The mediating role of barriers and trust on the intentions to consume plant-based foods in Europe

Ilona Faber a, Listia Rini b, Joachim J. Schouteten b, Michael Bom Frøst a,*, Hans De Steur b, Federico J.A. Perez-Cueto a, c

a Department of Food Science, University of Copenhagen, Frederiksberg, Denmark
b Department of Agricultural Economics, Ghent University, Ghent, Belgium
c Department of Food, Nutrition and Culinary Science, Umeå University, Umeå, Sweden

ARTICLE INFO

Keywords:
Web-based survey
Plant-based food alternatives
Intentions to purchase
Food choice motives
Pan-European survey
Structural Equation Modelling

ABSTRACT

Plant-based food alternatives have increased in popularity, particularly plant-based meat alternatives, while plant-based cheese alternatives less so. However, their acceptance remains low in Europe. Food choice motives (FCM) and trust towards alternative proteins may contribute to purchasing plant-based food alternatives, while other FCM and barriers can hinder this. The present study aimed to investigate whether FCM focused on “Environment & ethics” and “Intrinsic product quality” are associated with behavioural intentions towards plant-based meat and cheese alternatives, and specifically investigating the mediating role of perceived barriers to plant-based food consumption and trust towards plant-based alternative proteins. A survey was conducted in 10 European countries (AT, DE, DK, ES, FR, IT, NL, PL, RO, UK) with quotas on age and gender (N = 7588). Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to determine factors associated with behavioural intentions towards plant-based meat and cheese alternatives. Results showed that “environmental & ethical” motives are positively associated with intentions to consume plant-based alternatives to meat (in 6/10 countries) and cheese (in 8/10 countries). “Intrinsic product quality” motives were not directly associated with behavioural intentions towards plant-based meat alternatives. However, country differences were observed for effects of “Intrinsic product quality”. Perceived barriers to plant-based food consumption and trust towards plant-based alternative proteins play a significant mediating role among all 10 countries. The implications are that environmental and ethical motivations could contribute to effectively promoting plant-based alternatives to meat and dairy. High sensory quality for plant-based meat and cheese alternatives is needed to build trust.

1. Introduction

Global warming and food security are major concerns in relation to the current food system. Excessive consumption of animal-based foods, especially meat, is linked to negative effects on human and planetary health (Aiking, 2014; Willett et al., 2019). Global climate goals appear unlikely to be reached without dietary changes (Aiking, 2014; Theurl et al., 2020) and require a shift towards diets lower in animal-based proteins and rich in plant-based foods.

The launch of new plant-based food alternatives (PBFA) has increased rapidly as a response to the increasing demand and interest in alternative proteins (Kyriakopoulou et al., 2019). PBFA are foods based on plant protein, such as oats, soy and pulses, and are developed to resemble the sensory properties of meat and dairy. In particular, plant-based meat alternatives are becoming more widely available and easily accessible to mainstream consumers (The Good Food Institute, 2021). Europe’s market for plant-based food alternatives has grown by 49 % from 2018 to 2020, with largest sales observed in Germany and the United Kingdom (Smart Protein Project, 2021). Plant-based meat alternatives showed the most substantial growth in sales, while plant-based cheese alternatives are still in the early development stage (Smart Protein Project, 2021).

Even though a variety of PBFA exist in the European market, the market share remains small compared to conventional meat and dairy (Alae-Carew et al., 2022). The acceptance of PBFA remains low due to unsatisfactory sensory and nutritional quality (Kyriakopoulou et al., 2019; Onwezen et al., 2021). Previous studies showed that primarily women, people with higher education and young adults consume PBFA.

* Corresponding author.
E-mail address: mbf@food.ku.dk (M. Bom Frøst).

https://doi.org/10.1016/j.foodqual.2024.105101
Received 14 May 2023; Received in revised form 19 December 2023; Accepted 3 January 2024
Available online 4 January 2024
0950-3293/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
Despite the challenges of PBFA in their sensory and nutritional quality compared to conventional meat and dairy, environmental concerns seem to become an important driver of the increasing consumption of PBFA (Rosenfeld & Burrow, 2017).

Motivational factors of plant-based food consumption have been extensively studied in recent years (e.g. Bryant et al., 2023; Graça et al., 2019; Martínez-Padilla et al., 2023; Onwezen et al., 2021; Pennanen et al., 2023; Reipurth et al., 2019; Siegrist & Hartmann, 2019; Wang & Scrimgeour, 2021), with most research focusing on a single-country perspective (e.g. in Denmark (Martínez-Padilla et al., 2023; Reipurth et al., 2019), Portugal (Graça et al., 2019), and the United Kingdom (Bryant et al., 2023)) and only a few studies including multiple countries (e.g. Pennanen et al., 2023; Wang & Scrimgeour, 2021). In a cross-country study by (Wang & Scrimgeour, 2021), food choice motives focused on environmental concerns could significantly predict willingness to adopt a plant-based diet in both New Zealand and China (Wang & Scrimgeour, 2021), which aligns with other research (e.g. Marty et al., 2022; Pointke et al., 2022; Siegrist & Hartmann, 2019). However, some studies showed inconsistent findings of the link between motivational factors and plant-based food behaviour (e.g. Bryant et al., 2023; Martínez-Padilla et al., 2023; Pennanen et al., 2023). In an attempt to explain the variation in acceptance of sustainable foods, previous research has investigated the so-called motivation-behaviour gap (Dong et al., 2022; Groening et al., 2018; Pennanen et al., 2023). A cross-country study in the Netherlands, Germany and France investigated the mediating role of health-related values in the association between general food choice motives and likelihood to purchase plant-based drinkable snacks (Pennanen et al., 2023). Health-related values played a significant mediating role in the association between certain general food choice motives and intentions to purchase (Pennanen et al., 2023). However, besides health-related values, there could be other factors playing a mediating role in the relationship between general motivations for food choice and behavioural intentions towards PBFA. Barriers to purchasing plant-based foods, such as unavailability (Mäkinen & Vainio, 2014), lack of information (Lee et al., 2006b), high price (Mäkinen & Vainio, 2014), taste (Waehrens et al., 2023) and nutritional and satiating sufficiency (Perez-Cueto et al., 2022), could impact the acceptance of plant-based foods. Further, trust has also been found to influence (Carfora et al., 2019; Giampietri et al., 2018; Menozzi et al., 2015) or hinder (Kerslake et al., 2022) acceptance of sustainable foods, but this concept remains understudied.

