.28, .03]	.48** [.34, .59]	−.04 [−.20, .12]	—											
5. Artificialness	2.96	1.05	.07 [−.08, .23]	.24** [.09, .38]	−.03 [−.19, .12]	.49** [.36, .61]	—										
6. Perceived healthiness	3.88	0.82	−.08 [−.23, .07]	.37** [.23, .50]	.04 [−.12, .19]	.83** [.77, .87]	.47** [.34, .59]	—									
7. Product intentions (WTT + WTB)	3.59	0.92	−.18* [−.33, −.03]	.33** [.19, .46]	−.01 [−.16, .15]	.78** [.70, .83]	.44** [.30, .56]	.73** [.65, .79]	—								
8. Food-Related Lifestyle																	
a. Product Information	4.13	0.61	−.04 [−.19, .11]	−.13 [−.28, .03]	−.01 [−.16, .15]	.14 [−.01, .29]	.10 [−.06, .25]	.15 [−.00, .30]	.17* [.02, .32]	—							
b. Price-quality criterion	4.25	0.52	−.15 [−.29, .00]	−.05 [−.20, .11]	.05 [−.11, .20]	.17* [.02, .32]	.09 [−.07, .24]	.14 [−.02, .29]	.14 [−.02, .28]	.62** [.52, .71]	—						
c. Interest in cooking	2.29	0.84	.34** [.20, .47]	.03 [−.12, .19]	−.08 [−.23, .07]	−.03 [−.18, .13]	.04 [−.12, .20]	−.01 [−.17, .14]	−.16* [−.30, .00]	−.18* [−.32, .02]	−.16* [−.30, .00]	—					
d. Convenience	2.75	0.94	.18* [.03, .32]	.05 [−.10, .21]	−.14 [−.29, .01]	.10 [−.05, .25]	.10 [−.05, .26]	.09 [−.07, .24]	.03 [−.12, .19]	−.07 [−.22, .08]	−.02 [−.18, .13]	.20** [.05,.35]					
e. Social and Cultural influence	3.84	0.68	−.30** [−.44, −.16]	−.12 [−.27, .04]	−.06 [−.21, .09]	.21** [.06, .36]	−.04 [−.20, .11]	.18* [.02, .32]	.26** [.11, .39]	.45** [.32, .56]	.43** [.29, .54]	-.35** [-.48,-.21]	.01 [-.15,.16]				
f. Taste	4.52	0.47	−.32** [−.45, −.17]	−.04 [−.19, .11]	.04 [−.11, .19]	.14 [−.02, .29]	.03 [−.12, .19]	.12 [−.03, .27]	.16* [.00, .30]	.37** [.24, .50]	.52** [.39, .62]	-.29** [-.42,-.14]	-.06 [-.21,.10]	.49** [.36,.60]			
g. Health1	3.99	0.61	−.15 [−.29, .01]	−.27** [−.41, −.12]	.03 [−.13, .18]	−.01 [−.17, .15]	.04 [−.12, .20]	.03 [−.13, .18]	.11 [−.04, .26]	.59** [.49, .68]	.42** [.29, .54]	-.32** [-.46,-.18]	-.22** [-.36,-.06]	.49** [.36,.60]	.38** [.24,.51]		
h. Health2	3.96	0.81	−.14 [−.29, .01]	−.08 [−.23, .07]	−.04 [−.19, .11]	.18* [.02, .33]	−.05 [−.20, .11]	.11 [−.05, .25]	.05 [−.10, .21]	.43** [.30, .55]	.41** [.28, .53]	-.17* [-.32,-.02]	.06 [-.10,.21]	.47** [.34,.58]	.19* [.04,.34]	.43** [.30,.55]	—