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Consumer attitudes and beliefs towards plant-based food in different degrees of processing – The case of Sweden

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ABSTRACT

The aim of this study was to gain an understanding of consumer attitudes and beliefs on three different types of plant-based meat alternatives (covering two highly processed Plant Based Meat Alternatives (PBMA) products: a. vegetarian nuggets and b. soy mince, and pulses: c. pre-cooked beans). The analysis was based on data obtained from a questionnaire-based survey (N = 483) conducted in Sweden in November 2020. Consumers were separated into four food preference groups (all of whom consume meat): 1. flexitarians (meat reducers), 2. omnivores (mixed diet), 3. consumers who prefer meat and fish (avoid vegetarian food) and 4. consumers who explicitly prefer to only eat meat (avoid vegetarian food and fish). Products were chosen with the intention that they represent products from a scale ranging from a less processed product (pre-cooked beans), via soy mince (a processed PBMA product) to vegetarian nuggets (ready-to eat processed PBMA). The two PBMA products were also chosen to represent one convenience product (vegetarian nuggets) and one product mainly used as an ingredient (soy mince). Gender, age, education, consumption frequencies, food neophobia, health concern, ranking of qualities, awareness of climate change, and the link between food and climate were explored. The results illustrate differences and similarities between the four groups in attitudes and beliefs as well as the three products. Flexitarians represent the group that expresses the most positive and sustainably connected attitudes and beliefs. Results also show that for all groups, PBMA products are perceived as more modern, artificial and expensive compared to pulses, which, in turn, are perceived as healthier and a better climate choice compared to PBMA products. Meat and "meat and fish" eaters attach much importance to taste, perceived protein content, satiety and domestic origin (from Sweden), whereas omnivores are guided by taste, ease of cooking, health, climate change, and the link between food and climate. The outcome is expected to support policymakers and market actors in developing target group applied strategies addressing differences among the four food preference groups, thereby increasing consumers' intake of sustainable plant-based protein-rich products.

1. Introduction

There is scientific consensus that a diet rich in plant-based products is better for the climate (Aiking, 2014; Springmann et al., 2018; Willett et al., 2019), reduces the risk of certain diseases and supports a healthier lifestyle (Ekmekcioglu et al., 2018; Westhoek et al., 2014). An increase in consumption of plant-based protein, replacing meat, is thus seen as an important step in an urgent transition towards a more sustainable diet (de Boer & Aiking, 2019; Godfray et al., 2018; Graça et al., 2019; Willett et al., 2019). However, despite the identified necessity and urgency, the adoption rate still needs to increase. As Dagevos (2021) illustrates, the adoption process of replacing meat with plant-based protein is often gradual, which highlights the importance of studying different food preference groups at different stages of adoption. To the individual consumer, a strategy of taking gradual steps may also be perceived as less demanding as well as reasonable and encouraging (Dagevos, 2021; Lacroix & Gifford, 2020). Eckl et al. (2021) also emphasise the relevance of studying different consumer segments in order to identify distinctions and support in framing information campaigns in line with motivations within different consumer groups (Cliceri et al., 2018). As stated by Michel et al. (2021a) and de Boer et al. (2017), it is thus of high relevance to continue to adopt a research focus that covers potential future

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consumers (e.g. consumers who currently consume and even prefer to eat meat). An argument that builds on the identified great potential in how consumption changes within such consumer groups may lead to a substantial reduction in overall meat consumption. To sum up, by exploring different food preference groups, we aim to identify drivers and inhibitors among different consumer groups, which are expected to assist in developing more target group adapted strategies supporting the adoption of non-meat protein sources. Hence, within this study, we explore drivers and inhibitors of the Swedish consumer to reduce their meat consumption, separated into four food preference groups: 1. flexitarians (meat reducers), 2. omnivores (mixed diet), 3. consumers who prefer meat and fish (avoid vegetarian food) and 4. consumers who explicitly prefer to only eat meat (avoid vegetarian food and fish).

Findings by Cliceri et al. (2018) highlight the importance of developing plant-based food that is perceived as positively hedonic as animal-based food, suggesting that studies should focus on both sensory properties and consumer food consciousness. Looking at drivers and barriers among the four different food preference groups, Eckl et al. (2021) state that the main drivers (among omnivores and flexitarians) for replacing meat with non-meat protein sources were linked to gender (women consuming more compared to men) (Deliens et al., 2021; Wozniak et al., 2020), information on health and the environment, and non-meat protein sources being connected to a lower price. Identified barriers among these two groups were also found to be linked to food neophobia (Eckl et al., 2021, Pliner & Hobden, 1992; Pliner & Salvy, 2006), a bond with meat, and a perceived social limitation in eating Plant Based Meat Alternatives (PBMA) (Eckl et al., 2021). However, it should be emphasized that there are also differences within groups, such as flexitarians, in how much meat individuals consume (Dagevos, 2021; Verain et al., 2022). Turning to studies exploring consumers who prefer meat, findings continue to report a gender gap, with the consumer group that prefers meat being dominated by men (Keller & Siegrist, 2015; Lemken et al., 2019; Love & Sulikowski, 2018; Rosenfeld & Tomiyama, 2021), often with a lower level of education (Van Bussel et al., 2020). In addition to this explored resistance, key barriers and patterns of consumer (non-) acceptance of meat replacements and reported identified explanatory factors, are connected to unfamiliarity, lower sensory attractiveness of substitutes compared with meat, as well as unawareness of the environmental and health consequences (Cheah et al., 2020; Hartmann & Siegrist, 2017; Sanchez-Sabate & Sabaté, 2019; Stoll-Kleemann & Schmidt, 2017).

When looking at the Swedish market, it can be stated that there has been changes in Swedish consumerś consumption of both meat and plant-based protein. The Swedish meat consumption has decreased from 88.4 kg per capita (2016) to 78.6 kg per capita (2020) (Swedish Board of Agriculture, 2022), and consumer demand in PBMA has increased (National Board of Trade, 2020). Consequently, the Swedish vegetarian assortment is growing, both in terms of sales and choices. In a study by Sifo/Axfood (2022), it is explained that the proportion of Swedes who eat vegetarian meals 2–6 days a week has increased from 19 to 30% in recent years, and that the proportion of consumers who never eat vegetarian meals has decreased from 21 to 12%. It is further stated that the trend among consumers is not to change to a completely vegetarian diet, but to gradually increase the proportion of vegetarian food in their diet. According to Collier et al. (2021), the main barriers to meat substitutes among Swedish consumers relate to scepticism about the necessity for reducing meat intake, sensory qualities, lack of necessary cooking skills, greater familiarity and pleasurable aspects of eating meat, health concerns and finally, a desire to remain in control of the actual food choice. Main drivers that have been suggested are linked to concern for the climate and environment, in combination with an increased interest in the labelling regarding origin and products produced from Swedish raw materials (Sifo/Axfood, 2022). Several studies also highlight that environmental and health arguments have been identified as the main drivers for consumers buying plant-based, protein-rich products (Hartmann & Siegrist, 2017; He et al., 2020; Onwezen et al., 2021).

Among consumers, however, there is not only a variation in the adoption of plant-based protein but also in the consumption of different types of products. In this study, we include 1. “Plant Based Meat Alternatives” (PBMA), i.e. products that are made from processed plant-based ingredients, such as legume protein isolates, composed with the aim of resembling meat in sensory qualities and experience, such as taste, appearance and texture (Estell et al., 2021) and 2. pulses (e.g. unprocessed or pre-cooked beans and peas). Due to the minimal processing and resource use, pulses represent the product category with the greatest gain in environmental sustainability (Van der Weele et al., 2019). PBMA, on the other hand, are produced by using highly purified and processed ingredients, which has been suggested to lead to more uncertain sustainability gains (Alexander et al., 2017). Studies have also shown that PBMA food products not necessarily lead to better health due to high amounts of e.g. salt, sugar, unsaturated fats and low levels of dietary fibres (Gehring et al., 2021; Satija et al., 2017). Van der Weele et al. (2019) also explain how consumption of beans is presently hampered by numerous factors, such as a long-term decline and neglect of use within the western cuisine, which has led to the product category being associated with poverty and being out of date. These associations and prerequisites are in stark contrast to the more technology intensive PBMA, presently gaining momentum through media attention and interest from entrepreneurs and actors with financial power and investment initiatives (Blease, 2015; Smith, 2017; Van der Weele et al., 2019). Taken together Van der Weele et al. (2019) explain how these identified factors have led to a situation where the most sustainable alternative is neglected in several areas (attention, money, human resources and scientific capacity), whereas PBMA are gaining increased interest even though these products are often technologically challenging with a lower sustainability potential. Based on these sustainability arguments, Van der Weele et al. (2019) and Bohrer (2019) point out the importance of exploring consumer acceptance among different consumer groups towards non-meat protein sources representing different processing levels.

