Food Quality and Preference 133 (2025) 105636

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Exploring the association of personal factors with affective responses to plant-based meat alternatives with consideration of their perceived similarity to meat.

Caroline Giezenaar [a], Annu Mehta [a], Rebekah E. Orr [a], A. Jonathan R. Godfrey [b], Meika Foster [c], Joanne Hort [a,d,*]

[a] Food Experience and Sensory Testing (Feast) Lab, School of Food Technology and Natural Sciences, Massey University, Palmerston North 4410, New Zealand
[b] Statistics Group, School of Mathematical and Computational Sciences, Massey University, Palmerston North, New Zealand
[c] Edible Research Limited, Ohoka 7475, New Zealand
[d] Riddet Institute, Massey University, Palmerston North 4410, New Zealand

ARTICLE INFO

Keywords:
Plant-based meat alternatives
Liking
Emotional response
Diet
Age
Personality characteristics

ABSTRACT

Plant-based meat alternatives (PBMAs) have gained popularity as perceived sustainable replacements for meat, yet consumption remains limited. Understanding how personality traits shape PBMA consumption experience is therefore essential. This study surveyed 140 New Zealand consumers, assessing behavioural traits and attitudes related to willingness to reduce meat consumption/increase PBMA consumption. Participants completed tasting sessions evaluating commercially available PBMA products, based on flavour, texture, overall liking and emotions evoked, and sample perceived similarity to meat. Participants reported their demographic information, dietary habits, and frequency of meat and PBMA consumption. Results showed that higher social status derived from PBMA consumption were linked with higher liking ratings and citation proportion of 'hungry' for PBMAs. However, high negative attitude towards vegetarianism/veganism was linked to higher citation proportion for 'unhappy' for wholefood samples, while lower citation proportion for 'unhappy' for somewhat meat-like samples. High meat attachment was associated with lower perceived similarity to meat in both meat-like and somewhat meat-like samples. Additionally, the high meat consumption group reported lower texture and overall liking for meat-like samples. High variety seeking consumers (VARSEEK scores) were positively associated with flavour and overall liking for wholefood samples. Based on dietary groups, meat avoiders, generally driven by environmental and animal welfare concerns, reported more negative emotions such as 'unhappy' when tasting wholefood PBMAs compared to omnivores and flexitarians, despite their strong ethical and environmental motivations. The research highlights the impact of consumer behavioural traits and attitudes on their PBMA perception and acceptance, providing valuable insights for improving product development.

1. Introduction

Reducing meat consumption is advocated to improve environmental and human health (Willett et al., 2019) as a means to lower greenhouse gas emissions and water usage (Goldstein, Moses, Sammons, & Birkved, 2017; Sabaté & Soret, 2014; Xu et al., 2021). Plant-based meat alternatives (PBMAs), made using plant-derived components, such as pea or soy protein, are perceived to support environmental sustainability, nutrition and health while providing a convenient substitute for traditional meat products (Andreani et al., 2023; Bryant, 2022). PBMAs often imitate meat-like texture and flavours, although some, particularly those made from wholefoods (such as chickpeas or quinoa), are not made to imitate meat characteristics (Tso, Lim, & Forde, 2020).

Despite perceived benefits and offering of large product variety, PBMAs have relatively low consumer uptake (Institute, G. F, 2021), with perception and acceptance differing largely between consumers with

Abbreviations: A-NZ, Aotearoa New Zealand; PBMA, plant-based meat alternative; ML, meat-like; SML, somewhat meat-like; NML, not meat-like; GLM, generalised linear model.

* Corresponding author at: Food Experience and Sensory Testing (Feast) Lab, School of Food and Advanced Technology (SF&AT) PN 452, Massey University, Private Bag 11222, Palmerston North 4410, New Zealand.
E-mail address: j.hort@massey.ac.nz (J. Hort).

https://doi.org/10.1016/j.foodqual.2025.105636
Received 26 March 2025; Received in revised form 23 June 2025; Accepted 9 July 2025
Available online 10 July 2025

different dietary preferences. An online survey conducted in Central (Austria, Germany), Western (Belgium, The Netherlands) and Northern (Denmark, Sweden) Europe ($n = 416–1829$) indicated that vegans rated commercially available PB chicken and beef alternatives more favourably than flexitarians (Waehrens et al., 2023). This enhanced product experience may be due to shifts in taste preferences, closer alignment with ethical and environmental motivations (North, Klas, Ling, & Kothe, 2021) or lack of direct sensory comparisons to meat-based products (MacDonald, Brauer, & Yi, 2023). Further findings revealed that meat avoiders and flexitarians rated PBMAs higher than omnivores for taste, texture, effort to prepare, protein content, and environmental friendliness (Michel, Knaapila, Hartmann, & Siegrist, 2021). Similarly, supporters of meat reduction had more positive perceptions of PBMAs in terms of healthiness, sustainability, and processing, compared to rejectors of meat reduction, based on an online evaluation by 368 participants in Spain (Moussaoui et al., 2023). However, a positive perception of healthiness alone may not be sufficient to encourage meat reduction. In another online survey with 200 participants in UK (Vural, Ferriday, & Rogers, 2023), both meat eaters and avoiders rated plant-based burgers and nuggets as healthier than their conventional meat counterparts suggesting that increased perceived healthiness is not necessarily enough to facilitate meat omission/reduction.

Consumers with different dietary preferences evaluate PBMAs through varied perspectives, influenced by demographics, behavioural traits, attitudes and values. Behaviour is defined as the range of actions or reactions individuals exhibit in response to external or internal stimuli (Oszust & Stecko, 2020), while attitudes refer to consumer learned predispositions to respond favourably or unfavourably to a product (Ajzen, 2005), often shaped by beliefs about the product's taste, healthiness or environmental impact. Values on other hand, are deeply held principles that guide behaviour over time such as health, sustainability and animal ethics (Corner, Markowitz, & Pidgeon, 2014; Horlings, 2015; Nazirova & Borbala, 2024). Understanding how these factors shape food choices is essential for PBMAs, as motivations may vary according to health consciousness, sustainability and/or ethical considerations (Weerawarna et al., 2024).

Food choice motives, can be related to an individual's behavioural traits, attitudes and value system (Lindeman & Sirelius, 2001). Behavioural traits such as variety seeking tendencies and meat attachment, along with demographic factors, play a crucial role in understanding consumer behaviour towards PBMA acceptance. For instance, variety seeking consumers who maintain a positive attitude towards trying new foods are more likely to incorporate PBMAs into their diets, especially if these products align with their health, sustainability or ethical values (Zhang, 2022). An online survey of more than 1500 consumers from Germany, France, and the United Kingdom found that older age, higher neophobia scores, meat attachment and increased negative attitudes towards vegetarianism and veganism (commonly abbreviated as veg*nism) were associated with lower ratings of pea burgers' taste, health, and environmental friendliness (Michel et al., 2021). The survey also confirmed earlier findings of Hoek Luning, Weijzen, Engels, Kok, and De Graaf (2011), that high attachment to meat and food neophobia (Graça, Calheiros, & Oliveira, 2015), are associated with lower acceptance of PBMAs. However, growing interest in PBMAs suggests a potential shift in consumer behaviour. A cross-sectional survey conducted in Belgium showed a significant increase in the demand for PBMAs, rising from 44 % in 2019 to 51 % in 2020, with young consumers driving the growth. Vegetarians and females, in particular, showed a stronger preference for PBMAs compared to men (Bryant & Sanctorum, 2021). Similarly, consumer attitudes and values like environmental self-identity, climate concerns, negative attitude towards veg*nism, perceived naturalness and food safety, also contribute to consumption intention (Bschaden, Mandarano, & Stroebele-Benschop, 2020; Martin, Lange, & Marette, 2021; Seo, Jang, & Cho, 2023). Martin et al. (2021) demonstrated that the presence of health and environmental information on packaging enhanced consumer preference for plant-based products and increased their willingness to pay. Similarly, online responses from Korean foodservice consumers revealed that environmental and health benefits were their main drivers of PBMA consumption while perceived unnaturalness had a negative impact on PBMA consumption (Seo et al., 2023). An online survey conducted in the U.K. and the Netherlands found that motivation to choose ethical foods significantly contributed to a higher preference for meat alternatives. Social norms, including social status and perceived societal attitudes, are personality and behaviour traits that impact PBMA acceptance (McCarthy, Parker, Ameerally, Drake, & Drake, 2017; Shin, Im, Jung, Kim, & Shin, 2024; Spendrup & Hovmalm, 2022). However, further identification of behavioural traits that affect sensory and emotional response towards PBMAs could help to identify drivers to increase PBMA uptake.

Most studies examining the influence of demographics, personality/behavioural traits and sensory expectations on PBMA perceptions have relied on online surveys. Consequently, these studies may not adequately capture the true impact of the above factors on PBMA consumption, particularly in terms of product variety, as consumers may express aspirational values or socially desirable responses towards the product rather than actual behaviours, especially when not tasting products. This highlights the importance of incorporating sensory experiences, such as product tasting, to better understand the value-action gap and its effect on consumer behaviour (Barr, 2006; Blake, 1999). A product's sensory properties play a crucial role in shaping both pre-consumption and post-consumption expectations (Cardello, 1996; Krishna & Elder, 2021; Starowicz, Poznar, & Zieliński, 2022). Unpleasant or unexpected sensory properties can adversely affect product acceptance. Although alternative proteins such as tofu and tempeh have been available in the market for a considerable time, meat consumers continue to avoid these products due to their perceived lack of appeal, as well as their unfavourable taste and other sensory properties upon tasting (Hoek et al., 2013). Reipurth, Hørby, Gregersen, Bonke, and Cueto (2019) also reported that negative attitudes towards the taste perception of meat analogues were associated with low acceptance of plant-based products among meat lovers, based on a survey conducted with 462 Danish consumers. Studies investigating factors influencing sensory perception of PBMAs are relatively scarce, but existing evidence suggests that sensory attributes are the primary barrier to PBMAs consumption among meat eaters (Jaeger, de Matos, Oduro, & Hort, 2024; Kim, Öström, Mihnea, & Niimi, 2024). Sensory characteristics are closely related to emotional responses (Spinelli & Jaeger, 2019), which in turn play an important role in shaping consumer perceptions and driving both the acceptance and rejection of PBMAs.

Emotions evoked by a product's sensory attributes during consumption play a key role in driving its liking and acceptance among consumers (Giezenaar et al., 2024). Meat can trigger negative emotions relating to morality, such as 'guilt' and 'disgust', especially in those with ethical concerns around animal welfare, meat production (Ioannidou, Lesk, Stewart-Knox, & Francis, 2023) and animal slaughter (Graça, Oliveira, & Calheiros, 2015). Concurrently, the prospect of not eating meat has been associated with 'grief' by some consumers, due to meat attachment (Graça, Calheiros, & Oliveira, 2015). Emotional response towards PBMAs may also be affected by attitudes towards meat. High and medium supporters of meat reduction experienced more positive emotions towards consumption of PBMAs (happy, good, satisfied), whereas rejecters of meat reduction experienced more negative emotions (bored, disgusted) but also felt more 'adventurous' – possibly because they have not experienced the products before (Moussaoui et al., 2023). Furthermore, female and flexitarians expected to have more positive emotions towards a plant-based burger than men and meat eaters (Zandstra, Ossel, & Neufingerl, 2024). Specifically, flexitarians expected to feel more 'satisfied' and 'relaxed' and less 'disappointed', 'dissatisfied', and 'disgusted' than meat eaters; and female expected to feel more 'proud', 'satisfied', 'cool', and less 'guilty' than male. Again, the data from these studies came from online surveys, and

so, may not translate when to the PBMA consumption context. Moreover, existing online studies conducted to understand the sensory drivers of meat-like and vegetable-based meat alternatives have been limited to either a single product category such as burger patties (Ettinger et al., 2022; Grasso, Rondoni, Bari, Smith, & Mansilla, 2022; Taylor, Ahmed, Al-Juhaimi, & Bekhit, 2020) or a small number of samples. Therefore, to better understand the drivers of liking within the PBMA category, more extensive research is required, using a wider range of samples with regards to their sensory properties and perceived similarity to meat.

Recognising these gaps, the present exploratory study aimed to understand how consumer behavioural traits, attitudes and values, alongside dietary habits and demographics, influenced affective evaluation (both liking and emotional responses) of PBMAs, both in general and in relation to their perceived similarity to meat. The study aimed to extend existing research on consumer motivations for increasing PBMAs uptake by investigating how these factors shape product liking and emotional experiences during actual product experience. Focusing on perceived similarity to meat, the research sought to provide deeper insight into the drivers of PBMA acceptance and consumer preferences.

2. Methods

This study was conducted in two stages: a survey collecting data regarding behavioural traits, attitudes and values as well as demographics and dietary behaviours, followed by sensory evaluation sessions of 21 PBMAs representative of those available in the Aotearoa-New Zealand (A-NZ) market.

