



Attitudes and preferences regarding plant-based yoghurt analogues among Swedish consumers with different dietary habits

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ABSTRACT

This study evaluated drivers and barriers in consumer willingness to purchase plant-based yoghurt analogues (PBYA) and assessed the most important attributes of PBYA. Questionnaire data from 702 Swedish adults (19% vegan, 20% lacto-ovo-vegetarian, 21% flexitarian, 41% omnivore) showed that attitudes and preferences regarding PBYA differed between consumers with different dietary preferences. Animal welfare was an important driver for vegans, while interest in trying new foods was one of the main drivers for omnivores. All four consumer groups believed that PBYA is good for the environment. The main reasons indicated for not consuming PBYA were unpleasant taste and lack of motive to switch from dairy yoghurt to PBYA.

All groups indicated taste, appearance and price as overall driving forces when choosing PBYA. The importance of some factors, such as local ingredients, few additives and low sugar content, was rated higher by flexitarians and omnivores than by vegans and lacto-ovo vegetarians. These data about consumer attitudes and preferences regarding PBYA should be implemented during PBYA product development, especially when targeting different food preference groups.

1. Introduction

A large body of research suggests that a diet rich in plant-based foods is associated with better population health and reduced impacts on the environment (Willett et al., 2019). Accordingly, many consumers are now actively seeking alternatives to meat and dairy food products (Aschemann-Witzel et al., 2020). The global market share for plant-based foods has grown each year in the past decade. In the USA, unit sales of plant-based foods increased by 20% from 2019 to 2022 but with a slight decline (3%) in 2022, although dollar sales continued to rise due to increased retail prices (Retail sales data: Plant-based meat, eggs, dairy | GFI, 2023). Similarly, European unit sales increased by 20% during 2020–2022.

The food industry has responded to emerging consumer demand by rapid product development of meat and dairy analogues. The market now offers a wide range of plant-based analogues, but challenges remain regarding the palatability of such products (Cordelle et al., 2022; Pua

et al., 2022; Jaeger et al., 2023).

The terms dairy analogue, dairy substitute and dairy alternative are often used interchangeably to describe a food product in which animal-derived milk has been replaced by a vegetable source intended to mimic the characteristics of the dairy product. The global market is dominated by analogues based on soy, oat, almond, rice and coconut (Pua et al., 2022).

Plant-based yoghurt analogue (PBYA), also referred to as 'gurt' (Kårlund et al., 2022), is the most consumed fermented dairy analogue in Europe (Market insights on European plant-based sales 2020–2022 - GFI Europe, 2023), with soybean being a common crop substitute for bovine milk (Pua et al., 2022). In countries with a temperate climate, such as Sweden, there is strong interest in replacing soy in plant-based foods with locally grown, cold-climate crops, which could bring several agronomic benefits (Röös et al., 2020). However, the use of 'new' ingredients may create challenges regarding consumer acceptance.

To advance development of PBYA products, it is important to have

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good knowledge of specific consumer preferences regarding ingredient content, nutritional composition and sensory attributes. In addition, a deeper understanding of drivers and barriers to consuming PBYA-like products could help food industry stakeholders tailor their product range to consumer expectations and perhaps reach new consumer groups.

Females and the younger generation may be associated with a higher likelihood of choosing plant-based foods, whereas males and the older generation tend to be more attracted to animal-based foods (Bryant and Sanctum, 2021; Deliens et al., 2022; Hinrichs et al., 2022). A Danish study on the likelihood of consuming PBYA showed that females were more likely to consume PBYA than males, but that age and dietary lifestyle did not have an impact on willingness to consume PBYA (Pande et al., 2021). Previous research has mainly focused on demographic differences, while differences between consumer groups based on their interest habits has received less attention, e.g. differences between vegetarians and non-vegetarians (Köster, 2003). One Swedish study investigated consumer attitudes and beliefs regarding plant-based meat alternatives and compared groups of consumers with different meat intake. The results showed that drivers and barriers to consume meat alternatives differed between the dietary groups (Spendrup and Persson Hovmalm, 2022).