The present study’s aim was to investigate which food choice motives are significant factors associated with behavioural intentions towards PBFA. Specifically, the study’s purpose was to investigate whether barriers to plant-based food consumption and trust towards plant-based alternative protein mediate this effect. The present research adds on findings from (Wang & Scrimgeour, 2021) and (Pennanen et al., 2023) by targeting two specific PBFA categories (meat and cheese alternatives), as previous research showed that acceptance of PBFA may depend on the target food product category (Cardello et al., 2022). In an attempt to explain variation and inconsistencies in the link between general food choice motives and plant-based food behaviour, we explored the mediating role of barriers to plant-based food consumption and trust towards plant-based alternative protein. The present study applies a cross-country perspective by focussing on adults from ten European countries, representing different geographical and (food) cultural regions: north (Denmark), east (Romania, Poland), west (The Netherlands, France, United Kingdom), south (Italy, Spain) and central (Austria, Germany). The study’s findings are expected to contribute to the literature by providing insights into important factors associated with behavioural intentions towards plant-based meat and cheese alternatives from a cross-country perspective. Further, it is expected to gain a better understanding of the mechanisms behind general motivational factors of food consumption and plant-based food behaviour.

2. Conceptual framework and hypotheses

A conceptual model, including hypotheses, was developed based on findings from previous research on determinants of behavioural intentions towards PBFA (Fig. 1). Behavioural intention is one of the fundamental components of the Theory of Planned Behaviour (Ajzen, 1991). According to the Theory of Planned Behaviour, behavioural intention is considered the antecedent of actual behaviour (Ajzen, 1991). Data in the present study were collected using a web-based survey, in which selected determinants of behavioural intentions were included: food choice motives, trust towards plant-based alternative proteins and barriers to plant-based food consumption.

2.1. Food choice motives

Multiple factors can serve as drivers for food choices, including food choice motives such as sensory appeal and health benefits (Steepte et al., 1995). Previous studies showed the importance of taking into account food choice motives, as it can lead to a better understanding of important determinants of sustainable food consumption (Bowd & Burke, 2013; Verain et al., 2015). Health and environmental sustainability concerns were reported as contributors to more plant-based food consumption (Pennanen et al., 2023; Rosenfeld & Burrow, 2017; Wang & Scrimgeour, 2021). However, not all food choice motives may contribute equally to purchasing more plant-based foods. Even though previous research has highlighted important food choice motives (Onwezen et al., 2021; Steepte et al., 1995), not all may be relevant in the acceptance of PBFA. While environmental and ethical motives may contribute to the consumption of more PBFA (Rosenfeld & Burrow, 2017; Wang & Scrimgeour, 2021), other motives, such as price and familiarity, might hinder the purchase of PBFA (Hoek et al., 2017; Mäkinen & Vainio, 2014). Sensory characteristics of food, including taste and familiarity, were generally considered crucial in the intention of food purchasing (Steepte et al., 1995), but have also been observed as essential for sustainable food choices (Verain et al., 2015). The taste and freshness of foods are considered most relevant as product quality indicators (Petrescu et al., 2022). Therefore, this could indicate that both environmental and ethical motives as well as sensory quality motives could predict behavioral intentions towards PBFA.

Direct effects:

H.1. Food Choice Motives – “Environment & ethics” are significantly associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives.

H.2. Food Choice Motives – “Intrinsic product quality” are significantly associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives.

H.3. Food Choice Motives – “Environment & ethics” are significantly associated with a) trust towards plant-based alternative proteins and b) barriers to plant-based food consumption.

H.4. Food Choice Motives – “Intrinsic product quality” are significantly associated with a) trust towards plant-based alternative proteins and b) barriers to plant-based food consumption.