Achieving a transition to a more sustainable plant-based food intake requires a strategy that addresses the fact that there are differences in driving forces and barriers among different consumer groups and that they may vary depending on different types of products. The aim of this study was to gain an understanding of attitudes and beliefs on three different types of plant-based meat alternatives (covering two highly processed PBMA products (a. vegetarian nuggets and b. soy mince) and pulses (c. pre-cooked beans)) among four food preference groups: 1. flexitarians (meat reducers), 2. omnivores (mixed diet), 3. consumers who prefer meat and fish (avoid vegetarian food) and 4. consumers who explicitly prefer to only eat meat (avoid vegetarian food and fish). The chosen products represent products on a scale ranging from a less processed product (pre-cooked beans), via soy mince (a processed PBMA product) to vegetarian nuggets (ready-to eat processed PBMA). The two PBMA products were also chosen to represent one convenience product (vegetarian nuggets) and one product mainly used as an ingredient (soy mince). The influence of several factors were explored to ascertain if consumption of different categories of plant-based products among these four food preference groups can be explained by socio-demographic factors, food neophobia, health concern, and/or awareness of climate change as well as the link between food and climate change.

In order to answer the aim, four research questions were formulated:

RQ1. How do the four food preference groups differ with regard to age, gender, education and consumption frequencies of pulses and PBMA?

RQ2. How do attitudes and beliefs towards pulses and PBMA differ among the four food preference groups?

RQ3. What is the impact of food neophobia, health concern, climate change, and link between food and climate on consumption frequencies of beans and PBMA among the four food preference groups?

RQ4. What qualities do the food preference groups rank as important or less important when buying a plant-based food product?

To our knowledge, this is the first study quantitatively exploring plant-based protein adoption among these four food preference groups in a Swedish context. We also believe that the focus on different degrees of processing adds to the scientific knowledge in identifying differences among consumer food preference groups towards pulses and PBMA. The outcome of the study is expected to support policymakers and market actors in developing target group applied strategies in line with conditions and preferences that apply to the four different food preference groups. The goal is to support consumers in their transition towards a more sustainable plant-based protein intake and less meat-rich diets.

2. Methods

2.1. Survey participants

Data were collected during November 2020 in Sweden by using a questionnaire in Swedish (consumer panel, provided by PFM Research in Sweden AB), which was completed online. Measures were taken to ensure equal representation of gender and age categories. Implementation of the survey followed the Swedish University of Agricultural Sciences policy for processing personal data (https://www.slu.se/en/about-slu/contact-slu/personal-data/). The data were coded prior to delivery, ensuring anonymity. The general international code and guidelines on market and social research used by the International Chamber of Commerce (ICC/ESOMAR, 2016) were followed.

Consumption of meat was set as the inclusion criterion for respondents (self-estimated food preference), meaning that vegetarians and vegans were excluded from the survey. This delimitation is in line with the aim of the study, specifically, the intention to study food preference groups where there is a potential to increase consumption of plant-based protein. Participants were requested to indicate which food preference description best described their diet. To ensure that participants understood the terms, each was defined with a short sentence and/or examples: (i) I prefer to only eat meals that contain meat, and I avoid vegetarian food; (ii) I eat a mixed diet with meat and fish, and I avoid vegetarian food; (iii) I eat an omnivorous diet with meat, fish and vegetarian food; and (iv) I am flexitarian (I eat a lot of vegetarian food, but also meat, fish and eggs a few times a week). The following food preferences were excluded: a) Vegetarian (I am a vegetarian), b) Vegan (I am a vegan) and finally c) Other.

In total, 483 complete participant datasets were registered and used for the analysis. Due to the low number of participants in the gender category 'Other' (N = 1), results are only presented for men and women. The analysis was based on participants who met the inclusion criterion (i.e. consumption of meat) and completed all measures included in the questionnaire. Demographics (gender, age and level of education) and food preferences are presented in Table 1. The participants ranged in age from 19 to 89 years, with a mean age of 51 years (SD = 17.33). Comparing the study sample with the Swedish population at large (SCB, 2021), gender ratio was in line with the general trend, but age and education level deviated somewhat. The older participant groups were slightly larger and there was a higher proportion of university graduates than in the general population. Among the participants, 6% described themselves as primarily being meat eaters and avoiding vegetarian food, 14% ate a mixed diet of "meat and fish" but avoided vegetarian food, 68% described themselves as omnivores, and 12% as flexitarians.

Table 1
Demographic characteristics of the study sample (N = 483) in relation to the Swedish population.

	Study sample N	%	Swedish population[a] %
Gender			
Men	228	47	50
Women	255	53	50
Age group			
18–24 years	20	4	8
25–34 years	100	21	14
35–49 years	109	23	19
50–64 years	107	22	18
65 and older	147	30	20
Education			
Elementary school	18	4	11
High school	196	40	45
University	269	56	44
Food preferences			
Meat eater (avoid veg.)	29	6	
Meat and fish (avoid veg.)	66	14	
Omnivore (mixed diet)	331	68	
Flexitarian	57	12	

[a] SCB (2021).

2.2. Consumption frequencies of plant based meat alternatives (PBMA) and pulses

To estimate consumption frequencies of different plant-based protein rich food products, two different product categories were chosen. The first one "Plant Based Meat Alternatives" (PBMA) follows the definition put forward by Estell et al. (2021) who state that these products are made from processed plant-based ingredients, such as legume protein isolates, composed with the aim of resembling meat in sensory qualities and experience, such as taste, appearance and texture. The second one includes unprocessed pulses (e.g. beans and peas) that may be dried or pre-cooked, but have otherwise not undergone any other type of additional process technology prior to sale to consumer. The choice of products was made with the intention of studying consumption of products representing different levels of processing: one product group that is produced using new and energy intensive technology (PBMA) and one that is not (pulses). Intake of the two different categories was measured through the question: If you think back on the last 12 months, how often have you eaten …? The protein categories were described as: 1) Vegetarian plant-based meat alternatives (e.g. vegetarian nuggets, vegetarian sausages and burgers, vegetarian cold cuts, falafel, vegetarian minced meat, tempeh, tofu) and 2) Vegetarian protein-rich commodities (e.g. dry or pre-cooked beans and lentils, frozen soybeans, frozen chickpeas). Responses were assessed on a 6-point scale, from rarely or never to several times a day. Reported consumption frequencies were coded in line with the approach used by Michel et al. (2021a), Dohle et al. (2014) and Hagmann et al. (2019) and presented as a combined score to represent the individual number of portions of PBMA and pulses and beans consumed per week. Thus, "several times per day" was coded as 14 times per week, "daily" was coded as 7 times per week, "4–6 times per week" was coded as 5 times per week, "1–3 times per week" was coded as 2 times per week, "1–3 times per month" was coded as 0.5 times per week, and "seldom or never" was coded as 0.

2.3. Measures

2.3.1. Beliefs and attitudes towards three plant-based protein-rich products

Once respondents had answered questions covering demographics, food preferences and protein intake, they were asked questions relating to three plant-based, protein-rich food products. Products studied were either defined as PBMA (a. vegetarian nuggets and b. soy mince) or pulses (c. pre-cooked beans in cardboard packaging).

To explore and understand differences in beliefs and attitudes towards the three products, connotative meaning was assessed using a semantic differential test (Funk et al., 2020; Hartmann et al., 2018; Michel et al., 2021a; Osgood, 1952). Twenty-two adjectives were presented as 11 bipolar pairs: Festive | Everyday, Traditional | Modern, Easy to cook | Hard to cook, Healthy | Unhealthy, Good for the climate | Bad for the climate, Masculine | Feminine, Low price | Expensive, Not

tasty | Tasty, High in protein | Low in protein, Artificial | Natural, and Saturating (i.e. filling) | Not saturating. The pairs were explored on a sliding scale from 0 to 100, following the outline in Michel et al. (2021a).

2.3.2. Ranking of quality characteristics

Respondents were asked to rank nine quality characteristics in relation to vegetarian nuggets. The question was phrased: "Imagine a situation where you are buying vegetarian nuggets, then which of the following is important to you …?": good climate choice, free from additives, from Sweden, organic, frozen, fresh, good for my health, taste, texture. The characteristics were ranked from 9 = most important to 1 = least important. Vegetarian nuggets were deemed interesting to explore since the product is marketed by several companies, represents a convenience product and has an established place in the Swedish market.

2.3.3. Attitudes regarding the association between health and food

Participants' attitudes towards health and food were measured using a General Health Interest (GHI) scale, a subscale of the 'Health and Taste Attitudes Questionnaire', developed by Roininen et al. (1999). The scale included eight items, which were rated from strongly disagree (1) to strongly agree (5). The items were: (i) The fact that the food is healthy is not decisive for my food choices; (ii) I am very careful that the food I eat is healthy; (iii) I eat what I like, and I do not worry much about how healthy the food is; (iv) It is important to me that the food I eat is low in fat; (v) I always follow a healthy and balanced diet; (vi) It is important to me that my daily diet contains a lot of vitamins and minerals; (vii) Whether snacks are healthy or not does not matter much to me; and (viii) I do not avoid any type of food, not even when it can raise my LDL cholesterol level. The GHI scale was combined with two items from the Food Choice Questionnaire (Steptoe et al., 1995), which were related to specific health benefits of protein-rich products: (i) It is important to me that the food I eat on a typical day is high in protein and (ii) It is important to me that the food I eat on a typical day keeps me healthy. This combination of scales followed the approach used in Fenko et al. (2015). Prior to calculating total scale scores, negatively worded items were reversed, and the Cronbach alpha coefficients for GHI scale (0.796) were calculated.