2.1. Participants

Participants ($n = 140$) were recruited using the Food Experience and Sensory Testing (Feast) consumer database and internal emails according to the following criteria: i) aged between 25 and 55 years (Gen X and Millennials who are most likely to consumer PBMAs), ii) able to communicate effectively in English, iii) not allergic or intolerant to any sample ingredients, iv) not pregnant or lactating, and v) willing to try PBMAs. The study was submitted to the Massey University Human Ethics process and was judged to be low risk (Application ID 4000025647). Participants were asked to read an information sheet providing the study details and gave written informed consent before participation. Participants were assigned a unique code to ensure anonymity and were offered a supermarket voucher to compensate for their time.

2.2. PBMA samples

As previously described in Giezenaar, Godfrey, Foster, and Hort (2024), 21 PBMAs (Table 1) that would be eaten as part of a dinner meal, were selected to represent the PBMA product range available in A-NZ. This included eight burger patties, four sausages, four chicken alternatives, three meatball alternatives, one beef alternative, and one bacon alternative. The Turkey Style roast (Quorn™ Roast) contained egg white but was included as it is a popular meat substitute brand in New Zealand and globally.

2.3. Determining participant characteristics

Prior to attending sensory evaluation sessions, participants completed an online survey (Compusense® software (version 24.0.28086); Compusense Inc., Guelph, ON, Cananda) to indicate their gender, age and dietary habits with respect to meat consumption (i.e. meat eater, flexitarian, vegetarian, pescetarian, vegan). Participants also indicated how many of their main meals (lunch and dinner) in a week contained meat and their frequency of PBMA consumption frequency on a 7-point scale (never, 2–3 times in a year, once a month, once a fortnight, once a week, 2–3 times a week and every day). Participants completed questions consisting of both validated and in-house developed questionnaires to evaluate their behavioural traits, attitudes and values (Table 2). Surveys previously used to segment consumer groups based on traits to reduce meat or consume a flexitarian diet were adopted (Sheen, Lim, & Forde, 2023; Weerawarna et al., 2024).

2.4. Sensory evaluation of PBMAs

Sample evaluation took place in ISO standard (ISO 8589:2007) sensory booths under white light. Data was collected using Compusense Cloud® Software (Compusense Inc., Ontario, Canada) via iPads. Low risk ethical requirements allowed maximum consumption of 25 % of the daily recommended intake of sodium in a session, allowing seven samples to be tested per session. Each participant completed three tasting sessions (~45–60 min each) scheduled on weekdays at either 11 am, 1.30 pm or 4 pm. Samples were divided into three blocks of seven products (Table 1). Instead of random allocation, each block was structured to include a variety of product types, incorporating both meat products and wholefoods products. This design ensured variation within each block, preventing direct comparisons within a single product category.

2.4.1. Sample preparation and presentation

Samples were cooked according to manufacturer instructions, either between a top and bottom plate on a commercial grill (Built-in oven OB60, Fisher & Paykel, Costa Mesa, California, U.S.A) set at 180 °C in an oven (200 °C) (High Speed Contact Grill, Roband, Sydney, NSW, Australia), or in a frying pan with canola oil. A trial prior to the study was conducted to confirm cooking times. Samples were cut into pieces, and two pieces of each sample were wrapped together in aluminium foil and labelled with a random three-digit code. Serving sizes ranged between 10 and 20 g per sample and were kept consistent between sessions for each sample. Samples were placed into a ceramic dish for serving. All samples were cooked prior to the session and held in a food warmer (E84 Food Warmer, Bakbar, New Zealand) heated to 50 ± 5 °C for up to 20 min prior to serving.

Within a session, samples were presented monadically according to a partially balanced order following a Williams' Latin square. Each participant received two pieces of sample, one piece to evaluate liking and emotions and the second to evaluate sensory characteristics (not reported here). Unsalted water crackers (Carr's, Kellogg Company, United States of America) and filtered water were provided as palate cleansers. In between each sample, a minimum of a 1-min break was enforced to allow participants to palate cleanse to minimise carry over effects.

2.4.2. Sample evaluation

For each sample, participants first assessed the sample for overall, flavour and texture liking on a continuous 100-point scale ranging from 0 = 'dislike extremely' to 100 = 'like extremely', with a midpoint labelled 'neither like nor dislike'. Participants evaluated emotional response evoked by the samples using Check-All-That-Apply (CATA). An emotion lexicon to assess emotional response to plant-based burger patties was used (Orr, Giezenaar, Godfrey, & Hort, 2023). Participants were provided with emotion synonyms to ensure clarity of emotion meaning. Emotion terms used included: 'adventurous', 'amazed', 'calm', 'energetic', 'pleasant', 'loving', 'hopeful', 'happy', 'hungry', 'nostalgic', 'satisfied', 'unhappy', 'angry', 'anxious', 'afraid', 'suspicious', 'bored', 'disappointed', 'deceived', 'dissatisfied', 'disgusted', 'uncertain', 'neutral' and 'curious'. Participants were instructed to *"Select the words that best describe how the sample makes you feel"*. Emotional terms were presented according to a Williams Latin Square across participants but fixed for each participant for all samples within a session. Finally, participants rated each sample for perceived similarity to meat on a 5-point scale ranging between 'not at all meat-like' and 'extremely meat-like'.

Table 1
Product names, main ingredients, and images of twenty-one plant-based meat alternatives that were evaluated for perceived similarity to meat and affective responses.

Sample block	Product name	Main ingredients		
A	Beef style patty 3	Textured vegetable protein (TVP)		
A	Crumbed chicken style patty	Wheat, pea protein		
A	Broccoli/quinoa patty	Faba bean, pea protein		
A	Tofu based sausage	Tofu (soy beans)		
A	Meatball alternative 1	Wheat, soy, pea protein		
A	Turkey style roast	Mycoprotein, egg white, milk proteins		
A	Bacon style rasher	Wheat, soy protein		
B	Beef style patty 1	TVP, pea, hemp protein		
B	Chickpea/massala patty	Chickpeas		
B	Chorizo style sausage	TVP, pea, hemp protein		
B	Pea/lime veggieball	Faba bean, pea protein		

(*continued on next page*)

Table 1 (*continued*)

Sample block	Product name	Main ingredients		
B	Chicken style pieces 2	Pea protein, hemp		
B	Chicken style pieces 3	Pea protein		
B	Beef style dices	Pea, faba bean protein		
C	Beef style patty 2	TVP, pea, hemp protein		
C	Crumbed cauliflower patty	Cauliflower		
C	Tomato/cauliflower patty	Tomato, cauliflower		
C	Sage/onion sausage	Soy TVP		
C	Mushroom/grain sausage	Faba bean, pea protein		
C	Meatball alternative 2	Soy, wheat protein		
C	Chicken style pieces 1	Pea protein		

2.5. Data analysis

All statistical analyses were performed in R version 4.3.0 using R Studio software version 2022.12.0.353 (Core, 2019). Package dplyr was used for data handling and visualisation (Wickham, François, & Henry, 2022). An α risk of 0.05 was considered statistically significant and mean ± standard deviation (SD) values are presented.

2.5.1. Meat/PBMA consumption frequency

Meat consumption data were categorised into two groups: low meat consumers consuming meat ≤7 meals per week, and high meat consumers consuming meat ≥8 times per week. PBMA consumption data were also categorised into two groups: low PBMA consumers consuming PBMAs monthly or less frequently, and high PBMA consumers consuming PBMAs once a fortnight, or more.

Table 2
Behavioural traits, attitudes and values, questionnaire/statements and scales used in the survey.

Factors	Questionnaire/Statements	Scales
Behavioural traits		
Variety Seeking Tendency Scale (VARSEEK) (Van Trijp & Steenkamp, 1992)	• When I eat out, I like to try the most unusual dishes, even if I am not sure I would like them. • While preparing food or snacks, I like to try out new recipes • I think it is fun to try out new foods one is not familiar with. • I like to eat exotic food. • I am eager to know what kind of food people from other countries eat. • Dishes on the menu that I am unfamiliar with make me anxious (R). • I prefer to eat food products I am used to (R). • I am curious about food products I am not familiar with.	5-point Likert scale 'strongly disagree' to 'strongly agree'. (Max score: 40)
Meat attachment scale (Graça, Calheiros, & Oliveira, 2015)	• To eat meat is one of the food pleasures in life. • Meat is irreplaceable in my diet. • According to our position in the food chain, we have the right to eat meat. • I feel bad when I think of eating meat. (R) • I love meals with meat. • To eat meat is disrespectful towards life and the environment. (R) • To eat meat is an unquestionable right of every person. • Meat consumption is crucial to my balance. • A full meal is a meal with meat. • I'm a big fan of meat. • If I couldn't eat meat I would feel weak. • If I was forced to stop eating meat I would feel sad. • Meat reminds me of diseases. (R) • By eating meat I'm reminded of the death and suffering of animals. (R) • Eating meat is a natural and undisputable practice. • I don't picture myself without eating meat regularly. • Meat sickens me. • I would feel fine with a meatless diet. (R) • Meat consumption is a natural act of one's affirmation as a human being. • A good steak is without comparison.	5-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score:100)
Attitudes		
Naturalness scale (Michel & Siegrist, 2019)	• I make sure to buy products that are preferably free from artificial ingredients. • I avoid food that contains preservatives. • I avoid food that contains additives. • I avoid food that contains artificial colors and flavours. • I am worried about residues from chemicals in food. • I avoid food that is made from genetically modified plants. • It is important to me that foods contain as many natural ingredients as possible. • I avoid highly processed foods. • I prefer unprocessed foods over processed foods.	6-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score: 54)
General health interest (Health and Taste Attitudes Subscale) (Roininen, Lähteenmäki, & Tuorila, 1999)	• The healthiness of food has little impact on my food choices. (R) • I am very particular about the healthiness of food I eat. • I eat what I like and I do not worry much about the healthiness of food. (R) • It is important for me that my diet is low in fat. • I always follow a healthy and balanced diet. • It is important for me that my daily diet contains a lot of vitamins and minerals. • The healthiness of snacks makes no difference to me. (R) • I do not avoid foods, even if they may raise my cholesterol. (R)	7-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score: 56)
Environmental self-identity scale (Van der Werff, Steg, & Keizer, 2014)	• Acting environmentally friendly is an important part of who I am. • I am the type of person who acts in an environmentally friendly way. • I see myself as an environmentally friendly person.	7-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score: 28)
Animal Attitudes (Cembalo et al., 2016)	• It is important to me that the food I normally eat has been produced in a way that animals' right have been respected. • It is important that the food I normally eat has been produced in a way that animals have not experienced pain.	7-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score: 14)
Knowledge about climate change (items related to concern for climate change) (Tobler, Visschers, & Siegrist, 2012)	• We must protect the climate's delicate equilibrium. • Climate protection is important for our future.	7-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score: 28)

(continued on next page)

Table 2 (*continued*)

Factors	Questionnaire/Statements	Scales
	• I worry about the climate's state. • Climate change has severe consequences for humans and nature.	
Attitudes towards veganism (Michel et al., 2021)	• Vegetarianism is just a temporary fashion. • Vegans are extremists. • Meat alternatives are only for vegetarians and vegans. • Veganism is just a temporary fashion.	7-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score: 28)
Concerns for food safety (Weerawarna et al., 2024)	*How much do you agree that you are concerned with:* • Diseases from meat (e.g. Salmonella, *E. coli*, BSE/ mad cow disease) • Genetically modified ingredients • Antibiotics used in meat production • Pesticides and herbicides on plants	7-point Likert scale 'Strongly disagree' to 'Strongly agree' per statement
Values Impression management items to assess food choice motives (Pula, Parks, & Ross, 2014)	*It is important to me that the food I eat on a typical day:* • Would be met with approval by relatives. • Is in agreement with my friends' expectations of me. • Gives people the right impression of me. • Portrays a positive image of me. • Makes a statement about me	7-point Likert scale 'Strongly disagree' to 'Strongly agree' (max score: 35)
Social status derived from: i)meat consumption ii) PBMA consumption (Weerawarna et al., 2024)	*Eating meat/PBMAs makes me feel:* • Ethical • Virtuous • Healthy • Accepted	7-point Likert scale 'Strongly disagree' to 'Strongly agree' per statement

"R" denotes a reverse-scored question for calculating Total scores.

2.5.2. Survey responses

Where required survey responses were computed to summed scores. The VARSEEK, meat attachment, and health interest scales contained reverse-scored questions, which were inverted before calculating summed scores.

2.5.3. Selection of emotional terms for analysis

Emotional terms were selected based on the frequency of citation (>10 %) categorisation. Emotional terms with average citation proportions across all samples <10 % and/or where the number of participants engaging with the term was less than 100 were excluded from the data analyses.

2.5.4. Categorising sample similarity to meat

A stacked bar was used to visualise the proportional contribution of each meat similarity scale point for each sample to evaluate their perceived similarity to meat. Samples were categorised into three categories based on the median scores: (a) meat-like, if at least 50 % of participants rated them as 'very' or 'extremely' meat-like; (b) not meat-like, if at least 50 % of participants rated them as 'not at all' or 'not very' meat-like; and (c) somewhat meat-like, for the remaining samples.