The objective of this study was to investigate Swedish consumer attitudes and preferences regarding PBYA through an internet-based consumer survey. Differences and similarities in the attitudes of different groups of consumers based on their preferred diet were analysed. By gaining more knowledge about different food preference groups, the results from this study is expected to support product development of PBYA.

Participants in the survey were divided into four groups based on their diet: (1) Vegans (strict plant-based diet), (2) lacto-ovo vegetarians (diet excluding meat and fish), (3) flexitarians (primarily plant-based diet, but eat meat, fish and/or dairy occasionally) and (4) omnivores (often eat meat, fish and dairy).

2. Method

An internet-based questionnaire was constructed and launched via Netigate (Netigate AB, Stockholm, Sweden). The target group was Swedish consumers aged 18+ years. Employees and students at the Swedish University of Agricultural Sciences (SLU) and Kristianstad University (HKR), and employees at RISE Research Institutes of Sweden (RISE) were invited to participate in the study. Participants were also recruited via RISE on the social media platforms Facebook and LinkedIn.

Data on respondents' opinions and attitudes to food were collected, and thus the study did not involve handling of sensitive personal data according to the Data Protection Ordinance. The responses to the questionnaire cannot be used to identify any individual, in compliance with the General Data Protection Regulation (GDPR). Prior to starting the questionnaire, the respondents gave their consent to take part in the study and were informed that participation was anonymous (following GDPR) and that they could withdraw from the study at any time. Since no sensitive personal data were handled, the study did not require an ethical review from the Swedish authority (Swedish Ethical Review Authority, 2003). Data were collected from 3 May to 1 July 2022.

The questionnaire contained background questions about gender, age, dietary pattern, allergies or intolerances, and experience of consuming PBYA. The question concerning dietary pattern divided the respondents into the four consumer groups that were compared in the study. During evaluation of results the terms vegan, lacto-ovo vegetarian (L-O vegetarian), flexitarian and omnivore were used to define the four groups. Remaining questions following the demographic questions concerned preferences and attitudes regarding PBYA. The questionnaire with questions and answer options can be found in Appendix).

Respondents who answered "Yes" to whether they would like to consume PBYA, (Q11), received a follow-up question about reasons to

consume PBYA (Q12). Respondents who answered "No" received a follow up-question about reasons to *not* consume PBYA (Q13). Respondents who answered "Maybe" were asked to answer both Q12 and Q13.

2.1. Statistical analyses

Statistical analyses were performed using IBM SPSS software (version 29.0, Chicago, IL, USA) after stratification by dietary group. Descriptive statistical analyses included frequencies, mean values, standard deviation and standard error of mean. Continuous variables were further analysed by one-way ANOVA, followed by pairwise comparisons in Tukey's test. Principal component analysis (PCA; Panel Check, Nofima, Norway) was performed to obtain an overview of between-group differences regarding liking of ingredients and important factors for choosing PBYA. Nominal data were subjected to Cochran Q-test to evaluate between-variable differences and Pearson Chi-square was used for group comparisons. For question 13, concerning reasons not to consume PBYA, only two groups were compared and thus a paired comparison *t*-test was used. *P*-values <0.05 were considered statistically significant in all statistical analyses. A word cloud was generated through the free online application WordClouds.com (wordclouds.com, Zygomat, Vianen, The Netherlands). Group comparisons were based on diet, so respondents who did not state their diet were excluded. Respondents who did not complete the questionnaire were also excluded.

3. Results

A total of 702 individuals participated in the survey. The majority of the respondents were females (76%), followed by males (22%) and other (2%). All dietary groups had a higher proportion of females than males (Table 1). Age varied from 18 to 75 years, although a large majority of the respondents were in the age range 20–40 years. Most participants (85%) had no allergy or intolerance to lactose, milk protein or gluten, and 78% had eaten PBYA previously. The four groups compared in this study based on diet were all well represented in the survey: vegan (19%), L-O vegetarian (20%), flexitarian (21%) and omnivore (41%).