2.3.4. Food neophobia

Food neophobia was measured using the food neophobia scale, developed by Pliner and Hobden (1992). Eight items were included and rated from strongly disagree (1) to strongly agree (5). The items were: (i) I am constantly trying new and different foods; (ii) I am sceptical of new types of food; (iii) If I do not know what is in a food, I will not eat it; (iv) I like food from different countries; (v) At a dinner party, I like to try new food; (vi) I am afraid of eating things I have never eaten before; (vii) I am very picky about what food I eat; and (viii) I eat almost anything. Two items were de-selected (Ethnic food looks weird to eat, I like to try new ethnic restaurants) as they were not considered relevant in a Swedish context. This was mainly because a large part of Swedish restaurants have a menu that is not traditionally Swedish, but often have an international character, and it was considered that the questions could confuse more than lead to clarifications. Negatively worded items were reversed, and the Cronbach alpha coefficients for food neophobia were calculated (0.778).

2.3.5. Personal conviction about ongoing climate change and the link to food production

To measure personal conviction about ongoing climate change, two questions were included and rated from 1 = not at all convinced to 4 = totally convinced: Question (i) "How convinced are you that global warming (climate change) is taking place?" was in line with the implementation in Zaval et al. (2014) and initially developed by Leiserowitz et al. (2008). Question (ii) "How convinced are you that it is better for the climate if you reduce your meat consumption and eat more vegetarian food?" was applied to measure the perceived link between food choice and climate change, as implemented in Milford and Kildal (2019) in combination with Leiserowitz et al. (2008).

2.4. Statistical analysis

All statistical analyses were conducted using IBM (SPSS, ver. 26). Calculations done to answer RQ1 include calculations of descriptive data (age, gender, education) and a two-way ANOVA for analysing food consumption frequencies (including post-hoc comparisons using the Bonferroni test for mean scores). The result for RQ2 is based on a split-plot ANOVA and calculations of mean values with 95% confidence intervals in SPSS. To explore if differences were significant between the four food preference groups and the 11 adjective pairs, a one-way ANOVA was conducted. RQ3 was analysed by standard multiple regression analysed for PBMA and pulses separately. For RQ4, mean values were calculated in SPSS.

3. Results

3.1. The four food preference groups differ in demographics and consumption

The results in Table 2 illustrate that male participants dominated the group defining themselves as primarily meat eaters (avoiding vegetarian food). This group was also the youngest, with a mean age of 42 years, and had the lowest proportion of members with a university degree (35%). The "meat and fish" group shows approximately the same distribution as the meat preference group. However, the participants were about 10 years older and constituted a larger proportion (11%) that had elementary school as their highest education. Omnivores were more evenly distributed between men and women, and they reported a higher proportion with a university degree compared with "meat" and "meat and fish" eaters (58%). The flexitarian group was characterised by female dominance, with a mean age of 45 (almost as young as the meat eaters) and the highest proportion of participants with a university degree (72%).

To explore whether consumption frequencies of pulses and PBMA differ between the four food preference groups, a two-way ANOVA was conducted: PBMA; $F(3, 479) = 35.03$, $p = .00$ and pulses; $F(3, 479) = 19.09$, $p = .00$. Table 3 shows the number (mean and standard deviation) of self-reported portions of PBMA and pulses consumed by each food preference group (number of portions per week). The number of meals containing PBMA and pulses differed significantly between flexitarians and the other three food preference groups; however, no significant differences were identified between the omnivores, meat or "meat and

Table 2
Description of participants, gender, age and education level, divided by the four food preference groups.

Characteristics		Meat eater (avoid veg.) (N = 29)	Meat and fish (avoid veg.) (N = 66)	Omnivore (mixed diet) (N = 331)	Flexitarian (N = 57)
Gender	Men	21 (72%)	45 (68%)	144 (44%)	16 (28%)
	Women	8 (28%)	21 (32%)	187 (56%)	41 (72%)
Mean age	Years	42	53	52	45
Education	Elementary school	1 (3%)	7 (11%)	10 (3%)	–
	High school	18 (62%)	34 (51%)	128 (39%)	16 (28%)
	University	10 (35%)	25 (38%)	193 (58%)	41 (72%)

Table 3
Number of weekly portions of Plant Based Meat Alternatives (PBMA) and pulses consumed in total (overall mean) and divided by the four food preference groups.

Number of portions per week	Total (M ± SD)	Meat eater (M ± SD)	Meat and fish (M ± SD)	Omnivores (M ± SD)	Flexitarians (M ± SD)
PBMA	0.96 ± 1.63	0.85 ± 2.73[a]	0.31±.83[a]	0.78 ± 1.22[a]	2.80 ± 2.34[b]
Pulses	1.16 ± 1.63	1.05 ± 2.30[a]	0.45 ± 1.14[a]	1.09 ± 1.46[a]	2.50 ± 1.98[b]

Note: "several times per day" was coded as 14 times per week, "daily" was coded as 7 times per week, "4–6 times per week" was coded as 5 times per week, "1–3 times per week" was coded as 2 times per week, "1–3 times per month" was coded as 0.5 times per week, and "seldom or never" was coded as 0.

[a,b,] =significantly different from each other at 0.05 level Bonferroni (no. of portions, separated by food preferences).

fish" food preference groups (Table 3).

3.2. Attitudes and beliefs towards PBMA and pulses differs among the four food preference groups

To explore differences in attitudes and beliefs semantic differentials (mean values with 95% confidence intervals) were calculated for the three products (vegetarian nuggets, soy mince and beans) in line with calculations performed by Michel et al. (2021a); the results are presented in Figs. 1–3. The separation of the analysis was deemed relevant since the two PBMA products are not interchangeable (vegetarian nuggets, a convenience product, whereas soy mince mainly is used as an ingredient). To identify significant differences between the four food preference groups and the 11 adjective pairs, a one-way ANOVA was conducted (for calculations, see Appendix 1). Significant differences for each product are reported in text below.

The result illustrating attitudes towards vegetarian nuggets shows that there are three bipolar pairs that show significant differences between the four groups: cooking, taste and satiety (see Appendix 1). For cooking, the flexitarians are the group that find it easiest, followed by omnivores and "meat and fish" and finally, meat eaters. Regarding taste, the meat and "meat and fish" eaters perceived the product to be less tasty compared to the other two groups. The same pattern was identified for satiety, with meat and "meat and fish" eaters judging it as less saturating and flexitarians ranking it highest among the four groups, followed by omnivores. All groups perceived the product to be more everyday than festive, as well as more modern than traditional and finally, more artificial than natural. Regarding health, protein content and cost the product was perceived as neutral by all groups.

Turning to soy mince, seven significant bipolar pairs were identified between the four food preference groups (cooking, health, climate, taste, protein, artificial/natural, satiety) (see Appendix 1). Flexitarians and omnivores perceived the product as easier to cook compared to the other two groups who perceived it as neither easy nor hard. Significant differences in health were recorded, with flexitarians and omnivores perceiving the product as more healthy and meat and "meat and fish" eaters placing it at a more neutral position. The same pattern was identified for climate, with flexitarians and omnivores expressing soy mince as a better climate choice compared to the other two groups placing it in a more neutral range. Results for attitude towards the taste of soy mince show a rather wide range, with meat and "meat and fish" perceiving it as not being tasty, omnivores neutral, and flexitarians expressing it to be more tasty. Flexitarians also believed it to be high in protein, followed by omnivores whereas the other two preference groups perceived it as more neutral. The "meat and fish" group perceived the product as being artificial, followed by meat eaters and omnivores together with flexitarians. Finally, flexitarians found the product more saturating, followed by omnivores, whereas the other two groups were more neutral.