2.5.5. Relationship between behavioural traits, attitudes, values responses and demographics, dietary habits and meat/PBMA consumption frequency

To determine the relationship between age, gender, dietary habits, meat/PBMA consumption frequency and behavioural traits, attitudes and values, linear mixed effects models (LME) were generated for each trait in survey. Behavioural traits, attitude and value responses were the response variables; age, gender, meat and PBMA consumption frequency groups, and dietary habits were fixed factors; and participant was a random factor. For significant fixed factor effects, further post hoc testing for differences was conducted using Tukey HSD test to allow for multiple comparisons.

2.5.6. Determining the effect of behavioural traits, attitudes and values, demographics, dietary habit and meat/PBMA consumption frequency on liking and perceived similarity to meat

To determine effects of participant characteristics on liking scores and perceived similarity to meat, mixed effect models (LME) were adopted. Liking modality and perceived similarity to meat were response variables, while demographics, dietary habits, meat/PBMA consumption frequency, behavioural traits, attitudes, values and sample were included as fixed factors. Interactions between sample and the remaining factors were allowed to determine which factors contributed to differences between the samples. Participant was set as a random effect. Initially, the full model was run, and from there, insignificant interaction effects were removed one by one, starting with the least significant interaction based on its *p*-value. The same process was completed for the main effects, so that the final model only included significant interaction and main effects. Factors contributing to each model, based on ANOVA, were plotted individually against the relevant response variable.

2.5.7. Determining the effect of behavioural traits, attitudes and values, demographics, dietary habits and meat/PBMA consumption frequency on emotional response

To determine participant characteristic effects on emotional response, generalised linear models (GLMs), with binomial family, were conducted for each emotion, using the emotion as the response variable, the same fixed factors as used for liking modalities and the addition of participant. Participants who never, or always, engaged with a particular emotion were excluded to avoid/reduce multicollinearity. First, the full model was run. Then, backwards elimination ('step' function) was used to exclude main effects and interaction terms that did not contribute to the model. Factors significantly contributing to each model, based on ANOVA, were plotted individually against the relevant response variable.

3. Results

3.1. Demographics, dietary habits and meat/PBMA consumption frequency

With a median age of 35 ± 9 yr, 140 consumers (37 male, 103 female) completed the study, including 58 omnivores, 65 flexitarians and 17 meat-avoiders (1 pescetarian, 8 vegetarians, 8 vegans). Seventy-two consumers were classified as high meat consumers (≥ 8 meals /week), whereas 68 consumers were low or non-meat consumers (≤ 7/week). Furthermore, 53 consumers were classified as high PBMA users (once a fortnight or more frequent), and 87 were low or non- PBMA users (once a month or less frequent). Flavour, texture and overall liking, as well as

emotional response towards the samples, were reported previously (Giezenaar, Orr, et al., 2024). Meat-related flavours were key drivers of overall liking and meat like samples also evoked positive emotional responses, while wholefood samples were associated with negative emotions and described using terms such as 'gluey/slimy' and 'pasty/doughy' and low liking scores.

3.2. Perceived similarity to meat

Fig. 1 shows the categorisation of samples based on perceived similarity to meat. Five samples (Beef style patty 1 and 3, Crumbed chicken style patty, Bacon style rasher and Turkey style roast) were perceived by at least 50 % of the participants to be 'extremely' or 'very' meat-like and are herein referred as meat-like; six samples (Crumbed cauliflower patty, Tomato/cauliflower patty, Chickpea/masala patty, Broccoli/quinoa patty, Pea/lime veggieball and Mushroom/grain sausage) were perceived to be 'not very' or 'not at all' meat-like and are herein referred to as not meat-like, the remainder were categorised as 'somewhat meat-like'. Samples perceived to be somewhat meat-like or above were generally made from extruded plant proteins (e.g. soy, pea protein), whereas samples not perceived to be meat-like were made from wholefoods (e.g. legumes, vegetables).

3.3. The influence of behavioural traits, attitudes and values responses on demographics, dietary habits, and meat/PBMA consumption frequency

Mean scores for behavioural, attitude and value traits are presented in Table 3. Increasing age was associated with higher meat attachment scores ($p = 0.026$), higher naturalness scale scores ($p < 0.001$), and higher concern for food safety ($p = 0.046$). Female felt they derived more social status from PBMA consumption than male (female: 16.8 ± 3.8; male: 14.8 ± 5.2; $p = 0.015$). High, compared to low, frequency of meat consumption was associated with lower environmental concerns (high meat: 15.1 ± 3.0; low meat: 16.4 ± 2.8; $p < 0.009$), higher meat attachment (high meat: 68.4 ± 9.7; low meat: 53.8 ± 15.8; $p < 0.001$), a more negative attitude towards veg*nism (high meat: 11.4 ± 3.7; low meat: 8.8 ± 4.0; $p < 0.001$) and deriving lower status from PBMA consumption (high meat: 15.4 ± 3.9; low meat: 17.2 ± 4.5; $p = 0.01$). High, compared to low, frequency PBMA consumers had more concern for environmental sustainability (high PBMAs: 16.7 ± 2.3; low PBMAs: 15.1 ± 3.2; $p = 0.001$), lower meat attachment (high PBMAs: 53.0 ± 17.0; low PBMAs: 66.4 ± 10.8; $p < 0.001$), higher animal welfare concern (high PBMAs: 12.3 ± 1.6; low PBMAs: 11.1 ± 2.5; $p = 0.002$), higher climate concerns (high PBMAs: 25.6 ± 3.0; low PBMAs: 23.9 ± 4.0; $p = 0.009$) and derive more social status from PBMAs consumption (high PBMAs: 17.5 ± 4.5; low PBMAs: 15.5 ± 4.0; $p = 0.009$). Meat avoiders were found to have more concern for environmental (meat avoiders: 17.4 ± 3.0; omnivores: 15.0 ± 3.5; $p = 0.01$) and animal welfare than omnivores (meat avoiders: 13.3 ± 1.3; omnivores: 11.1 ± 2.7; $p = 0.001$). Omnivores had highest meat attachment scores (69.4 ± 9.4), followed by flexitarians (61.2 ± 11.2), and scores were much lower for meat avoiders (34.5 ± 10.4; $p < 0.001$). Omnivores (11.1 ± 3.9) and flexitarians (10.1 ± 3.8) were reported to have a more negative attitude towards veg*nism than meat avoiders (6.8 ± 3.9; $p < 0.001$). While meat avoiders derived less social status from meat consumption (9.4 ± 5.3), compared to both omnivores (15.7 ± 3.4) and flexitarians (15.1 ± 3.3; $p < 0.001$).

3.4. Effect of behavioural traits, attitudes and values responses, demographics, dietary habit and meat/PBMA consumption frequency on liking modalities and perceived similarity to meat

Table 4 presents factors with significant main effects and sample*-factor interaction effects for flavour, texture and overall liking and perceived similarity to meat. No significant main, or interaction, effects of General health interest and Impression management scores were observed on liking scores or perceived similarity to meat. PBMA consumption groups exhibited a significant main effect on liking scores and perceived similarity to meat. Age showed an interaction effect on the flavour, texture and overall liking, while gender and dietary habits exhibited interaction effects on perceived similarity to meat. Animal welfare concern had a significant main effect on all liking scores and

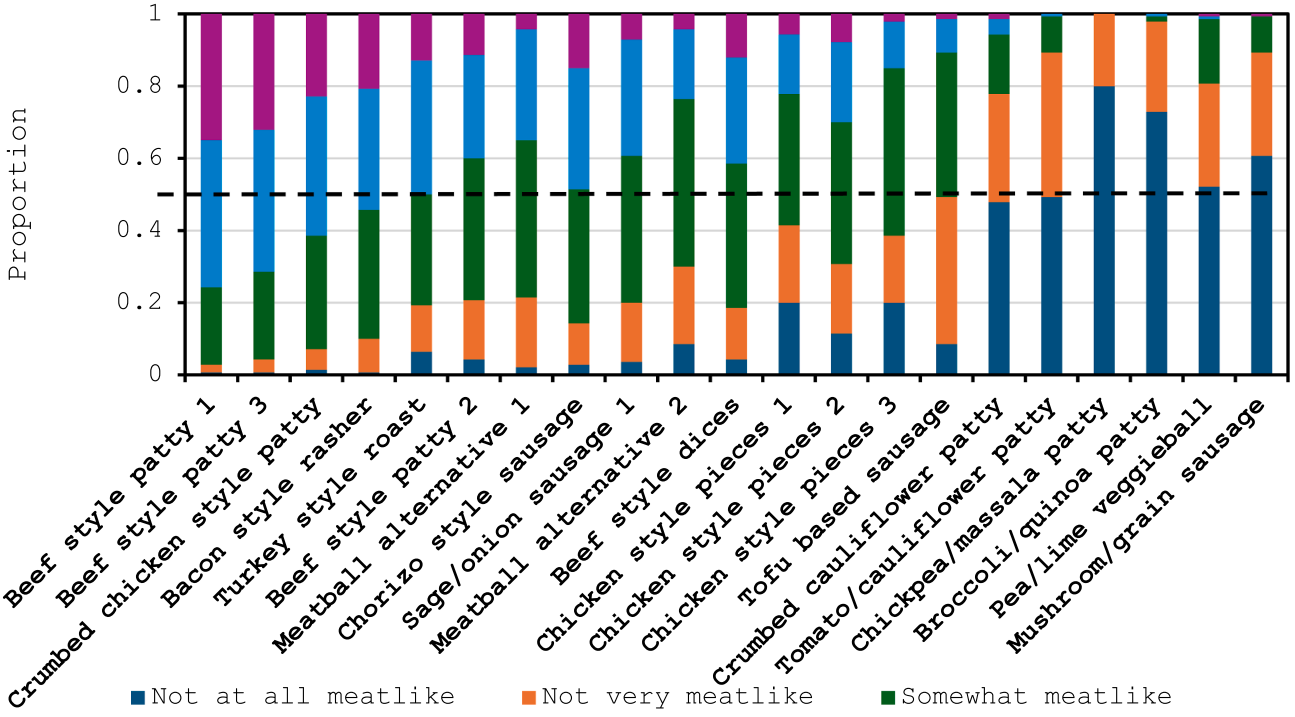

Fig. 1. Stacked bar chart showing proportion of sample categorisation based on perceived similarity to meat, ordered from most to least meat-like. The horizontal dashed line indicates the 50% mark.

Table 3
Mean scores (SD)[a,b,c,] and associated coefficient and p values[1] for demographics, meat/PBMA consumption frequency and dietary habits groups and their effect on behavioural, attitude and value trait responses.[a,b,c]