2.2. Product trust

Trust can be defined as “a heuristic that might be used in situations where lack of knowledge, experience or familiarity with firms, products or processes used to create products hampers decision making” (Hobbs & Goddard, 2015). Only a few studies have investigated trust towards alternative protein consumption (Onwezen et al., 2021). Trust is, nevertheless, a significant predictor of behavioural intentions towards sustainable foods (Carfora et al., 2019; Giampietri et al., 2018; Menozzi et al., 2015). Lack of trust in plant-based food alternatives across dietary lifestyles may hinder the acceptance of plant-based food alternatives (Kerslake et al., 2022). Especially when consumers know of novel food products and technologies is low, trust could be an important factor
in acceptance (Siegrist, 2008). Considering this, it is important to gain a better understanding of the link between product trust and PBFA consumption. Therefore, we propose the following hypotheses:

**Direct effect:**

H5. Trust towards plant-based alternative proteins is positively associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives.

**Mediation effects:**

- H7. Food Choice Motives – “Environment & ethics” are indirectly associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives via trust towards alternative proteins.
- H8. Food Choice Motives – “Intrinsic product quality” are indirectly associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives via trust towards alternative proteins.

2.3. Barriers to plant-based food consumption

Main barriers to purchasing plant-based foods are unavailability (Makiniemi & Vainio, 2014), lack of information (Lea et al., 2006b), high price (Makiniemi & Vainio, 2014), taste (Waehrens et al., 2023) and lay beliefs about nutritional and satiating sufficiency of plant-based diets (Perez-Cueto et al., 2022). While taste might be a main barrier to plant-based food consumption, some studies consider taste a driver (Onwezen et al., 2021). Moreover, habits and disbelief towards the climate effects of food consumption were the most significant factors negatively associated with sustainable food choices (Makiniemi & Vainio, 2014). Furthermore, familiarity and price may act as a barrier to plant-based food consumption (Hoek et al., 2017; Makiniemi & Vainio, 2014). Barriers to plant-based food consumption (Makiniemi & Vainio, 2014) can inhibit the adoption of more PBFA in the diet.

**Direct effect:**

H6. Perceived barriers to plant-based food consumption are positively associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives.

**Mediation effects:**

H9. Selected Food Choice Motives – “Environment & ethics” are indirectly associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives via barriers to plant-based food consumption.

H10. Selected Food Choice Motives – “Intrinsic product quality” are indirectly associated with behavioural intentions towards plant-based a) meat and b) cheese alternatives via barriers to plant-based food consumption.

3. Materials and methods

3.1. Study design

In May-September 2021, data were obtained through a Pan-European online survey in nine European Member States (Austria, Denmark, France, Germany, Italy, The Netherlands, Poland, Romania and Spain) and the United Kingdom. Data were collected anonymously and in accordance with the European General Data Protection Regulation. Before participating in the study, respondents were informed about the purpose of the study and the processing of their data. Before participating in the study, participants provided their informed consent statement. Ethical approval was obtained via the Research Ethics Committee of Science and Health at the University of Copenhagen, Denmark (Reference: 504-0249/21-5000). The study’s methodology has been described elsewhere (Perez-Cueto et al., 2022).

Briefly, an online survey was developed in English, including existing consumer scales (e.g. food choice motives, barriers to plant-based consumption, and others described in section 3.3) and constructs addressing trust and acceptance towards plant-based alternatives. Innova Market Insights translated the final version of the questionnaire into the official languages of each of the ten countries. Native speakers checked and verified the translations with the English questionnaire.

3.2. Participants

Participants were recruited through a random selection from external respondent panels of Innova Market Insights. Adult participants (18 years or older) were included when fully or partly responsible for grocery shopping in the household and when providing their informed consent. Participants received incentives for completing the survey through the market research agency. Participants were directed to the end of the survey and excluded from the study when no informed consent was provided. Predetermined quotas on gender (Female 50 %, Male 50 %) and age groups (20 % in each age group: 18–24 y/o, 25–34 y/o,
3.4. Data management and analysis

Participants were asked to report barriers to the consumption of plant-based foods using a 5-point Likert scale ranging from “1 = totally disagree” to “5 = totally agree”. The construct “trust towards plant-based food consumption” was replaced by 2 items for the construct “trust towards alternative proteins” (trust) and behavioural intentions towards plant-based meat and cheese alternatives included. The respondents were asked to assess to what extent the specified food and large effect sizes (Hair et al., 2019). All data analyses were conducted in R version 4.2.2. PLS-SEM was conducted using the SeminR package (Ray et al., 2021) in R.

4. Results

4.1. Participant characteristics

A total of 7,588 respondents completed the survey, and approximately 750 respondents were in each country sample. Table 1 shows the sociodemographic characteristics of the surveyed participants stratified by country of residence. Due to predetermined quotas, the total and country samples were balanced in age groups and female and male respondents. Most respondents reported following omnivore diets (approximately 60%), while vegetarian and vegan diets were reported by 2–5% of the participants.

4.2. Exploratory factor analysis

All constructs showed satisfactory results for Kaiser-Meyer-Olkin (a measure of sampling adequacy) and Bartlett’s test of sphericity (Table 2), indicating that the items in each of the constructs are significantly correlated and the constructs are suitable for factor analysis (Hair et al., 2019). For each construct, EFA was run using Principal Component
factor for trust and three factors for behavioural intentions. However, EFA revealed four factors for FCM, four factors for barriers, one loadings of items (two or more indicator loadings showed a factor by itself: FCM (6 items removed), barriers (6 items removed) and behavioural intentions (2 items removed). After deleting items in the FCM construct, one item represented a factor by itself and was subsequently removed, resulting in 2 factors for FCM and 2 factors for barriers. When evaluating the measurement model again, the final constructs showed reliability showed acceptable values between 0.80 and 0.95 for most constructs (Hair et al., 2019), except for 1 factor of FCM and 2 factors of barriers, trust and three factors for behavioural intentions. However, some items were omitted due to indicator loadings < 0.5, strong cross-loadings, or the item represented a factor by itself: FCM (6 items removed), barriers (6 items removed) and behavioural intentions (2 items removed). After deleting items in the FCM construct, one item represented a factor by itself and was subsequently removed, resulting in 3 factors for FCM. The final EFA showed that all items had indicator loadings higher than 0.5 and no strong cross-loadings for each factor. The latent traits with corresponding items were used to assess the measurement model.