The result for beans shows that nine adjective pairs (festive/

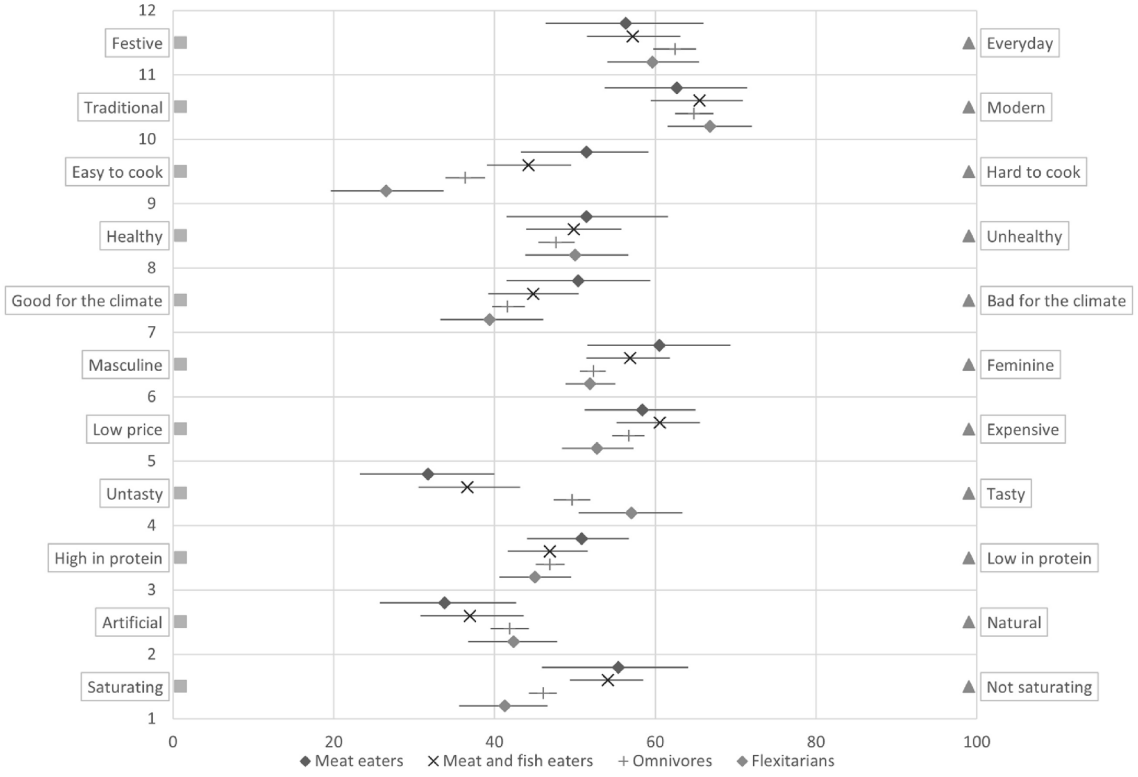

Fig. 1. Semantic differential results (mean values with 95% confidence intervals) for vegetarian nuggets, separated by the four different food preference groups, using 11 bipolar adjective pairs.

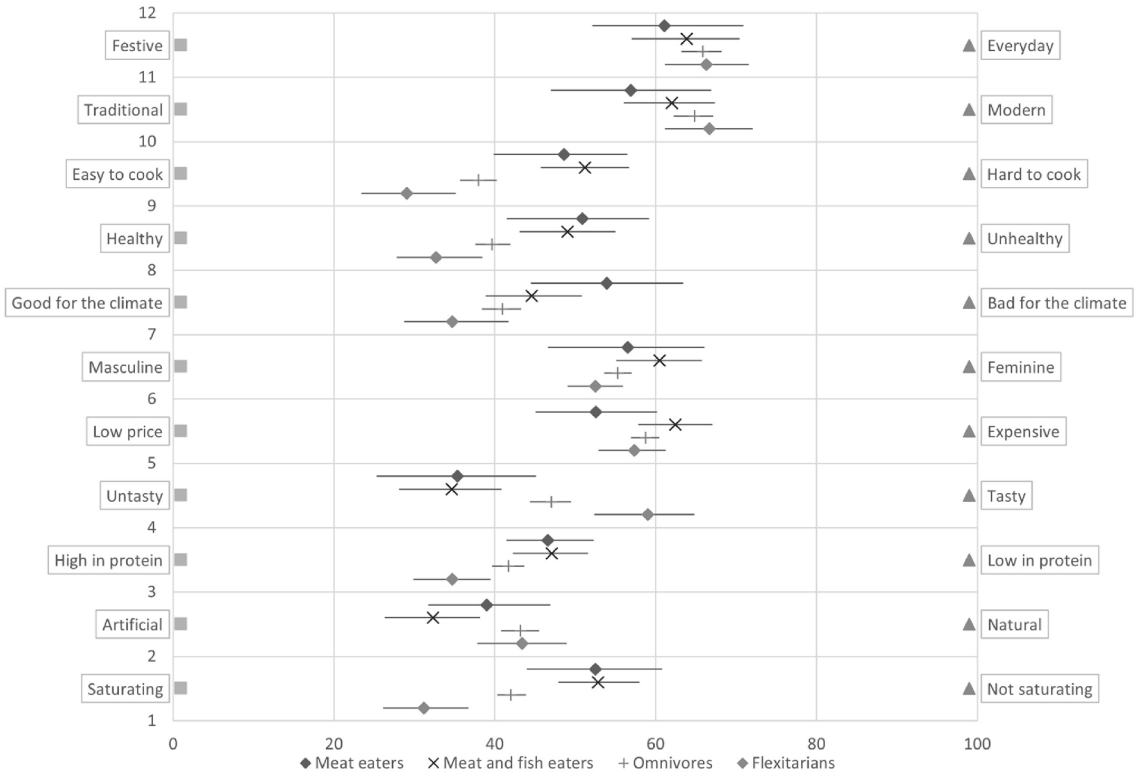

Fig. 2. Semantic differential results (mean values with 95% confidence intervals) for soy mince, separated by the four different food preference groups, using 11 bipolar adjective pairs.

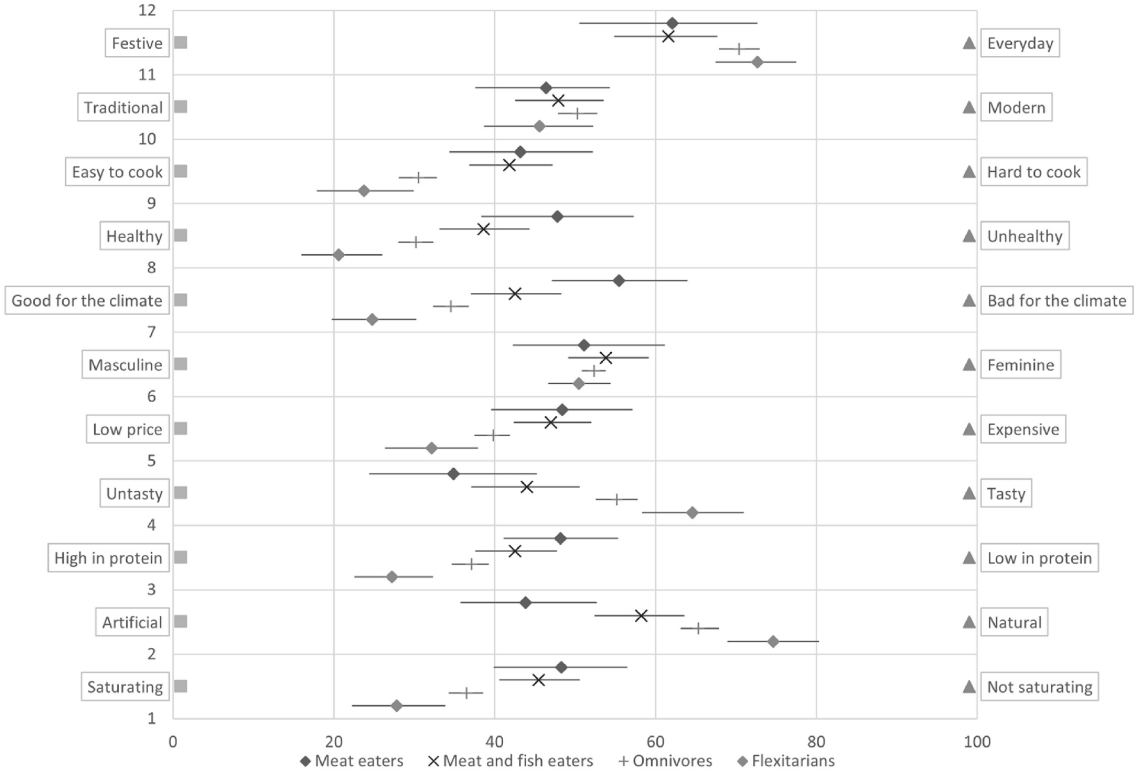

Fig. 3. Semantic differential results (mean values with 95% confidence intervals) for beans, separated by the four different food preference groups, using 11 bipolar adjective pairs.

everyday, cooking, health, climate, price, taste, protein, artificial/natural, satiety) were significantly different between the four food preference groups (see Appendix 1). Omnivores and flexitarians perceived beans as more everyday. Just as for the other products, flexitarians perceived it as more easy to cook, followed by omnivores and the two other groups. A similar pattern was identified for health and climate, with flexitarians ranking it as more healthy and a better climate choice compared to the other groups. Interestingly, significant differences were identified for price, with flexitarians perceiving the price to be lower, followed by omnivores whereas the other two groups were more neutral. Meat eaters did not think it was tasty, similar to "meat and fish" eaters, whereas omnivores perceived it as being more neutral and flexitarians as more tasty. Flexitarians considered the products as having high protein content, then in descending order came omnivores, "meat and fish" and meat eaters. The same pattern was identified for naturalness, with flexitarians ranking it as most natural and meat eaters as least natural. Finally, flexitarians believed it to be saturating, followed by omnivores whereas the two other groups ranked it as more neutral.

When comparing attitudes towards the three products between the four food preference groups, the results show the greatest number of significant differences for beans (9), followed by soy mince (7) and vegetarian nuggets (3). The results show no significant differences between the groups for any of the studied products when it comes to masculine/feminine or traditional/modern.

3.3. Food neophobia, health concern, climate change and understanding of the link between food and climate has an impact on consumption frequencies of beans and PBMA

Food neophobia is highest among meat eaters and lowest among flexitarians. Health concern, conviction about ongoing climate change, and link between food and climate (reduction of meat) are, in contrast, highest among flexitarians and lowest among meat eaters (Table 4).