		Age		Gender			Meat consumption frequency			PBMA consumption frequency			Dietary habits			
	Overall mean	Coefficient	p-value	Male (n = 37)	Female (n = 103)	p-value	Low (n = 68)	High (n = 72)	p-value	Low (n = 87)	High (n = 53)	p-value	Omnivore (n = 58)	Flexitarian (n = 65)	Meat avoider (n = 17)	p-value
Environmental concern	15.7 ± 3.0	0.01	0.87	16.1 ± 3.4	15.6 ± 2.8	0.39	16.4 ^{A} ± 2.8	15.1^{b} ± 3.0	**0.009**	15.1^{b} ± 3.2	16.7^{a} ± 2.3	**0.001**	15.0^{b} ± 3.5	15.9^{a,b} ± 2.2	17.4 ^{A} ± 3.0	**0.01**
VARSEEK	28.4 ± 3.8	−0.05	0.26	29.6 ± 6.0	29.4 ± 5.1	0.86	29.4 ± 5.9	29.6 ± 4.8	0.84	29.7 ± 5.5	29.1 ± 5.2	0.55	29.6 ± 5.5	29.5 ± 5.6	28.6 ± 3.6	0.80
Meat attachment	51.3 ± 13.4	0.007	**0.026**	61.1 ± 17.4	61.4 ± 14.0	0.92	53.8^{b} ± 15.8	68.4^{a} ± 9.7	**<0.001**	66.4^{a} ± 10.8	53.0^{b} ± 17.0	**<0.001**	69.4^{a} ± 9.43	61.2^{b} ± 11.2	34.5^{c} ± 10.4	**<0.001**
Health interest	38.4 ± 7.2	0.009	0.93	38.7 ± 7.4	38.3 ± 7.1	0.43	38.7 ± 7.5	38.1 ± 6.9	0.57	37.7 ± 7.0	39.5 ± 7.5	0.16	37.4 ± 37.5	39.5 ± 7.2	37.7 ± 7.5	0.26
Animal welfare concern	11.6 ± 2.2	0.024	0.78	11.4 ± 2.7	11.6 ± 2.1	0.60	11.8 ± 2.2	11.3 ± 2.3	0.20	11.1^{b} ± 2.5	12.3 ^{A} ± 1.6	**0.002**	11.1^{b} ± 2.7	11.6^{b} ± 1.8	13.3 ^{A} ± 1.3	**0.001**
Naturalness scale	34.8 ± 8.6	0.32	**<0.001**	36.0 ± 9.2	34.3 ± 8.4	0.33	34.6 ± 8.9	34.9 ± 8.3	0.83	34.4 ± 8.2	35.4 ± 9.3	0.47	34.1 ± 8.3	36.0 ± 8.9	32.3 ± 7.6	0.20
Impression management score	12.8 ± 6.6	−0.012	0.78	12.6 ± 6.3	12.9 ± 6.7	0.85	13.8 ± 7.2	11.8 ± 5.9	0.08	12.6 ± 6.1	13.1 ± 7.4	0.66	12.5 ± 6.6	12.5 ± 6.3	15.0 ± 7.3	0.34
Climate concern	24.5 ± 3.8	−0.044	0.11	24.4 ± 4.3	24.6 ± 3.6	0.85	25.1 ± 3.8	24.0 ± 3.6	0.09	23.9^{b} ± 4.0	25.6^{a} ± 3.0	**0.009**	23.4^{b} ± 4.3	25.3^{a} ± 2.9	25.3^{a,b} ± 3.5	**0.01**
Attitude towards veganism	10.1 ± 4.1	0.05	0.06	11.0 ± 4.5	9.8 ± 3.9	0.14	8.8^{b} ± 4.0	11.4^{a} ± 3.7	**<0.001**	10.7^{a} ± 4.1	9.3^{b} ± 3.9	**0.046**	11.1^{a} ± 3.9	10.1^{a} ± 3.8	6.8^{b} ± 3.9	**<0.001**
Social status derived from meat	14.7 ± 4.1	−0.047	0.83	14.4 ± 4.8	14.8 ± 3.9	0.66	13.6^{b} ± 4.9	15.7^{a} ± 2.9	**0.002**	15.4^{a} ± 3.3	13.5^{b} ± 5.0	**0.008**	15.7^{a} ± 3.4	15.1^{a} ± 3.3	9.4^{b} ± 5.3	**<0.001**
Social status derived from PBMAs	16.3 ± 4.3	0.008	0.89	14.8^{b} ± 5.2	16.8^{a} ± 3.8	**0.015**	17.2^{a} ± 4.5	15.4^{b} ± 3.9	**0.01**	15.5^{b} ± 4.0	17.5^{a} ± 4.5	**0.009**	15.7 ± 4.3	16.2 ± 4.2	18.2 ± 4.4	0.11
Food safety concern	18.7 ± 5.1	0.10	**0.046**	18.5 ± 5.5	18.7 ± 5.0	0.79	18.8 ± 5.2	18.5 ± 5.1	0.69	18.5 ± 5.5	19.0 ± 4.4	0.58	18.8 ± 5.8	18.5 ± 4.7	18.7 ± 4.7	0.93

[a,b,c,] different letters in superscript indicate significant differences ($p < 0.05$) within the meat, PBMA and dietary groups. Bold p-values are significant ($p < 0.05$) [1] A mixed effect model (LME) was used to analyse each survey factor, followed by Tukey's post hoc test for multiple comparisons.

Table 4
Significant main and interaction effect (with *p* values) of survey factors, demographics, meat/PBMA consumption groups and dietary habits on the liking scores and perceived similarity to meat.

	Flavour liking		Texture liking		Overall liking		Similarity to meat	
Effects (*p*-value)								
Sample	<0.001		<0.001		<0.001		<0.001	
Factors	Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction
Age	–	0.01	–	0.019	–	0.005	–	–
Dietary habits	–	–	–	–	–	–	–	0.007
Gender	–	–	–	–	–	–	–	0.044
PBMA consumption groups	0.024	–	0.002	–	0.003	–	0.01	–
Meat consumption groups	–	–	–	0.010	–	0.040	–	–
Meat attachment	–	–	–	<0.001	–	0.002	–	0.03
Environmental concerns	–	0.016	–	–	–	–	–	–
VARSEEK	–	<0.001	–	–	–	0.04	–	–
Attitude towards veganism	0.05	–	–	–	–	–	–	–
Animal welfare concern	0.001	–	0.028	–	0.011	–	0.006	–
Social status derived from PBMAs	0.023	0.037	–	–	0.014	–	0.001	–

Main (overall effect of factors) and interaction (sample*factors) effect on liking modalities and perceived similarity to meat, determined by ANOVA of a mixed effect model ($p < 0.05$). '-' signifies factor was not included in the final model predicting the outcome variable.

perceived similarity to meat, whereas social status derived from PBMAs showed a main effect only on overall liking and perceived similarity to meat. Other factors such as meat consumption group, meat attachment, environmental concern, VARSEEK and social status derived from PBMAs showed interaction effects on different liking scores and perceived similarity to meat.

The significant main effects are plotted in Fig. 2 **A-J**. Main effects indicate a pattern between outcome of sample evaluation (liking scores and perceived similarity to meat) and behavioural traits, attitude and value responses, independent of the specific sample. High PBMA consumption (Fig. 2 A, 2D & 2F) and greater concern for animal welfare (Fig. 2B, 2E & 2G) were associated with higher ratings for flavour, texture and overall liking, as well as increased perceived similarity to meat ((Fig. 2I)). Participants with a more negative attitude towards veg*nism had lower flavour liking ratings for the samples (Fig. 2C). Higher social status derived from PBMA consumption was associated with higher overall liking (Fig. 2H) and perceived similarity to meat (Fig. 2 J).

However, sample*factor interaction effects indicated that the observed main effects could not be generalised across all samples but rather, were sample-specific (Fig. 3 **A-N**). The range of liking ratings varied less between the samples with increasing age. Samples rated as meat-like, such as beef style patty 1 and 3, Crumbed chicken style patty and Turkey style roast, received lower ratings for flavour and texture likings with increasing participant age. However, samples rated as not meat-like, such as Mushroom grain sausage, Broccoli/quinoa patty, Pea/lime veggieball and Tomato/cauliflower patty, had higher flavour, texture and overall likings with increasing age (Fig. 3A, 3B & 3H). VARSEEK scores only had a significant effect on flavour and overall liking of PBMA samples (Fig. 3B & 3I). Participants with higher variety-seeking tendencies rated not meat-like samples (Tomato/cauliflower patty, Chickpea/masala patty, Broccoli/quinoa patty, Pea/lime veggieball and Mushroom/grain sausage) higher for both flavour and overall liking. However, participants with high VARSEEK scores rated meat-like samples Crumbed chicken style patty, Beef style patty 3 and Bacon style rasher low for flavour and overall liking, except Beef style patty 1 and

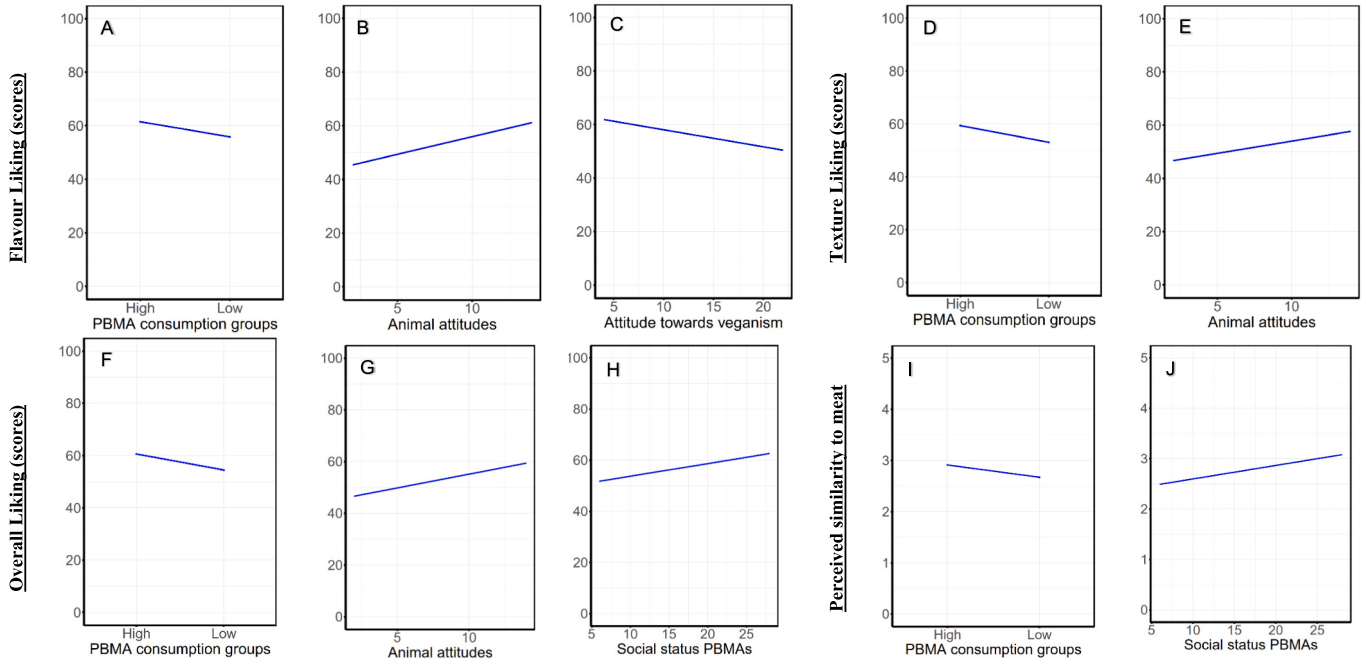

Fig. 2. A-J Main effects of significant behavioural traits, attitudes and values (columns) on flavour, texture, and overall liking, and perceived similarity to meat scores (rows).

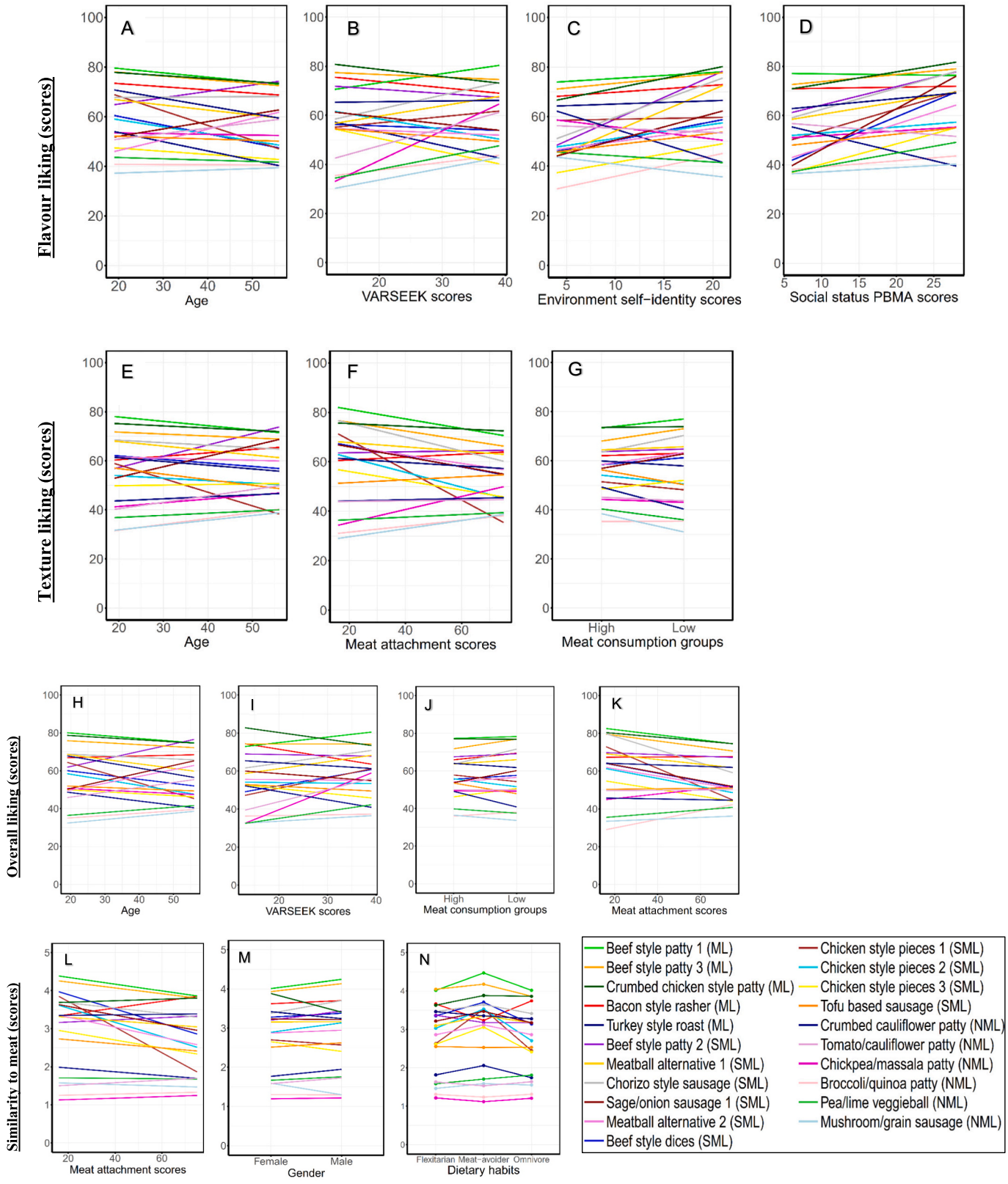

Fig. 3. A-N Interaction effects of behavioural traits, attitudes, values, age and gender (columns) on liking modalities and perceived similarity to meat (rows). "ML", "SML" and "NML" signifies meat-like, somewhat meat-like and not meat-like.