The respondents had a somewhat positive opinion on faba bean, pea, oat or a mixture of these as ingredients in PBYA (Q6) (Table 2). While flexitarians and omnivores had a neutral attitude towards using a mixture of plant-based ingredients and milk, vegans and L-O vegetarians were more negative. Taste was scored highest by all four consumer groups among factors considered important when choosing PBYA (Q7). Appearance, texture and price were also important factors for all groups, while macronutrient content appeared to be less important. Low fat content was regarded as the least important factor by all groups, but low sugar content was close to important for all groups and especially the flexitarian group. The other factors, such as local ingredients, few ingredients, few additives and colour (Q7), were more important to flexitarians and omnivores than to vegans and L-O vegetarians.

Fig. 1 shows a PCA plot of the correlations between 'opinion on ingredients', 'importance of factors' and the groups of consumers. The different dietary groups were responsible for most of the variation, as they were most spread out along principal component (PC1, which explained 87.9% of the total variation). The largest differences were observed between vegans and omnivores, while L-O vegetarians and flexitarians were intermediate. The factor 'Mix plant-based cow's milk'

Table 1
Distribution of gender in each dietary group.

Gender	Vegan	L-O vegetarian	Flexitarian	Omnivore
Female	77	85	81	68
Male	16	15	17	31
Other	7	1	1	1

Values shown are in percentage rounded off to nearest whole number.

Table 2

Respondents' preference for different ingredients, in total and in the different dietary groups, and the importance of different factors to them when choosing PBYA.

Factor	All	Vegan	L-O vegetarian	Flexitarian	Omnivore
Ingredients					
Faba bean	3.9 ± 1.1	4.0 ^a ± 1.1	4.0 ^{ab} ± 1.1	4.0 ^{ab} ± 1.1	3.7 ^b ± 1.2
Pea	3.8 ± 1.2	4.0 ^a ± 1.2	4.0 ^a ± 1.1	4.0 ^a ± 1.1	3.6 ^b ± 1.2
Oat	4.1 ± 1.1	4.3 ^a ± 1.1	4.3 ^a ± 1.0	4.4 ^a ± 1.0	3.9 ^b ± 1.3
Mixture of bean/pea and oat	4.0 ± 1.1	4.2 ^a ± 1.0	4.1 ^a ± 1.0	4.1 ^a ± 1.0	3.7 ^b ± 1.2
Mixture of plant-based and cow's milk	2.6 ± 1.5	1.1 ^a ± 0.4	2.2 ^b ± 1.3	3.0 ^c ± 1.4	3.4 ^d ± 1.4
Importance					
Local ingredients	4.1 ± 1.0	3.6 ^a ± 1.1	4.0 ^b ± 1.0	4.2 ^{bc} ± 0.9	4.4 ^c ± 0.9
Few ingredients	3.3 ± 1.2	3.0 ^a ± 1.2	3.3 ^{ab} ± 1.1	3.6 ^b ± 1.1	3.4 ^b ± 1.2
Few additives	3.6 ± 1.2	3.1 ^a ± 1.3	3.6 ^b ± 1.2	3.7 ^b ± 1.2	3.7 ^b ± 1.2
Taste	4.9 ± 0.3	4.9 ± 0.3	4.8 ± 0.4	4.9 ± 0.4	4.9 ± 0.3
Appearance	4.2 ± 0.9	4.1 ^{ab} ± 0.8	4.0 ^a ± 0.9	4.1 ^{ab} ± 0.8	4.3 ^b ± 0.9
Texture	4.6 ± 0.6	4.5 ^a ± 0.7	4.5 ^a ± 0.6	4.5 ^a ± 0.6	4.7 ^b ± 0.5
Colour	3.8 ± 1.0	3.6 ^a ± 0.9	3.6 ^a ± 1.0	3.8 ^{ab} ± 1.0	3.9 ^b ± 1.0
Price	4.1 ± 0.8	4.1 ± 0.7	4.0 ± 0.8	4.1 ± 0.8	4.1 ± 0.8
High protein content	3.1 ± 1.1	3.0 ± 1.2	3.2 ± 1.0	3.1 ± 0.9	3.2 ± 1.1
Low sugar content	3.7 ± 1.1	3.6 ^a ± 1.1	3.6 ^{ab} ± 1.1	3.9 ^b ± 1.0	3.7 ^{ab} ± 1.0
Low fat content	2.5 ± 1.1	2.5 ± 1.2	2.4 ± 1.0	2.5 ± 1.1	2.6 ± 1.0
Yoghurt culture	3.3 ± 1.0	3.4 ± 1.0	3.2 ± 1.0	3.4 ± 1.1	3.3 ± 1.0
Flavoured	2.8 ± 1.2	2.9 ± 1.3	2.7 ± 1.2	2.7 ± 1.2	2.9 ± 1.2
Unflavoured	3.1 ± 1.0	3.1 ± 1.1	3.1 ± 1.0	3.2 ± 1.1	3.0 ± 1.0