To explore differences among the four food preference groups in relation to consumption frequencies of PBMA and pulses, linear regression analyses were calculated. Included variables were weekly portions of PBMA and pulses, health interest, food neophobia, climate change conviction, and perceived link between food and climate (reduction of meat) (Table 5).Table A1.

Among meat eaters and "meat and fish" eaters no significant variables were identified. Looking at omnivores, a negative significant prediction was found for food neophobia and PBMA as well as pulses, suggesting that the less food neophobic, the higher consumption of both product types. Among omnivores the result also illustrated a significant value for the link between reduction of meat and climate change, for both products. The more convinced these consumers were of the link between meat and climate change, the more they consumed. For flexitarians a negative significant value was found between PBMA consumption and health, suggesting that the less health concern, the higher consumption of PBMA.

3.4. Differences in ranking of qualities when buying a plant-based product

To identify the qualities that respondents perceived as important when choosing plant-based products, they were requested to rank nine quality characteristics in relation to a convenience product, such as vegetarian nuggets (9 = most important to 1 = least important). Mean values of the ranking of the nine qualities separated by the four food preference groups are depicted in Fig. 4.

Looking at the different qualities, taste, free from additives, and from Sweden are ranked high by all groups. Health is ranked highest by omnivores and lowest by meat eaters. Fresh and frozen is more important to meat and "fish and meat" eaters compared to the other two groups. Organic is ranked highest by flexitarians. A good climate choice is ranked highest by flexitarians, followed by omnivores and meat eaters.

4. Discussion

This study analysed Swedish consumer attitudes and beliefs towards three different plant-based protein-rich products (vegetarian nuggets, soy mince and beans). In order to gain insights into differences among consumers in drivers and barriers, the results are presented divided into four different food preference groups: flexitarians, omnivores, "meat and fish" and meat eaters. A range of factors and qualities were explored, including socio-demographic variables, consumption frequencies, food neophobia, health concern and awareness of climate change. Products studied are either defined as Plant Based Meat Alternatives (vegetarian nuggets and soy mince) or pulses (pre-cooked beans).

When exploring differences among the four food preference groups, our results confirmed previous findings that a higher percentage of men, compared with women, primarily prefer to eat meat and that the flexitarian consumer group is dominated by women (Keller & Siegrist, 2015; Lemken et al., 2019; Rosenfeld & Tomiyama, 2021; Siegrist & Hartmann, 2019). The study also confirmed that level of education is lowest within the meat preference group and higher among flexitarians (Siegrist & Hartmann, 2019; Van Bussel et al., 2020). The results illustrate that flexitarians consume significantly more PBMA as well as pulses, compared to the other three groups; however, no significant differences were identified between omnivores, meat and "meat and fish" eaters. We can also conclude that flexitarians and meat eaters are approximately ten years younger than omnivores and "meat and fish" eaters. Our findings underpin findings presented by Collier et al. (2021) explaining that main barriers to meat substitutes among Swedish consumers relate to e.g. scepticism about the necessity for reducing meat intake, sensory qualities and perceived lack of necessary cooking skills. However, what our result add is identified differences between the four food preference groups.

Looking at attitudes and beliefs towards the three products, the results illustrate differences and similarities between the four food preference groups as well as the three products. We can conclude that among the four food preference groups, the attitudes and beliefs expressed by flexitarians are most in line with sustainability and they also express positive attitudes and beliefs towards all three products. Omnivores constitute the largest food preference group (68%), and the expressed attitudes within this group are mainly in line with flexitarians, albeit less strong and sometimes more towards the neutral spectra. Meat and "meat and fish" eaters are more neutral or more towards the negative spectra of

Table 4
Mean values for food neophobia, health concern, belief in climate change and the link between food and climate, presented for four different food preference groups.

	Total (M ± SD)	Meat eater (M ± SD)	Meat and fish (M ± SD)	Omnivore (M ± SD)	Flexitarian (M ± SD)	F(3,479)=
Food neophobia	2.47±0.73	3.10±.78[a]	2.76±.71[a]	2.39±.70[b]	2.32±.69[b]	13.58 p <.0001
Health	3.11±0.66	2.77±.71[a]	2.90±.55[a]	3.14±.66[b]	3.32±.64[b]	7.30 p <.0001
Climate change	1.90±0.30	1.72±.45[a]	1.77±.42[a]	1.92±.26[b]	1.97±.19[b]	9.03 p <.0001
Reduce meat	1.66±0.48	1.35±.48[a]	1.30±.46[a]	1.66±.48[b]	1.95±.23[c]	25.18 p <.0001

[a,b,c] significantly different from each other at 0.05 level Bonferroni test.

Table 5
Result of linear regression analysis for weekly consumption of PBMA and pulses, in relation to impact of health interest, food neophobia, conviction about ongoing climate change, and perceived link between reduction of meat and climate change, separated by the four food preference groups.

	Predictor	PBMA					Pulses				
		B	SE	Beta	*t*	*p*	*B*	SE	Beta	*t*	*p*
Meat eater	(constant)	1.99	1.38		1.44	0.16	1.70	1.56		1.09	0.29
	Food neophobia	-0.31	0.29	-0.21	−1.08	0.29	-0.36	0.33	-0.21	−1.10	0.28
	Health	0.11	0.32	0.07	0.35	0.73	0.31	0.36	0.16	0.86	0.40
	Climate conviction	-0.12	0.22	-0.10	-0.53	0.60	-0.18	0.25	-0.14	-0.72	0.48
	Reduce meat	0.28	0.22	0.26	1.25	0.22	0.41	0.25	0.33	1.63	0.12
Meat and fish	(constant)	0.16	0.66		0.25	0.81	1.23	0.77		1.60	0.11
	Food neophobia	0.15	0.13	0.15	1.19	0.24	-0.11	0.15	-0.09	-0.75	0.46
	Health	0.11	0.16	0.09	0.69	49	-0.02	0.19	-0.01	-0.11	0.92
	Climate conviction	0.08	0.10	0.11	0.80	0.42	0.09	0.12	0.10	0.73	0.47
	Reduce meat	0.09	0.09	0.13	0.96	0.34	0.17	0.11	0.21	1.60	0.12
Omnivore	(constant)	2.23	0.37		5.96	0.000	2.16	0.40		5.42	0.000
	Food neophobia	-0.21	0.07	-0.16	−2.98	0.003	-0.27	0.08	-0.20	−3.66	0.000
	Health	-0.04	0.08	-0.03	-0.49	0.63	0.14	0.08	0.10	1.73	0.08
	Climate conviction	-0.09	0.08	-0.07	−1.11	0.27	-0.06	0.09	-0.04	-0.66	0.52
	Reduce meat	0.20	0.05	0.24	3.81	0.000	0.13	0.06	0.15	2.32	0.02
Flexitarian	(constant)	4.48	1.55		2.89	0.006	4.28	1.37		3.13	0.003
	Food neophobia	0.40	0.22	0.23	1.78	0.08	-0.23	0.20	-0.17	−1.17	0.25
	Health	-0.87	0.23	-0.46	−3.79	0.000	-0.09	0.20	-0.06	-0.46	0.65
	Climate conviction	0.07	0.32	0.03	0.21	0.83	-0.17	0.28	-0.10	-0.62	0.54
	Reduce meat	0.08	0.25	0.04	0.30	0.76	0.06	0.22	0.04	0.28	0.78

included attitudes and beliefs. Taken together, we can conclude that drivers and barriers within different food preference groups as well as different types of food products do differ.

Regarding vegetarian nuggets, the perceived ease of cooking, the perception of the product as a good climate choice, taste, protein content and the understanding that the product is perceived as artificial indicate areas to explore. Nevertheless, it should be emphasized that among meat and "meat and fish" eaters, the most noticeable areas to address are taste, how artificial the product is perceived to be and satiety. The flexitarians express a fairly neutral attitude towards taste, which indicates a potential for development (Fig. 1). When considering the result presented in Fig. 4, the flexitarians rank taste as the most important quality criteria for vegetarian nuggets. The finding that flexitarians also perceive the product as being slightly artificial indicates an area that could be explored and taken into consideration, especially when considering the strong interest among this group in products being free from additives (Fig. 4).

Turning to soy mince, among meat and "meat and fish" eaters and omnivores, areas for improvement are connected to ease of cooking, health, climate, taste, perceived protein content and satiety. It should however be emphasised that attitudes towards perceived taste, protein level, artificiality and satiety are lowest among meat and "meat and fish" eaters, suggesting that these are areas of high relevance to these two food preference groups. We can also conclude that the pattern among flexitarians is in line with the one described for vegetarian nuggets, with the exception of the protein level, which is perceived as higher for soy mince.

Finally, when looking at beans, for omnivores the areas for improvement are how easy it is to cook, the link to health as well as climate, perceived taste, satiety and protein content. Among meat and "meat and fish" eaters, the areas for improvement are in line with previous findings for vegetarian nuggets and soy mince and once again confirms the importance of addressing protein level, taste and perceived satiety. We can also conclude that flexitarians express the highest attitude towards how easy the product is to cook, that it is healthy, represents a good climate choice, is low in price, tasty, high in protein, natural and saturating.