Table 5
Main and interaction effect of factors on the emotional terms 'bored', 'calm', 'disappointed', 'disgusted', 'hungry', 'neutral' and 'unhappy' with *p* values.

	Bored		Calm		Disappointed		Disgusted		Hungry		Neutral		Unhappy	
Citation (%)	10		16		21		10		26		17		13	
n engaged	104		112		129		101		109		128		115	
	Effects (p-value)													
Sample	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Factors	Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction
Dietary habits	–	–	–	–	–	–	NS	–	–	–	–	–	0.029	–
Age	–	–	–	–	–	–	NS	–	NS	–	–	–	NS	–
Gender	–	–	–	–	–	0.004	–	–	<0.001	–	–	–	NS	–
Meat consumption group	–	–	NS	–	–	–	–	–	NS	–	–	–	NS	–
PBMA consumption group	0.02	–	–	–	–	–	0.05	–	0.002	–	–	–	–	–
VARSEEK	NS	–	–	–	–	–	–	–	NS	–	–	–	0.026	–
Meat attachment	–	<0.001	–	<0.001	–	–	–	–	–	0.002	NS	–	NS	–
Naturalness scale	–	–	–	–	–	–	0.02	–	0.035	–	–	–	–	–
Health concern	–	–	–	–	–	–	–	–	NS	–	–	–	–	–
Environment self-identity	–	–	–	–	–	–	–	–	NS	–	–	–	–	–
Animal welfare concern	–	–	–	–	–	–	–	–	NS	–	–	–	<0.001	–
Impression management	–	–	–	–	–	–	–	–	–	<0.001	–	–	–	–
Climate concern	0.009	–	–	–	–	–	–	–	NS	–	–	–	–	–
Attitude towards veganism	0.03	–	–	–	–	–	0.02	–	0.033	–	<0.001	–	–	0.025
Social status meat	–	–	–	–	–	–	–	–	0.002	–	–	–	–	–
Social status PBMAs	–	–	–	–	–	–	–	–	0.004	–	NS	–	–	–
Concern food safety	–	0.004	–	–	–	–	–	–	NS	–	NS	–	NS	–
Participant	–	–	<0.001	–	<0.001	–	–	–	–	–	–	–	–	–

Significant main (overall effect of factors) and interaction (sample*factors) effects on emotions, determined by ANOVA of GLMs model (binary data). '-' signifies factor was not included in the final model predicting the outcome variable. NS signifies factor was included in the final model as determined by the 'step' function, but factor did not significantly affect the outcome variable.

Chorizo style sausage. High environment self-identity scores were associated with higher flavour liking of meat-like PBMAs (Fig. 3C). With some exceptions, high social status derived from PBMA consumption was associated with higher flavour liking for all the samples (Fig. 3D). With increase in meat attachment (Fig. 3F & 3 K), the texture and overall liking of Beef style patty 1 and 3, Crumbed chicken style patty (meat-like samples) and Chorizo style sausages (somewhat meat-like) decreased. While not meat-like samples such as Mushroom/grain sausage, Broccoli/quinoa patty, Pea/lime veggieball and Chickpea masala patty exhibited an increase in texture and overall liking with higher meat attachment. High meat attachment was associated with a decrease in perceived similarity to meat for most of the meat-like and somewhat meat-like samples except Crumbed chicken patty, Bacon style rasher and Beef style patty 2 (Fig. 3 L). The high meat consumption group reported lower texture and overall liking for meat-like samples (Beef style patty 1and 3 and Bacon style rasher) and somewhat meat-like samples (Beef style patty 2, Chorizo style sausages and Sage/onion sausages) (Fig. 3G & 3 J). In contrast, an opposite trend was observed for Chicken style pieces 2, Tofu based sausage, Crumbed cauliflower, Mushroom/grain sausages and Pea/lime veggieball (all not meat-like except chicken style pieces 2), which showed increase in texture and overall liking in high meat consumption group.

Perceived similarity to meat also varied by gender and dietary habits (Fig. 3 M & 3 N). Females considered meat-like and somewhat meat-like samples such as Beef style patty 1, 2 and 3, Bacon style rasher, Chorizo style sausage, Meatball alternatives 2 and Chicken style pieces 2 to be less similar to meat, while male participants rated these samples to be more similar to meat. Meat avoiders rated the Beef style patty 1 and 3, Chorizo style sausages and Beef style dices higher for similarity to meat compared to flexitarians and omnivores. In contrast, meat avoiders rated chickpea masala patty, Broccoli/quinoa patty and Tomato/cauliflower patty as less similar to meat than flexitarians and omnivores. Omnivores perceived the crumbled cauliflower patty and chicken style pieces 3 as less meat-like compared to flexitarians and meat avoiders, whereas omnivores perceived Pea/lime veggie ball to be more meat-like than both flexitarians and meat avoiders.

3.5. Effect of behavioural traits, attitude and value responses, demographics, dietary habits and meat/PBMA consumption frequency on emotional response

'Afraid', 'angry', 'anxious', 'deceived', 'energetic', 'loving' and 'nostalgic' were excluded from analysis as their citation was below 10 %, and/or was engaged with by less than 100 participants. According to the GLM, citation proportions for 'adventurous', 'calm', 'curious', 'dissatisfied', 'happy', 'hopeful, 'pleasant', 'satisfied', 'suspicious' and 'uncertain' were significantly affected by sample and participant (all $p < 0.001$) and 'amazed' was only affected by samples ($p < 0.001$), none were affected by demographics, dietary habits, behavioural traits, attitudes or values.

Table 5 presents the factors with significant main effects on emotional terms 'bored', 'disgusted', 'hungry', 'unhappy', and 'neutral'. Additionally, sample*factor interaction effects were significant for 'bored', 'disappointed', 'unhappy and 'hungry'. No significant main or interaction effects of General health interest and Environmental concern scores were observed on emotional responses. Attitude towards veganism, social status derived from meat and PBMA exhibited significant main effects on emotional terms, while gender, meat attachment and impression management showed interaction effects.

Main factor effects on emotional terms (no sample by factor interactions were identified) are shown in **Fig. 4 A-N**. Participants in the low PBMA consumption group exhibited higher citation proportions for 'bored' and 'disgusted' (Fig. 4A & 4D) and a lower citation proportion for 'hungry' (Fig. 4F). Negative attitude towards vegan*ism was associated with a higher citation proportion for 'bored', 'disgusted', 'unhappy' and 'neutral' (Fig. 4B, 4E, 4 K & 4 N) and a low citation

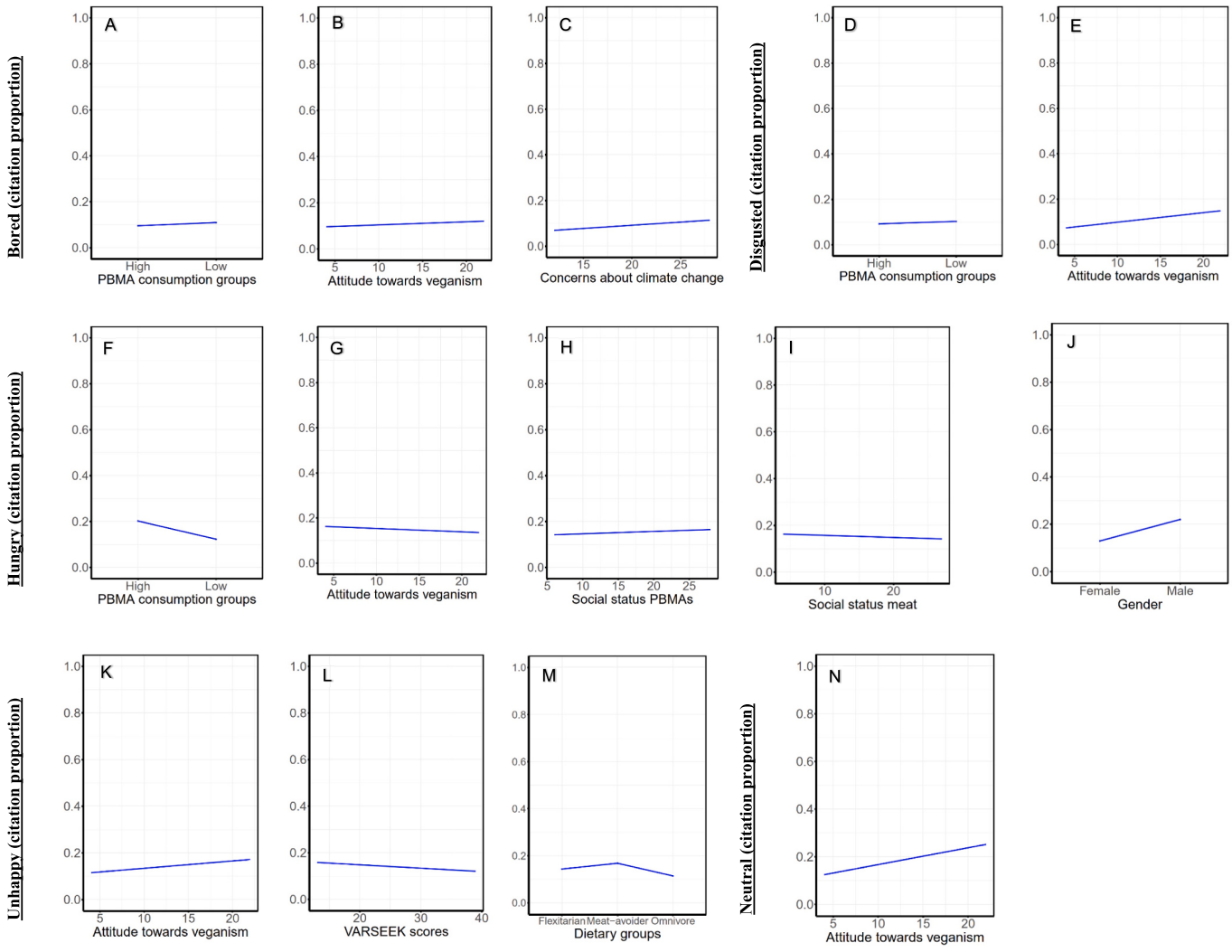

Fig. 4. A-N Main effects of significant behavioural traits, attitudes, values and demographics (columns) on emotional terms 'bored', 'disgusted', 'hungry', 'neutral' and 'unhappy' (rows).

proportion for 'hungry' (Fig. 4G). Increased concern about climate change was also associated with a higher citation proportion for 'bored' (Fig. 4C). Higher social status derived from meat was associated with lower citation proportion for 'hungry' (Fig. 4I), while participants deriving higher social status from PBMA exhibited a higher citation proportion for 'hungry' (Fig. 4H). Female participants demonstrated a lower citation proportion for 'hungry' compared to male participants (Fig. 4 J). High variety seeking scores were associated with a lower citation proportion for 'unhappy', while low VARSEEK scores were associated with a higher citation proportion for 'unhappy' (Fig. 4 L). Lastly, meat avoiders showed high citation proportion for 'unhappy' than omnivores and flexitarians (Fig. 4 M).

Interaction effects between samples and participant factors on citation proportions for emotions such as 'bored', 'disappointed', 'hungry' and 'unhappy' were identified and interaction plots are presented in **Fig. 5 A-F.** Most samples exhibited lower citation proportion for 'bored' with increasing meat attachment scores (Fig. 5 A), except for Chicken style pieces 1, 2 and 3. These samples showed higher citation proportion for 'bored' with increased meat attachment. Broccoli/quinoa patty, Chickpea/masala patty and Mushroom/grain sausage (not meat-like wholefood samples) showed strongest association between citation proportion for 'bored' and food safety concerns (Fig. 5B). In contrast, the beef style patty 2 and Chicken style pieces 2 and 3 showed consistently low citation proportion for 'bored', with increased food safety concerns. High meat attachment scores were associated with a higher citation proportion for 'hungry' in the bacon style rasher, beef style patty 3 and Tofu based sausage (Fig. 5E). Similarly, high impression management score was associated with increased citation proportion for 'hungry' in Turkey style roast, Beef style dices, Chicken style pieces 3 and Meatball alternative 1 (Fig. 5F). A more negative attitude towards vegan*ism was linked to a higher citation proportion for 'unhappy' in the not meat-like wholefood samples (Pea/lime veggieball, Broccoli/quinoa patty, Mushroom/grain sausage, Chickpea masala patty and Tomato/cauliflower patty), while lower citation proportion for 'unhappy' in the somewhat meat-like samples (Chicken style patty 1 and 3) (Fig. 5D).