### 4.3. PLS-SEM analysis

PLS-SEM was used to assess associations among the constructs FCM, barriers, trust and behavioural intentions towards plant-based meat and cheese alternatives. First, the measurement model was assessed and subsequently, the structural model was evaluated.

#### 4.3.1. Assessment of the measurement model

For each of the country samples, the constructs indicator loadings, construct reliability, convergent validity and discriminant validity were evaluated to assess the measurement model. First, the indicator loadings were evaluated, and these were considered acceptable as they were all above 0.4, which is the minimum required value of the loading for interpretation according to (Hair et al., 2019). Subsequently, convergent validity was assessed by evaluating the average variance extracted (AVE). The AVE was above the threshold of 0.5 for most constructs. However, three factors in the construct barriers and one factor in the construct FCM showed AVE just below 0.5. These factors could be retained if the composite reliability and discriminant validity are acceptable. Further, the constructs’ internal consistency reliability was determined by computing the composite reliability. The constructs reliability showed acceptable values between 0.80 and 0.95 for most constructs (Hair et al., 2019), except for 1 factor of FCM and 2 factors of barriers. Therefore, these three factors were not included in further analysis, resulting in 2 factors for FCM and 2 factors for barriers. When evaluating the measurement model again, the final constructs showed satisfactory results for indicator loadings (Table 2; Appendix A: Table S1), AVE (Table 2; Appendix A: Table S2) and composite reliability (Table 2; Appendix A: Table S3).

The predictor constructs’ Variance Inflation Factor (VIF) was evaluated to assess whether collinearity among the constructs is present. VIF values below 5 indicate no concerns for collinearity (Hair et al., 2019). VIF values were all below five, indicating no concerns for multicollinearity among the constructs (Table 3, Appendix B: Tables S4-S13). Discriminant validity was assessed using the Heterotrait-monotrait ratio (HTMT) to determine the degree to which selected constructs are...
Table 2
Mean values and standard deviation (SD) of items, indicator loadings, composite reliability and convergent validity.

<table>
<thead>
<tr>
<th>Factors and indicators</th>
<th>Food Choice Motives</th>
<th>Mean (SD)</th>
<th>Indicator loadings</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 1: Environmental and ethical motives</strong></td>
<td></td>
<td></td>
<td>0.873</td>
<td>0.536</td>
<td></td>
</tr>
<tr>
<td>FCM1 – Environment and climate</td>
<td>3.72 (1.07)</td>
<td>0.810</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM2 – Equal rights</td>
<td>3.63 (1.07)</td>
<td>0.777</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM3 – Animal friendly</td>
<td>3.75 (1.10)</td>
<td>0.759</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM4 – Organic</td>
<td>3.47 (1.12)</td>
<td>0.743</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM5 – Certified with label</td>
<td>3.61 (1.08)</td>
<td>0.682</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM6 – Local produced</td>
<td>3.59 (1.04)</td>
<td>0.604</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Factor 2: Intrinsic product quality motives</strong></td>
<td></td>
<td></td>
<td>0.868</td>
<td>0.569</td>
<td></td>
</tr>
<tr>
<td>FCM7 – Taste</td>
<td>4.31 (0.930)</td>
<td>0.741</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM8 – Fresh</td>
<td>4.21 (0.946)</td>
<td>0.795</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM9 – Pleasant texture</td>
<td>3.99 (0.960)</td>
<td>0.732</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM10 – Makes me feel good</td>
<td>3.96 (0.992)</td>
<td>0.738</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCM11 – Healthy</td>
<td>4.06 (0.977)</td>
<td>0.765</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Factor 3: Behavioural intentions towards plant-based meat alternatives</strong></td>
<td></td>
<td></td>
<td>0.924</td>
<td>0.859</td>
<td></td>
</tr>
<tr>
<td>TRU1 – Intention to replace conventional meat with plant-based meat</td>
<td>3.01 (1.28)</td>
<td>0.933</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRU2 – Intention to purchase</td>
<td>2.96 (1.27)</td>
<td>0.920</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRU3 – Intention to replace conventional meat with plant-based meat</td>
<td>2.64 (1.28)</td>
<td>0.942</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRU4 – Intention to purchase</td>
<td>2.69 (1.29)</td>
<td>0.933</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 (continued)
Factors and indicators | Food Choice Motives | Mean (SD) | Indicator loadings | CR | AVE |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 2: Nutrition &amp; Health barriers</strong></td>
<td></td>
<td></td>
<td>0.883</td>
<td>0.654</td>
<td></td>
</tr>
<tr>
<td>BAR10 – Not enough iron</td>
<td>2.91 (1.04)</td>
<td>0.804</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAR11 – Not enough protein</td>
<td>2.88 (1.08)</td>
<td>0.848</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAR12 – Not healthy</td>
<td>2.98 (1.15)</td>
<td>0.828</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAR13 – Indigestion</td>
<td>2.93 (1.18)</td>
<td>0.751</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KMO: 0.93; Bartlett’s Test of Sphericity: Chi square = 35191.2 (df = 55; p &lt; 0.001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Factor 1: Behavioural intentions towards plant-based cheese alternatives</strong></td>
<td></td>
<td></td>
<td>0.935</td>
<td>0.879</td>
<td></td>
</tr>
<tr>
<td>INT1 – Intention to replace conventional cheese with plant-based cheese</td>
<td>2.64 (1.28)</td>
<td>0.942</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT2 – Intention to purchase</td>
<td>2.69 (1.29)</td>
<td>0.933</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT3 – Intention to replace conventional cheese with plant-based cheese</td>
<td>2.64 (1.28)</td>
<td>0.942</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT4 – Intention to purchase</td>
<td>2.69 (1.29)</td>
<td>0.933</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KMO: 0.69; Bartlett’s Test of Sphericity: Chi square = 16899.6 (df = 6; p &lt; 0.001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AVE = Average Variance Extracted; CR = Composite reliability.