When exploring attitudes between the four food preference groups towards the two PBMA products (vegetarian nuggets and soy mince) and beans, the results show that the two PBMA products are perceived as more modern, artificial as well as more expensive compared to the pulses (beans). Beans are, on the contrary, perceived as more healthy and a better climate choice compared to the two PBMA products. These findings echo the present situation explained by van der Weele et al. (2019) as the paradox in the present situation, where the most sustainable plant-based protein, pulses, is neglected in several areas, and the less sustainable PBMA is gaining momentum, despite lower sustainability potential. An interesting finding is identified among flexitarians, where a negative significant value was found between PBMA consumption and health, suggesting that among health-concerned flexitarians, consumption of PBMA is lower.

When exploring ranking of qualities for vegetarian nuggets (Fig. 4), it is interesting to see that all preference groups rank domestic origin in the top three. This is particularly interesting given the fact that access to domestically produced raw material in Sweden is limited, and the present increased Swedish demand for protein-rich plant-based food is mainly provided by import from Europe, Asia, North and South America (Ekqvist et al., 2019). Nonetheless, it is possible to grow protein-rich crops such as broad beans and peas domestically (Niva et al., 2017), and several ongoing research projects have recently been implemented through the research platform SLU Grogrund, aiming at expanding the Swedish production of domestic protein crops (SLU, Grogrund, 2021). These findings thus suggest opportunities for Swedish growers and are in line with findings suggested by Sifo/Axfood (2022), highlighting an increased demand for domestic raw materials for plant-based protein-rich products.

To summarise, attitudes among flexitarians are overall positive; yet, their central interest in taste (in line with findings by Estell et al., 2021), should always be kept in mind when developing products aiming at this food preference group. We can also conclude that the negative result between health concern and PBMA suggests that among health-concerned flexitarians, consumption of PBMA is lower. The result also indicates that it could be of relevance to keep an eye on how artificial a product is perceived by this consumer group. Omnivores are also expressing a high ranking for taste (Fig. 4), and the findings in Figs. 1–3 illustrate that this quality criterion is not yet met by any of the studied products, which all fall within the neutral spectra. Omnivores do, however, find the products fairly easy to cook; yet when comparing with flexitarians, there is room for improvement. As seen in Table 4, this group also scores fairly high on health concern, suggesting that this is one area to address when communicating with omnivores. They are also aware of the climate change as well as the link between food and climate, suggesting that these areas should be included in the communication. Still, omnivores were the only food preference group reporting

Table A1
Mean values ± st.dev. and significant differences reported for vegetarian nuggets, soy mince and beans, presented for 11 adjective pairs and four food preference groups (one-way ANOVA).

Veg nuggets	Meat-eaters (M ± SD)	Meat and fish (M ± SD)	Omnivores (M ± SD)	Flexitarians (M ± SD)	F (3,479)=
Festive-Everyday	56.31 ± 27.15	57.20 ± 24.30	62.44 ± 24.03	59.65 ± 23.36	1.36 p =.26
Traditional-Modern	62.69 ± 24.74	65.52 ± 23.72	64.82 ± 22.04	66.82 ± 19.83	.25 p =.86
Easy to cook-Hard to cook	51.45 ± 22.79[a]	44.24 ± 21.92[a,b]	36.26 ± 22.62[b]	26.54 ± 25.31[c]	10.13 p <.0001
Healthy-Unhealthy	51.45 ± 27.51	49.88 ± 24.13	47.63 ± 20.19	50.04 ± 23.44	.54 p =.66
Good for the climate-Bad for the climate	50.41 ± 24.27	44.80 ± 22.60	41.60 ± 18.83	39.37 ± 22.83	2.42 p =.07
Masculine-Female	60.52 ± 23.84	56.86 ± 21.78	52.29 ± 14.88	51.88 ± 12.18	3.49 p =.02
Low price -High price	58.38 ± 19.21	60.58 ± 21.18	56.73 ± 18.50	52.72 ± 17.78	1.84 p =.14
Untasty-Tasty	31.72 ± 23.13[a]	26.61 ± 26.35[a]	49.64 ± 21.42[b]	57.02 ± 24.24[b]	14.19 p <.0001
High in protein-Low in protein	50.85 ± 16.27	46.89 ± 19.18	46.88 ± 16.83	45.02 ± 17.89	.74 p =.53
Artificial - Natural	33.79 ± 23.18	36.95 ± 26.56	41.90 ± 21.35	42.39 ± 21.13	1.99 p =.12
Saturating – Not saturating	55.38 ± 25.47[a]	54.11 ± 20.04[a]	46.05 ± 16.10[b]	41.28 ± 21.07[b]	7.77 p= p <.0001
Soy mince	**Meat-eaters (M ± SD)**	**Meat and fish (M ± SD)**	**Omnivores (M ± SD)**	**Flexitarians (M ± SD)**	F(3,479)
Festive-Everyday	61.07 ± 27.72	63.86 ± 28.42	65.86 ± 22.37	66.32 ± 20.68	.50 p =.69
Traditional-Modern	56.93 ± 27.27	62.03 ± 23.61	64.85 ± 22.96	66.70 ± 19.25	1.48 p =.22
Easy to cook-Hard to cook	48.62 ± 22.29[a]	51.23 ± 22.94[a]	37.98 ± 21.39[ba]	29.07 ± 22.14[c]	12.30 p <.0001
Healthy - Unhealthy	50.90 ± 24.96[a]	49.05 ± 25.55[a,b]	39.67 ± 19.36[b,c]	32.72 ± 20.93[c]	8.89 p <.0001
Good for the climate-Bad for the climate	53.93 ± 26.32[a]	44.59 ± 26.14[a,b]	40.93 ± 22.06[b]	34.72 ± 24.30[b]	4.87 p =.002
Masculine-Female	56.55 ± 28.05	60.50 ± 22.13	55.30 ± 15.60	52.54 ± 13.34	2.39 p =.07
Low price -High price	52.59 ± 19.99	62.48 ± 19.99	58.75 ± 16.84	57.37 ± 15.61	2.36 p =.07
Untasty-Tasty	35.38 ± 27.06[a,b]	34.68 ± 26.93[a]	47.02 ± 23.43[a,b]	59.04 ± 23.32[c]	12.44 p <.0001
High in protein-Low in protein	46.62 ± 14.83[a]	47.09 ± 19.54[a]	41.17 ± 18.36[a]	34.70 ± 19.17[b]	5.29 p =.001
Artificial - Natural	39.00 ± 22.27[a,b]	32.33 ± 24.82[b]	43.20 ± 22.62[a]	43.40 ± 21.28[a]	4.43 p =.004
Saturating – Not saturating	52.52 ± 23.90[a]	52.82 ± 21.48[a]	42.00 ± 17.77[b]	31.18 ± 19.84[c]	16.02 p <.0001
Beans					F(3,479)
Festive-Everyday	62.10 ± 30.07[a,b]	61.61 ± 26.17[b]	70.39 ± 23.07[a]	72.70 ± 20.4[a,b]	3.80 p =.01
Traditional-Modern	46.41 ± 23.82	47.94 ± 22.49	50.31 ± 23.30	45.58 ± 25.61	.89 p =.44
Easy to cook-Hard to cook	43.17 ± 24.12[a]	41.83 ± 22.43[a]	30.56 ± 22.21[b]	23.75 ± 23.57[b]	9.57 p <.0001
Healthy - Unhealthy	47.83 ± 26.28[a]	38.61 ± 22.21[a]	30.22 ± 20.63[b]	20.58 ± 18.99[c]	13.84 p <.0001
Good for the climate-Bad for the climate	55.45 ± 23.56[a]	42.56 ± 22.73[b]	34.56 ± 20.58[c]	24.79 ± 20.17[d]	16.32 p <.0001
Masculine-Female	51.14 ± 25.33	53.83 ± 19.26	52.38 ± 13.75	50.47 ± 15.55	.52 p =.67
Low price -High price	48.41 ± 23.03[a]	46.98 ± 19.87[a]	39.81 ± 20.39[a,b]	32.19 ± 22.51[b]	6.72 p <.0001
Untasty-Tasty	34.86 ± 27.26[a]	43.98 ± 26.61[a]	55.17 ± 24.91[b]	64.58 ± 24.45[b]	12.55 p <.0001
High in protein-Low in protein	48.21 ± 19.79[a]	42.55 ± 20.56[a,b]	37.08 ± 21.11[b]	27.25 ± 19.10[c]	8.57 p <.0001
Artificial - Natural	43.86 ± 24.74[a]	58.23 ± 23.07[b]	65.34 ± 22.72[b]	74.63 ± 22.70[c]	13.35 p <.0001
Saturating – Not saturating	48.28 ± 23.01[a]	45.45 ± 20.73[a]	36.53 ± 21.33[b]	27.84 ± 21.97[c]	9.56 p <.0001

[a,b,] =significantly different from each other at 0.05 level Bonferroni test.

a significant negative association between food neophobia and pulses, suggesting that consumers experiencing food neophobia are less interested in pulses. Food neophobia has previously been identified as a barrier among omnivores (Eckl et al. 2021, Pliner & Hobden, 1992; Pliner & Salvy, 2006) in replacing meat with non-meat protein sources. Recent studies exploring consumer preferences for replacing meat with pulses have found resistance among most respondents (Lemken et al., 2019; Melendrez-Ruiz et al., 2019), with products made from e.g. peas being perceived as less tasty than beef (Michel et al., 2021b).