Interaction effects between samples and gender were observed for citation proportions for 'disappointed' **(Fig. 5C).** Female participants reported a lower citation proportion for 'disappointed' with Tofu-based sausage and Pea/lime veggieball, but a higher citation proportion for Broccoli/quinoa patty, Mushroom/grain sausage, Sage/onion sausage 1 and Chicken style pieces 3. Male participants exhibited the opposite trend, highlighting gender-based differences in emotional responses to specific samples.

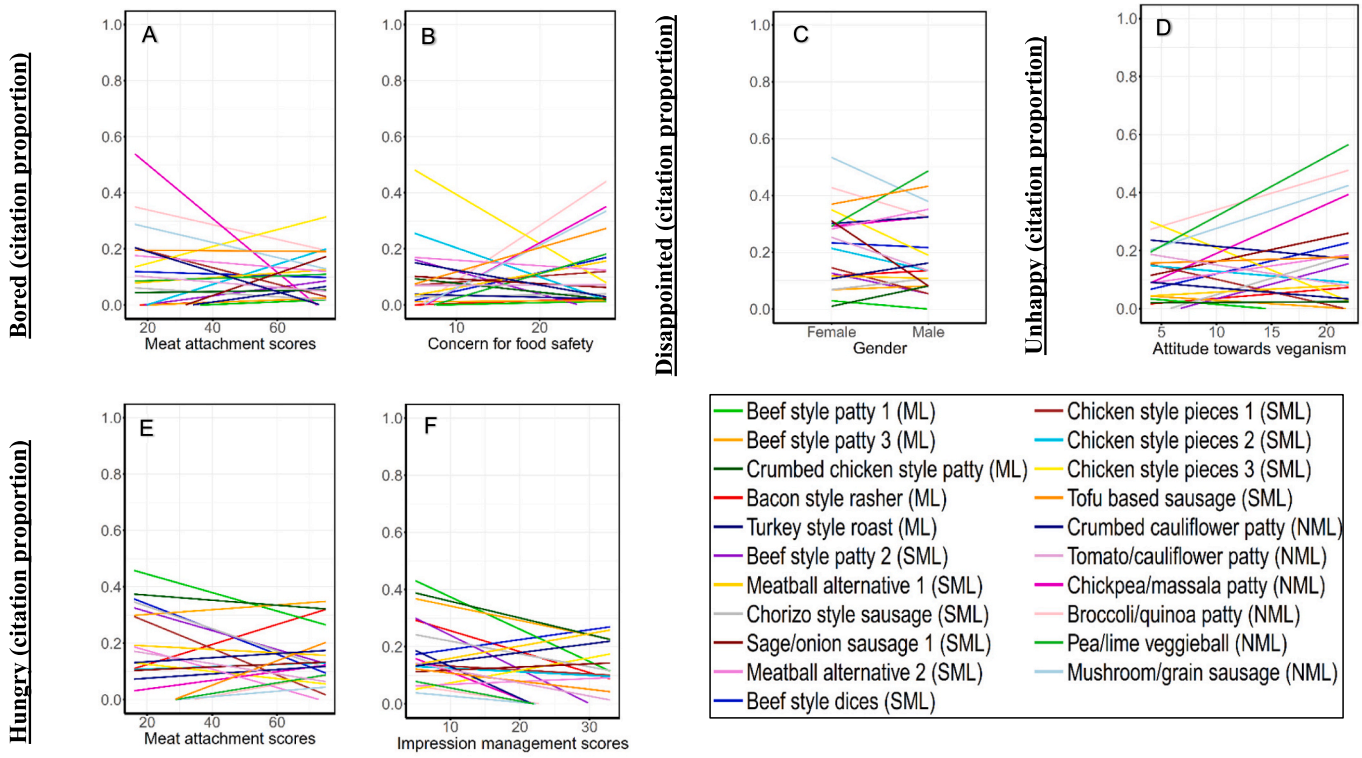

Fig. 5. A-F Interaction effects of behavioural traits, attitudes, values and gender (columns) on emotional terms ('bored', 'disappointed', 'unhappy' and 'hungry') "ML", "SML" and "NML" signifies meat-like, somewhat meat-like and not meat-like.

4. Discussion

This study determined that some behavioural traits, attitudes, values, demographics and dietary habits significantly effect PBMA evaluation, both in a general and product-specific manner. The findings suggest that, in addition to these factors shaping consumer motivation to reduce meat consumption or adopt PBMAs, they also play a critical role in shaping sensory and product experience during consumption. High PBMA consumption frequency, concern for animal welfare, positive attitudes towards veg*nism and social status derived from PBMA consumption were consistently associated with higher ratings of one or more liking modalities, regardless of the sample. Moreover, this study also highlighted that a multitude of participant demographics, behavioural traits, attitudes and values affected product evaluation in a sample-dependent manner. Therefore, when investigating the effect of these factors on meat reduction or PBMA consumption, the samples should be considered based on their perceived similarity to meat rather than generalising across the PBMA product category.

As associations exist between meat/PBMA consumption frequencies and behavioural traits and values (Giacalone, Clausen, & Jaeger, 2022; Safdar et al., 2022), it is not surprising that these traits and values also influenced sample evaluation in this study. Effects found in the current study could, indeed, be a result of these traits/values, but this could be confounded by consumption frequency. Specifically, individuals with higher PBMA or meat consumption frequencies might evaluate PBMAs differently due to greater product familiarity, which could obscure the isolated influence of traits or values on sample evaluation. Nevertheless, the results indicate that previous experience with PBMAs is related to a more positive product experience overall, regardless of the sample, and highlights that repeated exposure to PBMAs is a key strategy to improve PBMA product experience overall and hence increase their consumption.

4.1. Relationship between behavioural traits, attitudes and values and demographics, dietary habits and meat/PBMA consumption frequency

Behavioural traits, attitudes and values significantly affected meat and PBMA consumption frequency and dietary habits. Lower scores for environmental self-identity, higher meat attachment, a negative attitude towards vegan*ism and increased social status derived from meat consumption was associated with high meat consumption whereas the opposite was found for high PBMA consumption. These findings are not surprising given that the behavioural, attitude and value traits measured in this study have been previously shown to segment flexitarians (Weerawarna et al., 2024). Meat avoiders gave higher scores than omnivores in terms of animal welfare attitudes, whereas flexitarians scored higher than omnivores for concern about climate change (Weerawarna et al., 2024). The present study results emphasised that underlying reasons for meat reduction, whether through complete avoidance or reduction, may differ across dietary groups. These findings align with previous studies (Beardsworth & Keil, 1991; Fox & Ward, 2008; Ruby, 2012), which indicate that meat avoiders or vegetarians are typically health conscious and ethically driven. Health and animal welfare are their primary motivators, while environmental concerns exert comparatively less influence on their dietary choices.

Gender only impacted social status derived from PBMA consumption. Being female was identified as a motivator for substitution of meat with PBMAs (Eckl, Biesbroek, Van't Veer, & Geleijnse, 2021), and it indicates that female may consume PBMAs more for virtue signaling reasons than men. This supports previous findings indicating that female were more likely to belong to health- and environment-driven clusters, while taste- and organic-driven clusters tend to be male-dominated (Apostolidis & McLeay, 2016). Furthermore, female anticipated feeling more 'proud' to eat a plant-based, compared to meat burger, when compared to men (Zandstra et al., 2024). However, it is worth noting that the current sample included a higher proportion of female participants, which may have influenced these results. Future studies

with a more balanced gender representation are required to confirm and expand upon these findings. Older age, on the other hand, was associated with higher meat attachment, in agreement with previous literature (Eckl et al., 2021).

4.2. Effect of behavioural traits, attitudes values, demographics, dietary habit and meat/PBMA consumption frequency on liking modalities and perceived similarity to meat

The current study's results confirm that sensory evaluation during PBMA tasting is affected by consumer behavioural traits, attitudes and values. Factors such as PBMA consumption groups, negative attitude towards veg*nism and meat attachment were associated with lower product liking. These findings are in agreement with studies on PBMA perception, where characteristics associated with high meat consumption frequency, meat attachment, social status derived from meat, and negative attitudes towards veg*nism were associated with more negative evaluation of PBMA samples (Demartini, Vecchiato, Finos, Mattavelli, & Gaviglio, 2022; Jahn, Furchheim, & Strässner, 2021; Kim et al., 2024; Lähteenmäki & Arvola, 2001; MacDonald et al., 2023; Weerawarna et al., 2024). However, some of the results were unexpected and are discussed below.

In previous studies, climate concerns and environmental sustainability are often highlighted as major drivers for PBMA consumption (He, Evans, Liu, & Shao, 2020; Vainio, Irz, & Hartikainen, 2018). However, this study found no significant impact of these factors on the sensory experience of the samples. This suggests that while environmental concerns may influence intention to consume PBMA, they have minimal effect on actual product experience. Interestingly, in the present study, perceived social status derived from meat and PBMA consumption was repeatedly associated with sample evaluation, in opposing manners. This shows that consumers were less affected by environmental, self-identity and climate concerns, but more by the perceived social status they gained from eating these products. A similar point was raised by Hoek et al. (2013), who highlighted, albeit over a decade ago, that non-users of meat substitutes did recognise such products as more ethical, but this knowledge did not influence choice of these products due to low ethical value orientation (Hoek Luning et al., 2011).

Low PBMA consumption frequency and a negative attitude towards veg*nism was associated with lower flavour, texture and overall liking of PBMA products. This may be attributed to two main reasons. First, unfamiliarity with the sensory properties of PBMAs may create a sense of disconnection with their expectations (Hoek Luning et al., 2011). Second, deeply ingrained dietary habits and preferences make individuals less willing to accept alternatives to traditional meat products (Pohjolainen, Vinnari, & Jokinen, 2015). However, evidence from a repeated consumption investigation suggests that liking for PBMAs can improve as individuals become more familiar with the sensory characteristics through repeated exposure (Hoek et al., 2013).

Higher meat attachment was associated with lower texture and overall liking scores, as well as low perceived similarity to meat, for most of the meat-like samples and somewhat meat-like samples. The negative association between liking of meat-like samples could be attributed to their inability to replicate the distinct texture and taste experience that real meat provides (Graça, Calheiros, & Oliveira, 2015; Lea & Worsley, 2001, 2003). Previous research have also shown that consumers generally prefer PBMAs that closely mimic meats in terms of flavour and texture, particularly among consumers which have high meat attachment and consume meat frequently (Chen & Zhang, 2022; Elzerman, van Dijk, & Luning, 2022; Estell, Hughes, & Grafenauer, 2021). Wholefood PBMAs samples were associated with similar or slightly higher liking with high meat attachment scores, indicating that wholefood PBMAs failed to meet consumer acceptance across the board, and require substantial product development. No strong effects of PBMA consumption groups on any liking outcomes were reported. This may be because meat intake is a more discriminative factor than PBMA intake, as individuals can replace meat with various alternatives such as tofu, tempeh, seitan and legumes. Lastly, variety seeking behaviour has previously been associated with the incorporation of PBMA into diets (Zhang, 2022). Similar results were also observed in the present study, where high VARSEEK scores were associated with a positive flavour and overall liking ratings of the not meat-like samples.

Gender, dietary habits and meat attachment especially influenced how meat-like and somewhat meat-like samples were perceived. Female perceived these samples as less similar to meat than male, meat avoiders scored them higher for perceived meat-likeness than omnivores and flexitarians. Interestingly, previous studies involving online surveys and comparisons of PBMAs with hybrid or meat products have found that vegetarians and flexitarians were identified to have similar, more positive, perceptions of PBMAs compared to omnivores (Haas, Schnepps, Pichler, & Meixner, 2019; Michel et al., 2021; Pointke, Ohlau, Risius, & Pawelzik, 2022). Many of these studies were conducted in European countries, where the motivation to adopt PBMAs is stronger (Sanchez-Sabate & Sabaté, 2019), while this trend is still emerging in New Zealand, the largest exporter of meat (Realini et al., 2023). In the present study, similarity to meat perceived by flexitarians was more comparable to omnivores than to meat avoiders. This difference may be aligned to the fact that flexitarians have not completely eliminated meat from their diet, making it easier for them to compare PBMAs to meat-based products, as meat is still part of their dietary experience. In the current study, meat attachment was strongly associated with lower perceived similarity to meat, especially for the 'somewhat' meat-like samples, indicating meat-attached consumers have a higher threshold for products to be described as meat-like.