Table 3
Variance Inflation Factor values

<table>
<thead>
<tr>
<th>Predictor constructs</th>
<th>TRUST</th>
<th>BAR – C</th>
<th>BAR – NH</th>
<th>BI – M</th>
<th>BI – C</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCM – E</td>
<td>1.508</td>
<td>1.508</td>
<td>1.508</td>
<td>1.790</td>
<td>1.790</td>
</tr>
<tr>
<td>FCM – P</td>
<td>1.508</td>
<td>1.508</td>
<td>1.508</td>
<td>1.526</td>
<td>1.526</td>
</tr>
<tr>
<td>TRUST</td>
<td>1.348</td>
<td>1.348</td>
<td>1.348</td>
<td>1.348</td>
<td>1.348</td>
</tr>
<tr>
<td>BAR – C</td>
<td>2.132</td>
<td>2.132</td>
<td>2.132</td>
<td>2.132</td>
<td>2.132</td>
</tr>
<tr>
<td>BAR – NH</td>
<td>2.003</td>
<td>2.003</td>
<td>2.003</td>
<td>2.003</td>
<td>2.003</td>
</tr>
</tbody>
</table>

Table 4
Discriminant validity of constructs using Heterotrait-Monotrait Ratio (HTMT)

<table>
<thead>
<tr>
<th>Constructs</th>
<th>FCM-E</th>
<th>FCM-P</th>
<th>TRUST</th>
<th>BAR – C</th>
<th>BAR – NH</th>
<th>BI – M</th>
<th>BI – C</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCM – E</td>
<td>0.695</td>
<td>0.518</td>
<td>0.258</td>
<td>0.171</td>
<td>0.400</td>
<td>0.359</td>
<td>0.461</td>
</tr>
<tr>
<td>FCM – P</td>
<td>0.338</td>
<td>0.400</td>
<td>0.250</td>
<td>0.245</td>
<td>0.328</td>
<td>0.253</td>
<td>0.400</td>
</tr>
<tr>
<td>TRUST</td>
<td>0.138</td>
<td>0.125</td>
<td>0.527</td>
<td>0.250</td>
<td>0.253</td>
<td>0.332</td>
<td>0.764</td>
</tr>
<tr>
<td>BAR – C</td>
<td>0.300</td>
<td>0.488</td>
<td>0.479</td>
<td>0.253</td>
<td>0.764</td>
<td>0.328</td>
<td>0.250</td>
</tr>
<tr>
<td>BAR – NH</td>
<td>0.517</td>
<td>0.383</td>
<td>0.479</td>
<td>0.332</td>
<td>0.764</td>
<td>0.488</td>
<td>0.764</td>
</tr>
</tbody>
</table>

**Notes:**
- HTMT = Heterotrait-Monotrait Ratio.
distinct and to ensure that the constructs are sufficiently different. All values were below the threshold of 0.9 (Henseler et al., 2015) indicating discriminant validity for the constructs (Table 4, Appendix C: Tables S14-S23). In sum, the assessment of the measurement model showed satisfactory results, given there is substantial support for composite reliability, convergent validity and discriminant validity.