Since the conviction about climate change and the link between food and climate is significantly lower among meat and "meat and fish" eaters (Table 4), one idea could be to clearly address this issue when trying to convince people about the benefits of eating a more plant-based diet. However, as explained by Palm et al. (2020), such an approach may backfire and only be efficient among consumers who already are convinced of negative consequences of meat consumption (Vainio et al., 2016). Health concern also does not appear to be of high relevance for this group (Table 4). However, we can conclude that taste, perceived protein content and satiety are important areas to focus on; moreover they would probably be perceived as more relevant and less provocative. In addition, meat and "meat and fish" eaters also express the highest ranking of domestic origin, suggesting that this could be one way of gaining interest among these consumers in buying plant-based protein-rich products.

The present study produced novel information, but it also had some limitations. One concerns the uneven sizes of the four food preference groups, e.g. the meat eater group compared to the omnivore group and

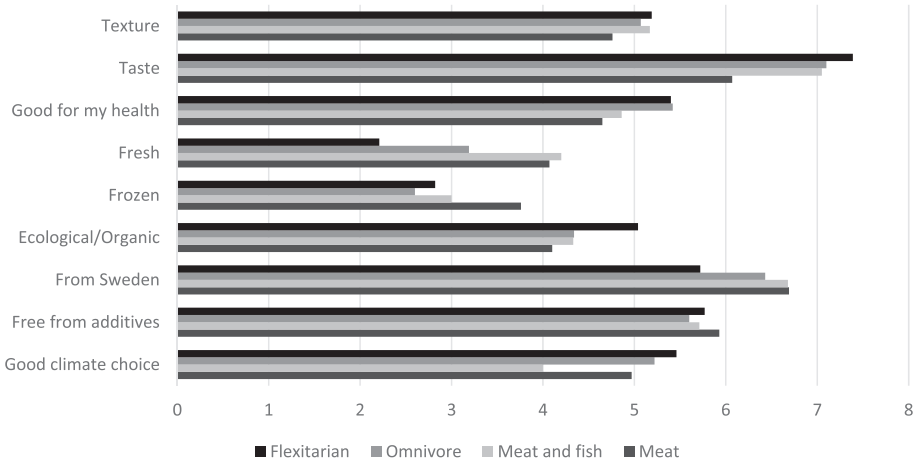

Fig. 4. Ranking of product qualities in vegetarian nuggets by the four food preference groups.

the possible effect this may have had on the power of conducted analyses. Still since the sizes of the groups reflect the relative sizes of the diet groups in the larger population, we believe that the special nature of the groups justifies the division. We can also conclude that the study sample represents a slightly older and more educated population, compared to Sweden in general. Another potential limiting factor relates to the fact that all data is based on self-reports, which may have had an impact on how well it relates to real choices and actual consumption frequencies. To gain a better understanding of drivers and inhibitors future studies may benefit from using qualitative methods, such as interviews and observations. The result of the conducted study highlights differences among the four food preference groups, and suggests different tracks to take and qualities to raise in communicating with the different groups.

5. Conclusions

Looking at the four food preference groups, flexitarians represent the group with the largest female share, highest level of education and significantly highest consumption of both PBMA and pulses. This group does also express overall positive attitudes towards the two product types. The other three groups report a larger variation and differences in attitudes and beliefs towards the products. To conclude, findings show that for all groups, PBMA products are perceived as more modern, artificial and expensive compared to pulses, which, in turn are perceived as healthier and a better climate choice.

We can also conclude that food neophobia is highest among meat and "meat and fish" eaters, whereas health concern is highest among omnivores and flexitarians. These two groups (omnivores and flexitarians) do also express the highest values for both conviction of climate change and the link between food (reduction of meat) and climate change. Among omnivores it could also be stated that food neophobia has a negative effect on weekly consumption of both PBMA and pulses, indicating that, among omnivores, food neophobia is an obstacle to deal with when looking for solutions to increase the consumption of both product types. It could also be seen that the understanding of the link between food and climate change (reduction of meat) had a positive impact on consumption of both product types among these consumers. It is also interesting to see that, among flexitarians, there is a negative effect between health consciousness and consumption of PBMA, suggesting that health concerned flexitarians consume less PBMA.

Flexitarians are strongly guided by taste when ranking qualities. Among omnivores, taste, ease of cooking, health, climate change and the link between food and climate are important aspects to address. Meat and "meat and fish" eaters rank qualities such as fresh and frozen higher than the other groups, suggesting that the convenience qualities for PBMA have to be stressed in order to attract these consumers. Considering preferences that are similar for all four groups, taste, domestic origin and free from additives are all qualities of high importance when buying a common vegetarian PBMA product (vegetarian nuggets). Finally, to support meat and "meat and fish" eaters in adopting a more plant-based protein-rich diet, focus should be placed on taste, perceived protein content, satiety and domestic origin (from Sweden).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions

SAS and HPH formulated the research questions and the design of the study. SAS was responsible for data analysis. SAS was responsible for writing the manuscript, with relevant and critical contribution from HPH. Both authors read and approved the final version of the manuscript.

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SAS and HPH formulated the research questions and the design of the study. SAS was responsible for data analysis. SAS was responsible for writing the manuscript, with relevant and critical contribution from HPH. Both authors read and approved the final version of the manuscript.

References

Aiking, H. (2014). Protein production: Planet, profit, plus people? *The American Journal of Clinical Nutrition, 100*(suppl_1), 483S–489S.

Alexander, P., Brown, C., Arneth, A., Dias, C., Finnigan, J., Moran, D., & Rounsevell, M. D. (2017). Could consumption of insects, cultured meat or imitation meat reduce global agricultural land use? *Global Food Security, 15*, 22–32.

Blease, G. (2015). Silicon Valley gets a taste for food. *The Economist*. https://www.economist.com/news/technology-quarterly/21645497-tech-startups-are-moving-food-business-make-sustainable-versions-meat (Accessed 21 February, 2022).

de Boer, J., & Aiking, H. (2019). Strategies towards healthy and sustainable protein consumption: A transition framework at the levels of diets, dishes, and dish ingredients. *Food Quality and Preference, 73*, 171–181.

de Boer, J., Schösler, H., & Aiking, H. (2017). Towards a reduced meat diet: Mindset and motivation of young vegetarians, low, medium and high meat-eaters. *Appetite, 113*, 387–397.

Bohrer, B. M. (2019). An investigation of the formulation and nutritional composition of modern meat analogue products. *Food Science and Human Wellness, 8*(4), 320–329.

Cheah, I., Shimul, A. S., Liang, J., & Phau, I. (2020). Drivers and barriers toward reducing meat consumption. *Appetite, 149*, Article 104636.

Cliceri, D., Spinelli, S., Dinnella, C., Prescott, J., & Monteleone, E. (2018). The influence of psychological traits, beliefs and taste responsiveness on implicit attitudes toward plant-and animal-based dishes among vegetarians, flexitarians and omnivores. *Food Quality and Preference, 68*, 276–291.

Collier, E. S., Oberrauter, L. M., Normann, A., Norman, C., Svensson, M., Niimi, J., & Bergman, P. (2021). Identifying barriers to decreasing meat consumption and increasing acceptance of meat substitutes among Swedish consumers. *Appetite, 167* (105643).

Dagevos, H. (2021). Finding flexitarians: Current studies on meat eaters and meat reducers. *Trends in Food Science & Technology, 114*, 530–539.

Deliens, T., Mullie, P., & Clarys, P. (2021). Plant-based dietary patterns in Flemish adults: A 10-year trend analysis. *European Journal of Nutrition*, 1–5.

Dohle, S., Hartmann, C., & Keller, C. (2014). Physical activity as a moderator of the association between emotional eating and BMI: Evidence from the Swiss food panel. *Psychology & Health, 29*(9), 1062–1080.

Eckl, M. R., Biesbroek, S., Van't Veer, P., & Geleijnse, J. M. (2021). Replacement of meat with non-meat protein sources: A review of the drivers and inhibitors in developed countries. *Nutrients, 13*(10), 3602.

Ekmekcioglu, C., Wallner, P., Kundi, M., Weisz, U., Haas, W., & Hutter, H.-P. (2018). Red meat, diseases, and healthy alternatives: A critical review. *Critical Reviews in Food Science and Nutrition, 58*(2), 247–261.

Ekqvist, I., Röös, E. & Tidåker, P. (2019). Grain Legumes on the Swedish market: Origin and Pesticide Use in the Production. Department of Energy and Technology, Swedish University of Agricultural Sciences (2019).

Estell, M., Hughes, J., & Grafenauer, S. (2021). Plant protein and plant-based meat alternatives: Consumer and nutrition professional attitudes and perceptions. *Sustainability, 13*(3), 1478.

Fenko, A., Backhaus, B. W., & van Hoof, J. J. (2015). The influence of product-and person-related factors on consumer hedonic responses to soy products. *Food Quality and Preference, 41*, 30–40.