4.3. Effect of demographics, dietary habits and meat/PBMA consumption frequency and survey outcome on emotional responses

Attitude towards veganism, social status derived from meat and PBMA exhibited a significant main effect on emotional response when tasting PBMAs. Individuals with a negative attitude towards veganism tend to have preconceived expectations of dissatisfaction regarding the sensory properties of PBMAs (Starowicz et al., 2022). When these expectations are confirmed, it leads to more negative emotions (Piqueras-Fiszman & Spence, 2015). This trend is evident in the present study where participants with higher negative attitude towards veg*nism exhibited more negative emotions towards the not meat-like samples compared to the meat-like samples. Previous studies have also linked negative attitude towards veganism to several negative emotions such as disgust, anger and discomfort (McDonald, 2000). In the current study, high PBMA consumption was associated with lower citation frequency of negative emotions such as 'bored' and 'disgusted', likely due to more familiarity with the products. Similarly higher variety seeking scores were associated with lower citation frequency for low negative emotions, likely due to their curiosity to try the new products.

The emotion 'hungry' was affected by several factors. Low PBMA consumption frequency, a more negative attitude towards veg*nism, more social status derived from meat and higher scores on the naturalness scale were associated with lower citations for 'hungry'. More social status derived PBMAs exhibited higher citations for 'hungry' likely because participants were more motivated to choose ethical foods (Bryant, 2019; Hoek et al., 2011). However, participants with high naturalness scale scores showed lower citation of 'hungry'. This may be because PBMAs are often perceived as artificial and highly processed, which conflicts with their preference for natural and less processed foods (Spendrup & Hovmalm, 2022).

Meat avoiders were found to report more negative emotions, such as "unhappy," when tasting whole-food PBMAs compared to omnivores and flexitarians. This result appears counterintuitive, given that meat avoiders and vegetarians typically express strong environmental, ethical, and animal-welfare motivations for consuming PBMAs (De

Backer & Hudders, 2015; Hagmann, Siegrist, & Hartmann, 2019; Lund, McKeegan, Cribbin, & Sandøe, 2016). However, these findings underscore the central role of sensory quality in shaping consumer experience. Despite their strong ethical motivations, meat avoiders' overall liking and emotional response can be negatively impacted when sensory expectations are not met (Elzerman, Hoek, Van Boekel, & Luning, 2011; Giezenaar, Coetzee, Godfrey, Foster, & Hort, 2024; Zioga, Tøstesen, Madsen, Shetty, & Bang-Berthelsen, 2022). Prior studies have described undesirable textural characteristics — such as grittiness, sliminess, and doughiness — as main barriers to PBMA acceptance (Giezenaar, Coetzee, et al., 2024). Thus, even highly motivated consumer groups may respond with negative emotions when the sensory properties of wholefood PBMAs fall short of their expectations.

Gender differences were also observed in emotional responses: female participants felt more 'disappointed' with less meat-like samples, while male participants cited 'disappointed' more for the meat-like samples. Previous studies showed that males tend to prefer a more meat-based diet over vegetarian or vegan options due to factors such as unfamiliarity, masculinity, taste preference and social stigma (Rosenfeld & Tomiyama, 2021). Therefore, for male participants, the taste preference of meat-like PBMAs sample may not have satisfied their expectations, resulting in more negative emotions. The most notable findings in this study were that 'amazed' was only significantly affected by the samples, not affected by participant behavioural traits, attitude and values, suggesting that sample sensory properties were the main drivers of amazement.

4.4. Impression management scores and general health interest

In contrast to factors affecting product evaluation, General Health Interest was not associated with either liking ratings or emotional response. However, some aspects of product evaluation were associated with the naturalness scale score. Previous research indicates that PBMAs are not necessarily perceived as healthier than meat, however, perceptions of health and naturalness were strongly correlated (Hartmann, Furtwaengler, & Siegrist, 2022). In this study, it could be possible that the samples were either not perceived as healthy or were all perceived as equally healthy, which may explain why General interest in health did not impact the evaluation. Instead, consumer's concern for naturalness is discerning for this product category, highlighted by a negative association between naturalness scale scores and feelings of 'disgust' in response to the wholefoods samples which had a less processed nature than the meat-like samples. The findings align with previous studies (Weerawarna et al., 2024), where consumers preferred wholefood PBMAs free from genetically modified ingredients.

Furthermore, impression management scores did not affect sample evaluation, indicating that consumers are not more likely to experience PBMAs positively because they are concerned about approval from their peers. However, social status derived from PBMAs did affect overall liking of the sample especially in case of females. Previous research has indicated that flexitarians associated meat consumption with social status (Dagevos & Voordouw, 2013; Weerawarna et al., 2024), linking it to wealth and masculinity (McIntyre, Li, Chapman, Lipson, & Ellison, 2011; Stanley, Day, & Brown, 2023). In contrast, PBMA consumption has been associated with prestige (Dagevos & Voordouw, 2013) and virtue (Levy, 2021), helping to build perception of moral character.

4.5. Limitations

This is the first study to explore how consumer behavioural traits, attitudes, and values—alongside dietary habits and demographic factors—influence the affective evaluation (both liking and emotional responses) of PBMAs, both generally and in relation to their perceived similarity to meat. However, several limitations should be acknowledged. First, the participant sample was overrepresented by female respondents, and consumer studies requires equal representations of gender for more relevant outcomes (Lakshmi, Niharika, & Lahari, 2017; Pirlympou, 2017). Additionally, the diet groups were unevenly distributed, with relatively few meat avoiders compared to omnivores and flexitarians. This imbalance could limit the generalizability of the results to those with more plant-based diets. Future research should aim for a more balanced sample in terms of gender and dietary representation to enhance the robustness and applicability of the findings.

5. Conclusions

To conclude, consumer behavioural traits, attitudes, values and dietary habits significantly influenced affective responses (liking and emotions) towards PBMAs, both in general and in relation to their perceived similarity to meat. The high meat consumption group reported lower liking and more negative emotions towards meat-like PBMAs, highlighting the need for further improvement in this product category to enhance meat like properties. Similarly, negative emotional responses from meat avoiders towards wholefood PBMAs suggest a need for improved formulation that align with consumer expectations. While environmental and animal concerns are often considered as key drives of PBMAs liking, our results suggests that these factors alone do not directly influence affective responses. Social status derived from PBMA/meat, PBMA consumption frequency, dietary habits and gender have significant effect on affective responses during tasting. These findings emphasised the important role of consumer characteristics in shaping the tasting experience and perception of PBMAs.

CRediT authorship contribution statement

Caroline Giezenaar: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Annu Mehta:** Writing – original draft, Formal analysis. **Rebekah E. Orr:** Writing – review & editing, Methodology, Formal analysis. **A. Jonathan R. Godfrey:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Meika Foster:** Writing – review & editing, Supervision, Funding acquisition. **Joanne Hort:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Ethical statement

The study was submitted to the Massey University Human Ethics process and was judged to be low risk (Application ID 4000025647). Participants were asked to read an information sheet providing the study details and gave written informed consent before participation. Participants were assigned a unique code to ensure anonymity and were offered a supermarket voucher to compensate for their time.

Funding

This work was funded by a NZ Ministry of Business Innovation and Employment (MBIE) Catalyst Grant (MAUX2001).

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.

Acknowledgements

The authors wish to acknowledge the support of Robyn Maggs, Rosie Linklater, and Dianne Fountaine-Cody, for their support with organisation of the study and help with the study sessions. Furthermore, we thank Vince (Olive & Ash Ltd), Let's Eat Plant Based (Inghams Enterprises NZ Pty Ltd) and Plan*t (Sustainable Foods Ltd) for provision

samples that were included in the study.

Data availability

The data that has been used is confidential.

References

Ajzen, I. (2005). *Attitudes, personality and behaviour* (second ed.). McGraw-hill education (UK).

Andreani, G., Sogari, G., Marti, A., Froldi, F., Dagevos, H., & Martini, D. (2023). Plant-based meat alternatives: Technological, nutritional, environmental, market, and social challenges and opportunities. *Nutrients, 15*(2), 452.

Apostolidis, C., & McLeay, F. (2016). Should we stop meating like this? Reducing meat consumption through substitution. *Food Policy, 65*, 74–89.

Barr, S. (2006). Environmental action in the home: Investigating the 'value-action'gap. *Geography, 91*(1), 43–54.

Beardsworth, A. D., & Keil, E. T. (1991). Vegetarianism, veganism, and meat avoidance: Recent trends and findings. *British Food Journal, 93*(4), 19–24.

Blake, J. (1999). Overcoming the 'value-action gap'in environmental policy: Tensions between national policy and local experience. *Local Environment, 4*(3), 257–278.

Bryant, C., & Sanctorum, H. (2021). Alternative proteins, evolving attitudes: Comparing consumer attitudes to plant-based and cultured meat in Belgium in two consecutive years. *Appetite, 161*, Article 105161.

Bryant, C. J. (2019). We can't keep meating like this: Attitudes towards vegetarian and vegan diets in the United Kingdom. *Sustainability, 11*(23), 6844.

Bryant, C. J. (2022). Plant-based animal product alternatives are healthier and more environmentally sustainable than animal products. *Future Foods, 6*, Article 100174.

Bschaden, A., Mandarano, E., & Stroebele-Benschop, N. (2020). Effects of a documentary on consumer perception of the environmental impact of meat consumption. *British Food Journal, 123*(1), 177–189.

Cardello, A. V. (1996). The role of the human senses in food acceptance. In *Food choice, acceptance and consumption* (pp. 1–82). Springer.

Cembalo, L., Caracciolo, F., Lombardi, A., Del Giudice, T., Grunert, K. G., & Cicia, G. (2016). Determinants of individual attitudes toward animal welfare-friendly food products. *Journal of Agricultural and Environmental Ethics, 29*, 237–254.

Chen, Y., & Zhang, Z. (2022). Exploring public perceptions on alternative meat in China from social media data using transfer learning method. *Food Quality and Preference, 98*, Article 104530.

Core, R. T. (2019). *R: A language and environment for statistical computing. In*. Vienna, Austria: R Foundation for Statistical Computing.

Corner, A., Markowitz, E., & Pidgeon, N. (2014). Public engagement with climate change: The role of human values. *Wiley Interdisciplinary Reviews: Climate Change, 5*(3), 411–422.

Dagevos, H., & Voordouw, J. (2013). Sustainability and meat consumption: Is reduction realistic? *Sustainability: Science, Practice and Policy, 9*(2), 60–69.

De Backer, C. J., & Hudders, L. (2015). Meat morals: Relationship between meat consumption consumer attitudes towards human and animal welfare and moral behavior. *Meat Science, 99*, 68–74.

Demartini, E., Vecchiato, D., Finos, L., Mattavelli, S., & Gaviglio, A. (2022). Would you buy vegan meatballs? The policy issues around vegan and meat-sounding labelling of plant-based meat alternatives. *Food Policy, 111*, Article 102310.

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.

Elzerman, J. E., Hoek, A. C., Van Boekel, M. A., & Luning, P. A. (2011). Consumer acceptance and appropriateness of meat substitutes in a meal context. *Food Quality and Preference, 22*(3), 233–240.

Elzerman, J. E., van Dijk, P. E., & Luning, P. A. (2022). Substituting meat and the role of a situational context: Exploring associations and motives of Dutch meat substitute-users. *British Food Journal, 124*(13), 93–108.

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.

Ettinger, L., Falkeisen, A., Knowles, S., Gorman, M., Barker, S., Moss, R., & McSweeney, M. B. (2022). Consumer perception and acceptability of plant-based alternatives to chicken. *Foods, 11*(15), 2271.

Fox, N., & Ward, K. (2008). Health, ethics and environment: A qualitative study of vegetarian motivations. *Appetite, 50*(2–3), 422–429.

Giacalone, D., Clausen, M. P., & Jaeger, S. R. (2022). Understanding barriers to consumption of plant-based foods and beverages: Insights from sensory and consumer science. *Current Opinion in Food Science, 48*, Article 100919.

Giezenaar, C., Coetzee, P., Godfrey, A. J. R., Foster, M., & Hort, J. (2024). Motivators and barriers to plant-based product consumption across Aotearoa New Zealand flexitarians. *Food Quality and Preference, 117*, Article 105153.

Giezenaar, C., Godfrey, A. J. R., Foster, M., & Hort, J. (2024). Effects of intrinsic and extrinsic product characteristics related to protein source, health and environmental sustainability, on product choice and sensory evaluation of meatballs and plant-based alternatives. *Food Quality and Preference, 113*, Article 105070.

Giezenaar, C., Orr, R. E., Godfrey, A. J. R., Maggs, R., Foster, M., & Hort, J. (2024). Profiling the novel plant-based meat alternative category: Consumer affective and sensory response in the context of perceived similarity to meat. *Food Research International, 188*, Article 114465.

Goldstein, B., Moses, R., Sammons, N., & Birkved, M. (2017). Potential to curb the environmental burdens of American beef consumption using a novel plant-based beef substitute. *PLoS One, 12*(12), Article e0189029.

Graça, J., Calheiros, M. M., & Oliveira, A. (2015). Attached to meat?(un) willingness and intentions to adopt a more plant-based diet. *Appetite, 95*, 113–125.