4.3.2. Hypothesis testing

4.3.2.1. Direct effects. Table 5 presents the path coefficients, effect sizes and 95% confidence intervals for each direct relationship in the structural model (Fig. 2). Table S24-S33 and Figure S1-S10 (Supplementary materials: Appendix D) present the path coefficients, effect sizes and 95% confidence intervals for each direct relationship in the structural model in each of the 10 country samples. Results from PLS-SEM on the total sample revealed that “Environment & Ethics” motives were significantly positively associated with behavioural intentions towards plant-based meat (β = 0.13, $f^2 = 0.01$) and cheese (β = 0.18, $f^2 = 0.02$) alternatives with a small effect size. In the country samples, “Environment & Ethics” motives were positively associated with behavioural intentions towards plant-based meat alternatives in DK, FR, IT, NL, RO, UK with a small effect size, but no significant association was found in AT, DE, ES and PL. Therefore, H1a is supported in the DK, FR, IT, NL, RO, UK, but not supported in the remaining 4 countries. In most country samples, except AT and IT, “Environment & Ethics” motives were positively associated with behavioural intentions towards plant-based cheese alternatives with a small effect size. Thus, H2a is supported in AT, DE, DK, ES, FR, NL, PL and UK, but not in AT and IT. In the total sample, “Intrinsic product quality” motives were not associated with behavioural intentions towards plant-based meat alternatives, but were significantly negatively associated with behavioural intentions towards plant-based meat alternatives (β = -0.09, $f^2 = 0.01$). However, the effect size was small. In the AT and DE samples, “Intrinsic product quality” motives were significantly positively associated with behavioural intentions towards plant-based meat alternatives with a small effect size, hence, H1b is supported in these two countries. However, in the remaining 8 countries no direct association was found between “Intrinsic product quality” motives and behavioural intentions towards plant-based meat alternatives. Thus, H1b could not be supported for these 8 countries. A significant negative relationship was found between “Intrinsic product quality” motives and behavioural intentions towards plant-based meat alternatives. Thus, H1b could not be supported for these 8 countries. A significant negative relationship was found between “Intrinsic product quality” motives and behavioural intentions towards plant-based cheese alternatives in DK, FR, NL, PL and UK with a small effect size, but no significant association was observed in AT, DE, ES, IT, and RO. Hence, H2b is supported in DK, FR, NL, PL and UK, but not in the remaining 5 countries. Furthermore, “Environment & Ethics” motives were significantly positively associated with trust with a medium effect size (β = 0.44, $f^2 = 0.16$) and were significantly negatively associated with barriers with a small effect size (β = -0.25, $f^2 = 0.04$). In all countries, “Environment & Ethics” motives were positively associated with trust with small to medium effect sizes. Therefore, H3a is supported. “Environment & Ethics” motives were negatively associated with barriers with a small effect size in all countries. Hence, H3a is supported. “Intrinsic product quality” motives were significantly associated with trust (β = 0.06, $f^2 < 0.01$) and barriers (β = -0.04, $f^2 < 0.01$) in the total sample; however, the effect sizes indicate no effect. “Intrinsic product quality” motives were positively associated with trust in ES, IT and NL with a small effect size, but no significant association was observed in the remaining 7 countries. Thus, H3b is only supported in ES, IT and NL. Furthermore, “Intrinsic product quality” motives were positively associated with barriers in the UK with a small effect size, but no significant association was found in the remaining 9 countries. Therefore, H4b is only supported in UK. In the total sample, trust was significantly positively associated with behavioural intentions towards plant-based meat (β = 0.32, $f^2 = 0.11$) and cheese (β = 0.33, $f^2 = 0.11$) alternatives with a small effect size. Barriers were significantly negatively associated with behavioural intentions towards plant-based meat (β = -0.27, $f^2 = 0.09$) and cheese (β = -0.19, $f^2 = 0.04$) alternatives with a small effect size. In all country samples, trust was positively associated with behavioural intentions towards plant-based meat and cheese alternatives with small to medium effect sizes. Barriers were negatively associated with behavioural intentions towards plant-based meat and cheese alternatives in all countries with small to medium effect sizes. Thus, H5a, H5b, H6a and H6b are supported in the country samples. Across the country samples, the in-sample predictive power of the model ($R^2$) indicated that the model could explain between 25 and 39% of the variance in “Behavioural intentions towards plant-based meat alternatives” and between 21 and 30% of the variance in “Behavioural intentions towards plant-based cheese alternatives”. Furthermore, the model could explain between 17 and 29% of the variance in trust and between 2 and 8% of the variance in barriers.

4.3.2.2. The mediating role of barriers and trust. Besides assessing direct relationships in the structural model, the study’s purpose was to explore the mediating effect of barriers and trust (Hypotheses 7–10). A detailed overview of PLS-SEM results for the total sample is provided in Table 6 and per country sample in Appendix D: Tables S23–S33. In all country samples, trust and barriers mediated the relationship between “Environment & Ethics” motives and behavioural intentions towards plant-based meat and cheese alternatives but not the association between “Intrinsic product quality” motives and behavioural intentions. More specifically, trust towards plant-based alternative proteins partially mediates the association between “Environment & Ethics” motives and behavioural intentions towards plant-based meat and cheese alternatives. The construct trust fully and partially mediates the association between “Intrinsic product quality” motives and behavioural intentions towards plant-based meat and cheese alternatives, respectively. Barriers

Table 5
Results of the structural model for direct effects.