Values shown are mean ± standard deviation. Different letters within rows indicate significant difference ($p \leq 0.05$) between the consumer groups. Scale for ingredients were 1 = Negative, 2 = Somewhat negative, 3 = Neutral, 4 = Somewhat positive, 5 = Positive. Scale for Importance were 1 = Not at all important, 2 = Not very important, 3 = Neutral, 4 = Important, 5 = Very important.

differed the most from the other 'Opinion on ingredient' factors as can be seen in PC1. The terms associated with 'importance of factors' showed larger variation along PC2 compared to PC1.

Approximately 35% of the respondents answered the free text

question about additional factors that are important when choosing PBYA (Q8). Several comments concerned topics that were not included in the questionnaire, such as a desire for user-friendly packaging and adequate calcium content. A summary of common words used in respondents' answers is presented as a word cloud in Fig. 2.

Most respondents (85%) chose breakfast as the best time/place to consume PBYA (Q9), followed by in-between meal (76%), at home (56%) and on-the-go (39%). The order of preferred choice was the same in all consumer groups (Fig. 3). Significant differences within the groups were found for all choices except for the choices 'Breakfast' and 'In-between meal' in the vegan and L-O vegetarian group.

All groups indicated a preference for stirred yoghurt over set or drinkable forms (Q10). There was no significant difference between the groups with regard to this characteristic of PBYA.

A majority of respondents (78%) indicated an interest in consuming PBYA (Q11) (Fig. 4). However, in the omnivore group, 30% answered 'Maybe' and 11% indicated that they would not like to consume PBYA.

When respondents were asked about the most important reasons for consuming PBYA (Q12), the most frequent answer for L-O vegetarians, flexitarians and omnivores was 'good for the environment'. In the vegan group, 'good for animal welfare' was the most frequent answer, followed by 'good for the environment'. For L-O vegetarians and flexitarians 'good for animal welfare' was the second most frequent answer, while for omnivores it was 'tasty' (Fig. 5). For omnivores, the most common reason for choosing not to consume PBYA (Q13) was 'see no reason to replace milk-based yoghurt' (75%), followed by 'not tasty' (52%) and 'expensive' (36%). For flexitarians, the most common reason was 'not tasty' (60%), followed by 'see no reason to replace milk-based yoghurt' (48%) and 'expensive' (36%). The difference between omnivores and flexitarians regarding 'see no reason to replace milk-based yoghurt' was statistically significant ($p = 0.007$). Vegans and L-O vegetarians were not assessed concerning reasons for not choosing to consume PBYA, due to too few responses (nearly all vegans and L-O vegetarians answered that they were interested in consuming PBYA and hence did not receive the follow-up question on reasons for not choosing to consume PBYA).

4. Discussion

This study investigated attitudes and preferences regarding PBYA among Swedish consumers, through an internet-based survey. The responses provided significant new knowledge on the reasons for the growing interest in plant-based alternatives and on factors affecting consumer choice during transition from animal-based to plant-based dietary products. A previous study by Köster (2003) stressed the importance of taking dietary patterns into account when comparing consumers, rather than making comparisons based on demographic factors. Accordingly, this study compared four consumer groups with different amounts of plant-based foods included in their diet (vegans, lacto-ovo-vegetarians, flexitarians, omnivores).