Graça, J., Oliveira, A., & Calheiros, M. M. (2015). Meat, beyond the plate. Data-driven hypotheses for understanding consumer willingness to adopt a more plant-based diet. *Appetite, 90*, 80–90.

Grasso, S., Rondoni, A., Bari, R., Smith, R., & Mansilla, N. (2022). Effect of information on consumers' sensory evaluation of beef, plant-based and hybrid beef burgers. *Food Quality and Preference, 96*, Article 104417.

Haas, R., Schnepps, A., Pichler, A., & Meixner, O. (2019). Cow milk versus plant-based milk substitutes: A comparison of product image and motivational structure of consumption. *Sustainability, 11*(18), 5046.

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., Furtwaengler, P., & Siegrist, M. (2022). Consumers' evaluation of the environmental friendliness, healthiness and naturalness of meat, meat substitutes, and other protein-rich foods. *Food Quality and Preference, 97*, Article 104486.

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.

Hoek, A. C., Elzerman, J. E., Hageman, R., Kok, F. J., Luning, P. A., & de Graaf, C. (2013). Are meat substitutes liked better over time? A repeated in-home use test with meat substitutes or meat in meals. *Food Quality and Preference, 28*(1), 253–263.

Hoek Luning, P. A., Weijzen, P., Engels, W., Kok, F. J., & De Graaf, C. (2011). Replacement of meat by meat substitutes. A survey on person-and product-related factors in consumer acceptance. *Appetite, 56*(3), 662–673.

Horlings, L. G. (2015). The inner dimension of sustainability: Personal and cultural values. *Current Opinion in Environmental Sustainability, 14*, 163–169.

Institute, G. F. (2021). *US retail market data for the plant-based industry*. Washington, DC: The good food institute.

Ioannidou, M., Lesk, V., Stewart-Knox, B., & Francis, K. B. (2023). Moral emotions and justifying beliefs about meat, fish, dairy and egg consumption: A comparative study of dietary groups. *Appetite, 186*, Article 106544.

Jaeger, S. R., de Matos, A. D., Oduro, A. F., & Hort, J. (2024). Sensory characteristics of plant-based milk alternatives: Product characterisation by consumers and drivers of liking. *Food Research International, 180*, Article 114093.

Jahn, S., Furchheim, P., & Strässner, A.-M. (2021). Plant-based meat alternatives: Motivational adoption barriers and solutions. *Sustainability, 13*(23), Article 13271.

Kim, A., Öström, Å., Mihnea, M., & Niimi, J. (2024). Consumers' attachment to meat: Association between sensory properties and preferences for plant-based meat alternatives. *Food Quality and Preference, 116*, Article 105134.

Krishna, A., & Elder, R. S. (2021). A review of the cognitive and sensory cues impacting taste perceptions and consumption. *Consumer Psychology Review, 4*(1), 121–134.

Lähteenmäki, L., & Arvola, A. (2001). Food neophobia and variety seeking—Consumer fear or demand for new food products. In *Food, people and society: A European perspective of consumers' food choices* (pp. 161–175). Springer.

Lakshmi, V. V., Niharika, D. A., & Lahari, G. (2017). Impact of gender on consumer purchasing behaviour. *IOSR Journal of Business and Management, 19*(8), 33–36.

Lea, E., & Worsley, A. (2001). Influences on meat consumption in Australia. *Appetite, 36*(2), 127–136.

Lea, E., & Worsley, A. (2003). Benefits and barriers to the consumption of a vegetarian diet in Australia. *Public Health Nutrition, 6*(5), 505–511.

Levy, N. (2021). Virtue signalling is virtuous. *Synthese, 198*(10), 9545–9562.

Lindeman, M., & Sirelius, M. (2001). Food choice ideologies: The modern manifestations of normative and humanist views of the world. *Appetite, 37*(3), 175–184.

Lund, T. B., McKeegan, D. E., Cribbin, C., & Sandøe, P. (2016). Animal ethics profiling of vegetarians, vegans and meat-eaters. *Anthrozoös, 29*(1), 89–106.

MacDonald, J., Brauer, P., & Yi, S. (2023). Meat reduction among post-secondary students: Exploration of motives, barriers, diets and preferences for meals with partial and full meat substitution. *Appetite, 188*, Article 106977.

Martin, C., Lange, C., & Marette, S. (2021). Importance of additional information, as a complement to information coming from packaging, to promote meat substitutes: A case study on a sausage based on vegetable proteins. *Food Quality and Preference, 87*, Article 104058.

McCarthy, K., Parker, M., Ameerally, A., Drake, S., & Drake, M. (2017). Drivers of choice for fluid milk versus plant-based alternatives: What are consumer perceptions of fluid milk? *Journal of Dairy Science, 100*(8), 6125–6138.

McDonald, B. (2000). " once you know something, you can't not know it" an empirical look at becoming vegan. *Society and Animals, 8*(1), 1–23.

McIntyre, M. H., Li, A. Y., Chapman, J. F., Lipson, S. F., & Ellison, P. T. (2011). Social status, masculinity, and testosterone in young men. *Personality and Individual Differences, 51*(4), 392–396.

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

Michel, F., & Siegrist, M. (2019). How should importance of naturalness be measured? A comparison of different scales. *Appetite, 140*, 298–304.

Moussaoui, D., Torres-Moreno, M., Tárrega, A., Martí, J., López-Font, G., & Chaya, C. (2023). Evaluation of consumers' response to plant-based burgers according to their attitude towards meat reduction. *Food Quality and Preference, 110*, Article 104955.

Nazirova, Z., & Borbala, S. (2024). Values, attitudes and the behaviour paradigm: A systematic literature review. *Journal of Human Values, 30*(2), 214–239.

North, M., Klas, A., Ling, M., & Kothe, E. (2021). A qualitative examination of the motivations behind vegan, vegetarian, and omnivore diets in an Australian population. *Appetite, 167*, Article 105614.
Orr, R. E., Giezenaar, C., Godfrey, A. J. R., & Hort, J. (2023). Development of a consumer-led emotion lexicon for meat and plant-based burger patties using digitally recreated eating contexts. *Journal of Sensory Studies, 38*(3), Article e12824.
Oszust, K., & Stecko, J. (2020). Theoretical aspects of consumer behaviour together with an analysis of trends in modern consumer behaviour. *Modern Management Review*, (4), 113–121.
Piqueras-Fiszman, B., & Spence, C. (2015). Sensory expectations based on product-extrinsic food cues: An interdisciplinary review of the empirical evidence and theoretical accounts. *Food Quality and Preference, 40*, 165–179.
Pirlympou, Z. (2017). A critical study: How gender determines consumer preferences. *Journal of Economics and Business, 2*, 29–37.
Pohjolainen, P., Vinnari, M., & Jokinen, P. (2015). Consumers' perceived barriers to following a plant-based diet. *British Food Journal, 117*(3), 1150–1167.
Pointke, M., Ohlau, M., Risius, A., & Pawelzik, E. (2022). Plant-based only: Investigating consumers' sensory perception, motivation, and knowledge of different plant-based alternative products on the market. *Foods, 11*(15), 2339.
Pula, K., Parks, C. D., & Ross, C. F. (2014). Regulatory focus and food choice motives. Prevention orientation associated with mood, convenience, and familiarity. *Appetite, 78*, 15–22.
Realini, C., Driver, T., Zhang, R., Guenther, M., Duff, S., Craigie, C., Saunders, C., & Farouk, M. (2023). Survey of New Zealand consumer attitudes to consumption of meat and meat alternatives. *Meat Science, 203*, Article 109232.
Reipurth, M. F., Hørby, L., Gregersen, C. G., Bonke, A., & Cueto, F. J. P. (2019). Barriers and facilitators towards adopting a more plant-based diet in a sample of Danish consumers. *Food Quality and Preference, 73*, 288–292.
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, 166*, Article 105475.
Ruby, M. B. (2012). Vegetarianism. A blossoming field of study. *Appetite, 58*(1), 141–150.
Sabaté, J., & Soret, S. (2014). Sustainability of plant-based diets: Back to the future. *The American Journal of Clinical Nutrition, 100*, 476S–482S.
Safdar, B., Zhou, H., Li, H., Cao, J., Zhang, T., Ying, Z., & Liu, X. (2022). Prospects for plant-based meat: Current standing, consumer perceptions, and shifting trends. *Foods, 11*(23), 3770.
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.
Seo, E.-H., Jang, H.-W., & Cho, M. (2023). Enabling the foodservice industry to transition consumers toward plant-based meat alternatives: A behavioral reasoning perspective. *International Journal of Hospitality Management, 114*, Article 103559.
Sheen, F., Lim, A. J., & Forde, C. G. (2023). Diversity among flexitarian consumers; stratifying meat reducers by their underlying motivations to move to a plant-based diet. *Food Quality and Preference, 112*, Article 105022.
Shin, Y. H., Im, J., Jung, S. E., Kim, H., & Shin, H. W. (2024). Factors influencing baby boomers' intention to choose a dish featuring plant-based meat alternatives (PBMA) at a restaurant: Findings from an online panel study. *Appetite, 196*, Article 107283.
Spendrup, S., & Hovmalm, H. P. (2022). Consumer attitudes and beliefs towards plant-based food in different degrees of processing–the case of Sweden. *Food Quality and Preference, 102*, Article 104673.
Spinelli, S., & Jaeger, S. R. (2019). What do we know about the sensory drivers of emotions in foods and beverages? *Current Opinion in Food Science, 27*, 82–89.
Stanley, S. K., Day, C., & Brown, P. M. (2023). Masculinity matters for meat consumption: An examination of self-rated gender typicality, meat consumption, and veg* nism in Australian men and women. *Sex Roles, 88*(3), 187–198.
Starowicz, M., Poznar, K. K., & Zieliński, H. (2022). What are the main sensory attributes that determine the acceptance of meat alternatives? *Current Opinion in Food Science, 48*, Article 100924.
Taylor, J., Ahmed, I. A. M., Al-Juhaimi, F. Y., & Bekhit, A. E.-D. A. (2020). Consumers' perceptions and sensory properties of beef patty analogues. *Foods, 9*(01), 63.
Tobler, C., Visschers, V. H., & Siegrist, M. (2012). Consumers' knowledge about climate change. *Climatic Change, 114*, 189–209.
Tso, R., Lim, A. J., & Forde, C. G. (2020). A critical appraisal of the evidence supporting consumer motivations for alternative proteins. *Foods, 10*(1), 24.
Vainio, A., Irz, X., & Hartikainen, H. (2018). How effective are messages and their characteristics in changing behavioural intentions to substitute plant-based foods for red meat? The mediating role of prior beliefs. *Appetite, 125*, 217–224.
Van der Werff, E., Steg, L., & Keizer, K. (2014). Follow the signal: When past pro-environmental actions signal who you are. *Journal of Environmental Psychology, 40*, 273–282.
Van Trijp, H. C., & Steenkamp, J.-B. E. (1992). Consumers' variety seeking tendency with respect to foods: Measurement and managerial implications. *European Review of Agricultural Economics, 19*(2), 181–195.
Vural, Y., Ferriday, D., & Rogers, P. J. (2023). Consumers' attitudes towards alternatives to conventional meat products: Expectations about taste and satisfaction, and the role of disgust. *Appetite, 181*, Article 106394.
Waehrens, S. S., Faber, I., Gunn, L., Buldo, P., Frøst, M. B., & Perez-Cueto, F. J. (2023). Consumers' sensory-based cognitions of currently available and ideal plant-based food alternatives: A survey in Western, central and northern Europe. *Food Quality and Preference, 108*, Article 104875.
Weerawarna, N., Giezenaar, C., Coetzee, P., Godfrey, A., Foster, M., & Hort, J. (2024). Motivators and barriers to plant-based product consumption across Aotearoa New Zealand flexitarians. *Food Quality and Preference, 117*, Article 105153. https://doi.org/10.1016/j.foodqual.2024.105153
Wickham, H., François, R., & Henry, L. (2022). *Müller K. Dplyr: A grammar of data manipulation. 2020*. In.
Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., … Wood, A. (2019). Food in the Anthropocene: The EAT–lancet commission on healthy diets from sustainable food systems. *The Lancet, 393*(10170), 447–492.
Xu, X., Sharma, P., Shu, S., Lin, T.-S., Ciais, P., Tubiello, F. N., … Jain, A. K. (2021). Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. *Nature Food, 2*(9), 724–732.
Zandstra, E. H., Ossel, L., & Neufingerl, N. (2024). Eating a plant-based burger makes me feel proud and cool: An online survey on food-evoked emotions of plant-based meat. *Food Quality and Preference, 113*, Article 105046.
Zhang, Y. (2022). Variety-seeking behavior in consumption: A literature review and future research directions. *Frontiers in Psychology, 13*, Article 874444.
Zioga, E., Tøstesen, M., Madsen, S. K., Shetty, R., & Bang-Berthelsen, C. H. (2022). Bringing plant-based cli-meat closer to original meat experience: Insights in flavor. *Future Foods, 5*, Article 100138.