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Patha</th>
<th>Path coefficient (β)</th>
<th>95% CI</th>
<th>Effect size ($f^2$)</th>
<th>Hypotheses conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a</td>
<td>FCM-E → BI-M</td>
<td>0.13*** [0.11; 0.16]</td>
<td>0.01</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H1b</td>
<td>FCM-P → BI-M</td>
<td>0.01NS [-0.01; 0.03]</td>
<td>&lt;0.01</td>
<td>Not supported</td>
<td></td>
</tr>
<tr>
<td>H2a</td>
<td>FCM-E → BI-C</td>
<td>0.18*** [0.15; 0.20]</td>
<td>0.02</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H2b</td>
<td>FCM-P → BI-C</td>
<td>-0.10*** [-0.12; -0.07]</td>
<td>0.01</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H3a</td>
<td>FCM-E → TRUST</td>
<td>0.44*** [0.41; 0.46]</td>
<td>0.16</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H3b</td>
<td>FCM-P → TRUST</td>
<td>0.06*** [0.03; 0.08]</td>
<td>&lt;0.01</td>
<td>Not supported</td>
<td></td>
</tr>
<tr>
<td>H4a</td>
<td>TRUST → BAR</td>
<td>-0.25*** [-0.28; -0.22]</td>
<td>0.04</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H4b</td>
<td>TRUST → BAR</td>
<td>0.04** [0.01; 0.07]</td>
<td>&lt;0.01</td>
<td>Not supported</td>
<td></td>
</tr>
<tr>
<td>H5a</td>
<td>TRUST → BI-M</td>
<td>0.32*** [0.30; 0.35]</td>
<td>0.11</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H5b</td>
<td>TRUST → BI-C</td>
<td>0.33*** [0.31; 0.35]</td>
<td>0.11</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H6a</td>
<td>BI-M → BAR</td>
<td>-0.27** [-0.29; -0.24]</td>
<td>0.09</td>
<td>Supported</td>
<td></td>
</tr>
<tr>
<td>H6b</td>
<td>BI-C → BAR</td>
<td>-0.19*** [-0.21; -0.17]</td>
<td>0.04</td>
<td>Supported</td>
<td></td>
</tr>
</tbody>
</table>

CI = Confidence Interval.


NS = not significant, *** = p-value < 0.001, ** = p-value < 0.01.
The present study's objective was to investigate significant factors associated with behavioural intentions towards plant-based meat and cheese alternatives using PLS-SEM. Selected FCM, namely “environment & ethics” and “intrinsic product quality”, were assessed as potential drivers for behavioural intentions towards plant-based meat and cheese alternatives. Furthermore, the study aimed to assess the mediating role of barriers and trust.

5. Discussion

The present study’s objective was to investigate significant factors associated with behavioural intentions towards plant-based meat and cheese alternatives. The association between “intrinsic product quality” motives and behavioural intentions towards plant-based meat and cheese alternatives was fully and partially mediated by the construct barriers, respectively.

5.1. Determinants of behavioural intentions towards plant-based food alternatives

“Environment & Ethics” motives were positively associated with the intentions to choose plant-based meat and cheese alternatives. These findings agree with earlier studies that identified environmental concerns as a determinant for plant-based food consumption (Rosenfeld & Burrow, 2017; Wang & Scrimgeour, 2021). Involvement in healthy and sustainable eating also contributes to more sustainable food consumption (De Boer et al., 2013). This indicates that “Environment & Ethics” motivations for food choice could contribute to increasing intentions to purchase and eat plant-based meat and cheese alternatives. Therefore, the environmental benefits of plant-based food alternatives should be considered a key cue to promote and sustain a dietary shift.

In general, “intrinsic product quality” refers to the inherent characteristics and attributes of a food product that contribute to its overall appeal, sensory experience, and nutritional value. In the context of the present study, “intrinsic product quality” is estimated by Factor 2 that includes taste, freshness, pleasantness, healthiness, and an overall good feeling (Table 2). “Intrinsic product quality” motives, such as taste, were negatively associated with participants’ willingness to choose plant-based cheese alternatives, but this was not the case for plant-based meat alternatives. This suggests that the food sector needs to optimise the sensory characteristics of plant-based cheese alternatives to increase consumption. People who haven’t tried these products often cite concerns about taste and processing as key reasons for not choosing plant-based alternatives (Clark & Bogdan, 2019). However, the present results indicate that “Intrinsic product quality” motive does not necessarily increase or decrease intentions to consume or purchase plant-based meat alternatives. While some studies underscore sensory quality as a significant barrier to adopting plant-based foods (Clark & Bogdan, 2019; Waehrens et al., 2023), a recent systematic review suggests that sensory quality can actually drive the adoption of plant-based foods.
Moreover, in line with previous studies (Carfora et al., 2019; Giampietri et al., 2018; Menozzi et al., 2015), in the present study trust towards environment and ethics associated to higher trust towards plant-based alternative proteins. Furthermore, it suggests the importance of maintaining or improving the intrinsic product quality of plant-based foods, particularly when consumers have limited knowledge about novel food items and technologies (Siegrist, 2008). “Intrinsic product quality” motives may contribute to purchase intentions through increasing trust in plant-based alternative proteins. Specifically, trust can positively contribute to the relationship between “Intrinsic product quality” motives and behavioural intentions towards plant-based meat alternatives, as a more substantial mediation effect was found in behavioural intentions towards plant-based meat alternatives compared to plant-based cheese alternatives. Therefore, trust may be a critical factor in the relationship between FCM and behavioural intentions. Furthermore, it suggests the importance of maintaining or improving the intrinsic product quality of plant-based food alternatives, such as their taste, texture and freshness, to support a higher trust in plant-based alternative proteins and contribute to behavioural intentions. These findings align and could further explain consumers demand for substantial improvements in the sensory quality of plant-based food alternatives, particularly plant-based cheese (Waehrens et al., 2023). Moreover, in line with previous studies (Carfora et al., 2019; Giampietri et al., 2018; Menozzi et al., 2015), in the present study trust towards plant-based alternative proteins was significantly associated with the intentions towards consuming plant-based meat and cheese alternatives.