Significant differences between the groups were observed for several survey questions. The large differences between the groups were also evident in a PCA plot (Fig. 1), where PC1 differentiated the vegan group on one extreme and the omnivore group on the other. Vegetarians and flexitarians were in intermediate positions, which is in line with suggestions by Köster (2003).

The vegan group had a significantly more positive attitude than the omnivore group towards the ingredients that were asked about in the survey (Q6): faba bean, pea, oat or a mixture of those. Omnivores indicated attitudes between 'neutral' and 'somewhat positive' on average, indicating that these ingredients potentially appeal to many consumers. It has been suggested that mixed products, containing plant-based and animal-based ingredients, can serve as "transitional products" to help consumers adapt to a more plant-based diet (Drigon et al., 2023; Profeta et al., 2020). However, the survey responses showed no clear positive attitude to mixed products. This is in line with findings in a previous study that consumers driven by altruistic food-choice criteria

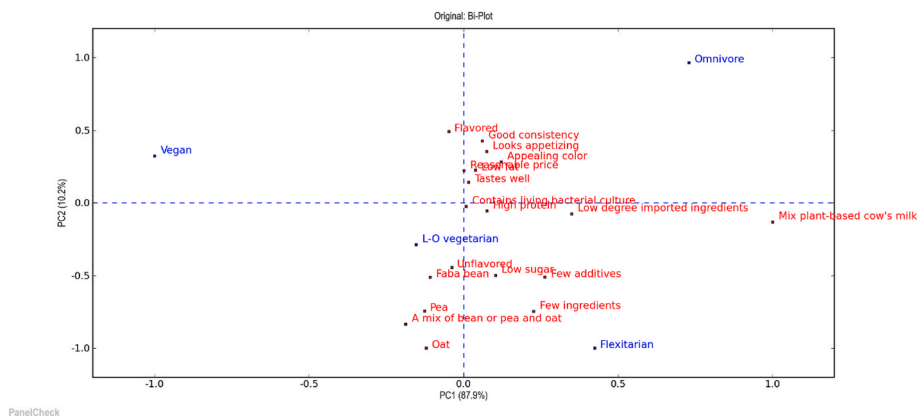


Fig. 1. Principal component (PC) plot for 'opinion on ingredients' and 'importance of factors' showing the separation of the different dietary groups (blue text; vegan, L-O vegetarian, flexitarian and omnivore).



Fig. 2. Word cloud of common words in responses to the free text question (Q8) about additional factors that are important when choosing PBYA. The larger font size represents words that were mentioned by more than three respondents and the smaller font size represents words that were mentioned by 2–3 respondents.

(mainly vegetarians and flexitarians, caring about animal welfare, environmental protection, fair trade, health and natural content) were less positive to mixed dairy products than omnivores, who did not discriminate between any food choice criteria (Drigon et al., 2023).

As found in previous research on important characteristics of plant-based foods (Blanco-Gutiérrez et al., 2020; Rini et al., 2022; Kołodziejczak et al., 2022), the survey responses showed that taste, texture, appearance and price are all important factors when buying PBYA. This was true for all consumer groups, with taste scoring the highest in all groups. However, the importance of factors correlated with the level of plant-based diet for four factors (local ingredients, few ingredients, colour, low sugar content), suggesting that the more plant-based diet a consumer follows, the lower the importance of these factors. Surprisingly, all consumer groups had on average a neutral opinion about the macronutrient content of PBYA. This contradicted expectations that consumers may prefer a high protein content, since research on meat analogues (Antoniak et al., 2022) and dairy analogues (Yang and Dharmasena, 2020) has demonstrated a preference for high-protein products. In addition, low fat and low sugar products are marketed as healthy (Küster and Vila, 2017) and could therefore be important to consumers. Of these three factors (high protein, low fat, low sugar), only low sugar content scored closer to 'important' than to 'neutral' in the survey responses. A previous study on food avoidance among Swedish consumers (age 20–65) found that sugar was the most avoided food component (52%), whereas fat was avoided much less (11%) (Bärebring et al., 2020). However, our survey concerned one product category only and did not take into account diet as a whole, which could explain why the respondents did not consider macronutrient content to be the most important attribute of PBYA.