Funk, A., Sütterlin, B., & Siegrist, M. (2020). The stereotypes attributed to hosts when they offer an environmentally-friendly vegetarian versus a meat menu. *Journal of Cleaner Production, 250*, Article 119508.

Gehring, J., Touvier, M., Baudry, J., Julia, C., Buscail, C., Srour, B., … Allès, B. (2021). Consumption of ultra-processed foods by pesco-vegetarians, vegetarians, and vegans: Associations with duration and age at diet initiation. *The Journal of Nutrition, 151*(1), 120–131.

Godfray, H. C. J., Aveyard, P., Garnett, T., Hall, J. W., Key, T. J., Lorimer, J., … Jebb, S. A. (2018). Meat consumption, health, and the environment. *Science, 361* (6399).

Graça, J., Godinho, C. A., & Truninger, M. (2019). Reducing meat consumption and following plant-based diets: Current evidence and future directions to inform integrated transitions. *Trends in Food Science & Technology, 91*, 380–390.

Hagmann, D., Siegrist, M., & Hartmann, C. (2019). Meat avoidance: Motives, alternative proteins and diet quality in a sample of Swiss consumers. *Public Health Nutrition, 22* (13), 2448–2459.

Hartmann, C., Ruby, M. B., Schmidt, P., & Siegrist, M. (2018). Brave, health-conscious, and environmentally friendly: Positive impressions of insect food product consumers. *Food Quality and Preference, 68*, 64–71.

Hartmann, C., & Siegrist, M. (2017). Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends in Food Science & Technology, 61*, 11–25.

He, J., Evans, N. M., Liu, H., & Shao, S. (2020). A review of research on plant-based meat alternatives: Driving forces, history, manufacturing, and consumer attitudes. *Comprehensive Reviews in Food Science and Food Safety, 19*(5), 2639–2656.

Keller, C., & Siegrist, M. (2015). Does personality influence eating styles and food choices? Direct and indirect effects. *Appetite, 84*, 128–138.

Lacroix, K., & Gifford, R. (2020). Targeting interventions to distinct meat-eating groups reduces meat consumption. *Food Quality and Preference, 86*, Article 103997.

Leiserowitz, A., Shome, D., Marx, S., Hammer, S., & Broad, K. (2008). *The New York City Global Warming Survey (A Columbia University/Yale University Poll)*. New Haven, CT: Yale Project on Climate change.

Lemken, D., Spiller, A., & Schulze-Ehlers, B. (2019). More room for legume–Consumer acceptance of meat substitution with classic, processed and meat-resembling legume products. *Appetite, 143*, Article 104412.

Love, H. J., & Sulikowski, D. (2018). Of meat and men: Sex differences in implicit and explicit attitudes toward meat. *Frontiers in Psychology, 9*, 559.

Melendrez-Ruiz, J., Buatois, Q., Chambaron, S., Monnery-Patris, S., & Arvisenet, G. (2019). French consumers know the benefits of pulses, but do not choose them: An exploratory study combining indirect and direct approaches. *Appetite, 141*, Article 104311.

Michel, F., Hartmann, C., & Siegrist, M. (2021a). Consumers' associations, perceptions and acceptance of meat and plant-based meat alternatives. *Food Quality and Preference, 87*, Article 104063.

Michel, F., Knaapila, A., Hartmann, C., & Siegrist, M. (2021b). A multi-national comparison of meat eaters' attitudes and expectations for burgers containing beef, pea or algae protein. *Food Quality and Preferences, 91*, Article 104195.

Milford, A. B., & Kildal, C. (2019). Meat reduction by force: The case of "meatless monday" in the norwegian armed forces. *Sustainability, 11*(10), 2741.

National Board of Trade (2020). The Swedish Market. Processed Food. https://www.kommerskollegium.se/en/publications/market-studies/the-swedish-market-for-processed-food/ (Accessed 2022-02-18).

Niva, M., Vainio, A., & Jallinoja, P. (2017). Barriers to increasing plant protein consumption in Western populations. In *Vegetarian and plant-based diets in health and disease prevention* (pp. 157–171). Elsevier.

Osgood, C. E. (1952). The nature and measurement of meaning. *Psychological Bulletin, 49* (3), 197.

Onwezen, M., Bouwman, E., Reinders, M., & Dagevos, H. (2021). A systematic review on consumer acceptance of alternative proteins: Pulses, algae, insects, plant-based meat alternatives, and cultured meat. *Appetite, 105058*.

Palm, R., Bolsen, T., & Kingsland, J. T. (2020). "Don't Tell Me What to Do": Resistance to climate change messages suggesting behavior changes. *Weather, Climate, and Society, 12*(4), 827–835.

Pliner, P., & Salvy, S. (2006). Food neophobia in humans. *Frontiers in Nutritional Science, 3*, 75.

Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite, 19*(2), 105–120.

Roininen, K., Lähteenmäki, L., & Tuorila, H. (1999). Quantification of consumer attitudes to health and hedonic characteristics of foods. *Appetite, 33*(1), 71–88.

Rosenfeld, D. L., & Tomiyama, A. J. (2021). Gender differences in meat consumption and openness to vegetarianism. *Appetite*, 105475.

Sanchez-Sabate, R., & Sabaté, J. (2019). Consumer attitudes towards environmental concerns of meat consumption: A systematic review. *International Journal of Environmental Research and Public Health, 16*(7), 1220.

Satija, A., Bhupathiraju, S. N., Spiegelman, D., Chiuve, S. E., Manson, J. E., Willett, W., … Hu, F. B. (2017). Healthful and unhealthful plant-based diets and the risk of coronary heart disease in US adults. *Journal of the American College of Cardiology, 70* (4), 411–422.

SCB. (2021). Statistics Sweden. Retrieved from https://www.scb.se/en (Accessed 21 September, 2021).

Siegrist, M., & Hartmann, C. (2019). Impact of sustainability perception on consumption of organic meat and meat substitutes. *Appetite, 132*, 196–202.

Sifo/Axfood (2022). Vegotrenden. Retrieved from https://www.axfood.se/nyhetsrum/pressmeddelanden/2022/01/vegobarometern-klimat-och-miljo-allt-viktigare-nar-vegetariskt-fortsatter-oka/ (Accessed 16 February 2022).

SLU, Grogrund (2021). Retrieved from https://www.slu.se/en/Collaborative-Centres-and-Projects/grogrund/ (Accessed 20 August, 2021).

Smith, K. (2017). 10 signs the food industry thinks the future of food is plant-based http://www.onegreenplanet.org/vegan-food/food-industry-thinks-the-future-of-food-is-plant-based/ (Accessed 18 February 2022).

Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L., … Willett, W. (2018). Options for keeping the food system within environmental limits. *Nature, 562*(7728), 519–525.

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a measure of the motives underlying the selection of food: The food choice questionnaire. *Appetite, 25*(3), 267–284.

Stoll-Kleemann, S., & Schmidt, U. J. (2017). Reducing meat consumption in developed and transition countries to counter climate change and biodiversity loss: A review of influence factors. *Regional Environmental Change, 17*(5), 1261–1277.

Swedish Board of Agriculture. (2022). Consumption of meat. Retrieved from https://jordbruksverket.se/mat-och-drycker/hallbar-produktion-och-konsumtion-av-mat/konsumtion-av-kott (Accessed 14 February 2022).

Vainio, A., Niva, M., Jallinoja, P., & Latvala, T. (2016). From beef to beans: Eating motives and the replacement of animal proteins with plant proteins among Finnish consumers. *Appetite, 106*, 92–100.

Van Bussel, L. M., Van Rossum, C. T., Temme, E. H., Boon, P. E., & Ocké, M. C. (2020). Educational differences in healthy, environmentally sustainable and safe food consumption among adults in the Netherlands. *Public Health Nutrition, 23*(12), 2057–2067.

van der Weele, C., Feindt, P., van der Goot, A. J., van Mierlo, B., & van Boekel, M. (2019). Meat alternatives: An integrative comparison. *Trends in Food Science & Technology, 88*, 505–512.

Verain, M. C., Dagevos, H., & Jaspers, P. (2022). Flexitarianism in the Netherlands in the 2010 decade: Shifts, consumer segments and motives. *Food Quality and Preference, 96*, Article 104445.

Westhoek, H., Lesschen, J. P., Rood, T., Wagner, S., De Marco, A., Murphy-Bokern, D., … Oenema, O. (2014). Food choices, health and environment: Effects of cutting Europe's meat and dairy intake. *Global Environmental Change, 26*, 196–205.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., … Murray, C. J. L. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet, 393*(10170), 447–492.

Wozniak, H., Larpin, C., de Mestral, C., Guessous, I., Reny, J.-L., & Stringhini, S. (2020). Vegetarian, pescatarian and flexitarian diets: Sociodemographic determinants and association with cardiovascular risk factors in a Swiss urban population. *British Journal of Nutrition, 124*(8), 844–852.

Zaval, L., Keenan, E. A., Johnson, E. J., & Weber, E. U. (2014). How warm days increase belief in global warming. *Nature Climate Change, 4*(2), 143–147.