Barriers were significantly and negatively linked to the intentions towards consuming plant-based meat and cheese alternatives. “Environment & ethics” motives could contribute to reducing barriers to plant-based food consumption. Major barriers to purchasing or consuming plant-based foods are unavailability (Mäkiniemi & Vainio, 2014), lack of information (Lea et al., 2006b; Perez-Cueto et al., 2022), price (Mäkiniemi & Vainio, 2014) and sensory attributes (Perez-Cueto et al., 2022; Waehrens et al., 2023). FCM focussed on “intrinsic product quality” were significantly positively linked to barriers and trust. However, the hypothesis could not be fully confirmed due to a very small effect size ($R^2 < 0.01$). Therefore, it is plausible that other factors should be considered as antecedents to barriers in future studies.

6. Strengths and limitations

To the knowledge of the authors, this is original work, and it is the first time that barriers to plant-based consumption and trust towards plant-based foods have been considered as mediators between traditional food choice motives and the intention to consume plant-based alternatives to meat and dairy. One of the strengths of the present study is the inclusion of a large number of respondents and targeted countries representing different geographical and cultural regions in Europe. The total and country sample size were sufficient to perform PLS-SEM. Furthermore, quota sampling provided a balanced distribution of males and females and age groups in the dataset (Perez-Cueto et al., 2022). However, using quota sampling and existing consumer panels for data collection may introduce bias. The balanced distribution of age groups attempted to mirror the stationary age pyramids in the studied countries; hence, cohort bias is unlikely. Country differences can be better compared, when the same distribution of respondents is used in all the sampled countries. Furthermore, selection bias is possible when recurring to consumer panels for data collection. External market agencies ensure that the data obtained is representative of the targeted populations in the relevant countries (Malhotra, 2019). As the sample does not fully represent the countries’ populations, and considering that a very small level of bias might be present, extrapolations should be made carefully. Although SEM usually allows for causality inferences, only associations could be obtained with the data used in this study. Furthermore, this study focussed on selected food choice motives to assess potential associations with behavioural intentions, barriers and trust. Although the samples might not be fully representative of the studied countries, they provide sufficient power to address the consistency and validity of constructs obtained from existing scales; it further provides insights on the usability of scales, justifies the elimination of redundant questions, and contributes to more user-friendly questionnaires. Future studies should also consider other food choice motives or factors associated with behavioural intentions, barriers and trust. For example, (Mäkiniemi & Vainio, 2014) observed that habits strongly predict behavioural intentions and could be linked to barriers to plant-based food consumption. Based on this cross-national survey, we suggest that shorter versions of the Barriers and FCM scales could be used with the items retained. Furthermore, the present research focussed on plant-based meat and plant-based cheese alternatives. While plant-based meat is considered a general food product category, plant-based cheese can be considered as a subcategory of plant-based dairy alternatives. The category plant-based dairy alternatives consist of a wide range of food items, such as plant-based milk, plant-based yoghurt and plant-based cheese. Therefore, comparison of results on plant-based meat and cheese alternatives should be interpreted carefully considering that plant-based meat is a general food category and plant-based cheese a subcategory of plant-based dairy alternatives. Future studies should consider including other plant-based food categories or a wider range of subcategories of plant-based diary alternatives, as findings cannot necessarily be completely generalized to other plant-based food categories due to potential differences in consumers’ acceptance and preferences of the targeted food product category (Cardello et al., 2022).

6.1. Implications and conclusion

The market of plant-based food alternatives has expanded rapidly in various countries in Europe (Smart Protein Project, 2021). In particular, the meat alternative market has experienced a rapid growth, while the market of plant-based cheese alternatives is still in its early development phase (Smart Protein Project, 2021). The present study provided insights into important factors associated with behavioural intentions towards plant-based meat and cheese alternatives, which can be important insights for plant-based food product development, marketing strategies and future research. The findings point out that “Environment & ethics” motives contribute positively to behavioural intentions, which may, in turn, contribute to purchasing plant-based meat and cheese alternatives. “Intrinsic product quality” motives were negatively related to behavioural intentions towards plant-based cheese alternatives but not directly associated with behavioural intentions towards plant-based meat alternatives. This could indicate that the sensory quality of plant-based cheese alternative is still considered unsatisfactory, while this might not be the case for plant-based meat alternatives as no direct association was observed among most countries. Moreover, “Environment & ethics” motives were linked to decreasing barriers to plant-based food consumption and increasing trust towards plant-based food alternatives, which in turn could contribute to increasing or decreasing behavioural intentions, respectively. Barriers and trust were observed as significant mediators in the association between food choice motives and behavioural intentions. This suggests that barriers and trust are important factors that could influence the link between food choice motives and intentions. Ensuring the intrinsic product quality of plant-based food alternatives, such as their sensory properties, may contribute to higher trust in plant-based alternative protein sources and hence, towards a higher intention to purchase.

CRediT authorship contribution statement

Ilona Faber: Conceptualization, Methodology, Investigation, Formal
Declarative 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.

Data availability

Data will be made available on request.

Acknowledgements

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 862597. The authors would like to thank Kai-Brit Schefold for contributing to the methodology development and data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2024.105101.

References


Benson, T., Lavelle, F., Spence, M., Elliott, C. T., & Dean, M. (2020). The development of a 6-component framework for conceptualising the work reported in this paper.