Calcium content and practical packaging were mentioned as important factors for buying PBYA by several respondents in the free

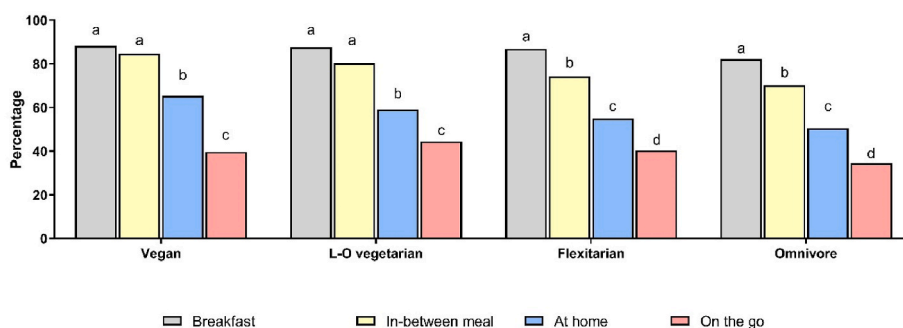


Fig. 3. Preference of the different dietary groups as regards when and where to consume PBYA, as % of respondents. Different letters above the bars indicates significance difference within the dietary group ($p < 0.05$).

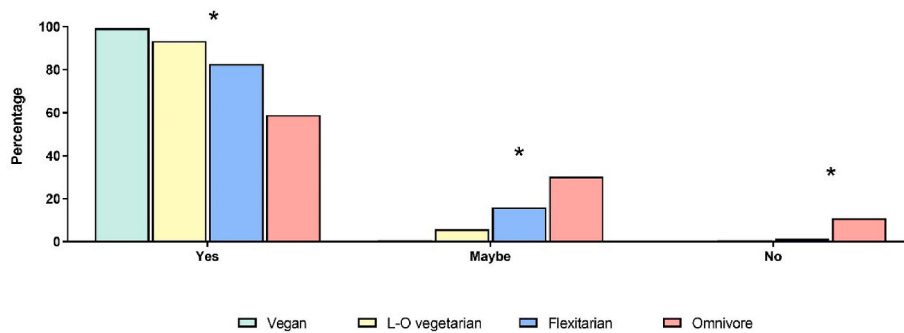


Fig. 4. Interest in consuming PBYA among the different dietary groups. * indicates significance between the dietary groups ($p < 0.05$).

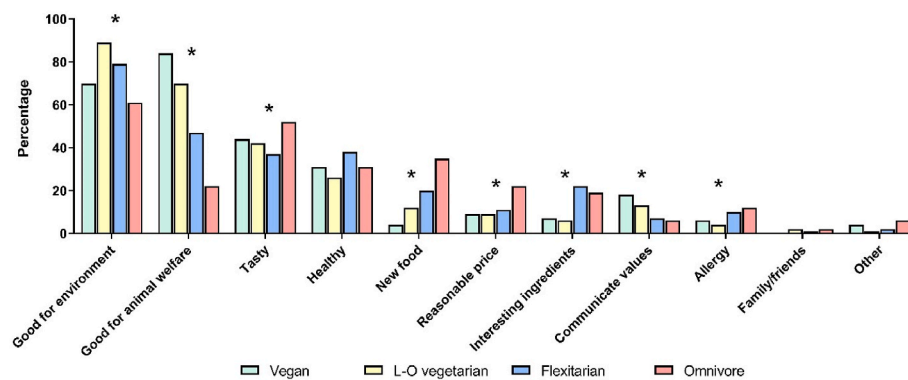


Fig. 5. Reasons for choosing to consume PBYA among the different dietary groups, as % of respondents. * indicates significance between the dietary groups ($p < 0.05$).

text responses to question 8 in the survey (Fig. 2), indicating that these factors may be important to many consumers and relevant in product development of PBYA.

All consumer groups preferred the same style of PBYA (stirred-type yoghurt) and the same time when it should be consumed (breakfast). The Swedish market offers a wide range of products in this category, dominated by soy- and oat-based PBYA. However, PBYA products have lower sensory properties than their dairy counterparts, according to a recent study (Greis et al., 2023). If the sensory properties of PBYA were to be improved, more consumers might choose PBYA for breakfast. If the products were based on locally produced ingredients this might increase the likelihood of consumers buying PBYA, especially non-vegetarian consumer groups, which rated local ingredients as an important factor when choosing to buy PBYA.

In line with previous studies on attitudes to plant-based foods (Spendrup and Persson Hovmalm, 2022; Clicer et al., 2018), this study suggest that the interest in consuming PBYA may be linked to presumed dietary intake of plant-based foods (vegan > L-O vegetarian > flexitarian > omnivore). However, only 11% of omnivores stated that they were not interested in consuming PBYA, implying that non-vegetarians are a potential consumer group for PBYA.

The reasons for choosing or not choosing PBYA differed between the consumer groups. In particular, 'good for animal welfare' stood out as the most important reason to choose PBYA for vegans, but was one of the least important reasons for omnivores. Omnivores indicated 'like to try new foods' significantly more frequently than vegans, while L-O vegetarians and flexitarians were positioned between vegans and omnivores in both cases. These results were reflected in the reasons indicated for not consuming PBYA, where the majority of omnivores chose 'see no reason to change from regular dairy yoghurt to PBYA'. The drivers 'good for animal welfare' and 'good for the environment' are most likely too weak for omnivores to choose PBYA, as opposed to the vegan group.

The results obtained in this study provided new insights into

preferences for PBYA and into differences between consumer groups that can be valuable for product development. Future research should investigate whether preferences in a sensory test that includes tasting of PBYA also depend on dietary lifestyle. A majority of respondents in this survey were either students or highly educated employees under the age of 40. Furthermore, all consumer groups consisted predominately of females. Hence, the study population was not representative of all Swedish consumers. Future studies could approach more males and consumers with a lower education level and include both country and city dwellers.

5. Conclusions

This internet-based survey on consumer preferences and attitudes regarding PBYA showed that a majority of respondents were interested in consumption of PBYA. Attitudes and preferences differed between the consumer groups. In general, vegans differed most from omnivores in their opinions, while L-O vegetarians and flexitarians were intermediate. Respondents who consume more animal-based foods had slightly higher demands on product characteristics than respondents who consume more plant-based foods. Furthermore, the motives to consume PBYA correlated to some extent with the level of plant-based diet. The new knowledge from this study about similarities and differences between consumer groups can be useful for product development and future consumer studies concerning PBYA.

Implications for gastronomy

The findings in this study suggest a window of opportunity for PBYA as a plant-based breakfast alternative. New insights about preferences in different consumer groups may guide the gastronomy sector to create additional value to novel PBYA and attract a broad range of consumers. For example, local ingredients appears to be appreciated by Swedish

consumers but most likely not at the expense of attributes such as taste, texture and price. Tailoring PBYA according to such preferences may increase the likelihood that consumers choose PBYA and thereby facilitating a diet rich in plant-based foods.

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CRedit authorship contribution statement

Johanna Östlund: Conceptualization, Formal analysis, Investigation, Visualization, Writing – original draft. **Hanna Eriksson Röhnisch:** Conceptualization, Supervision, Writing – review & editing. **Galia Zamaratskaia:** Conceptualization, Supervision, Visualization, Writing – review & editing. **Maud Langton:** Conceptualization, Funding acquisition, Supervision, Writing – review & editing. **Karin Wendin:** Conceptualization, Methodology, Supervision, Visualization, Writing – review & editing.

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.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijgfs.2023.100865>.

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