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Plant-based food – Purchasing intentions, barriers and drivers among different organic consumer groups in Denmark

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ABSTRACT

How do we design policies that support a shift in eating habits towards a diet that includes more vegetable-based products and less meat, and in particular red meat? To inform policy, more information is needed about consumers' perceptions of the plant-based protein alternatives that have become available on the market. The present study of 1000 Danish consumers examined oat drink and plant-based mince as substitutes for cows' milk and minced beef. While the popularity of these is increasing, in 2021 70% of Danish consumers had nonetheless never tried using oat drink or plant-based mince. Respondents who stated that they often bought organic food were more likely to associate the plant-based products with benefits as well as being more likely to have tried using the plant-based products. While plant-based products were associated mainly with public good characteristics, it was private good characteristics that explained consumption of the products. Therefore, improving taste – or changing people's expectations about it – and reducing price are ways to reduce barriers to consumption. Initiatives to improve public understanding of the ways in which plant-based and animal-based products differ are also important, as many respondents were somewhat unclear about which characteristics they associated with the two products.

1. Introduction

There is an increasing focus on climate change and the need for action to reduce or reverse its causation by human activity. An important milestone was reached when world leaders signed the Paris Agreement, which aimed to limit the global increase in temperature to 1.5 °C in comparison with pre-industrial levels (UN, 2015). As it is estimated that around a third of global emissions of greenhouse gasses are linked to food production there is a need to change both the way that food is produced and what types of food are produced (Babiker et al., 2022). Red meat and dairy production are for example major emitters of greenhouse gases (Godfray et al., 2018; Poore and Nemecek, 2018). The need for a considerable shift in human diet was clearly stated by the EAT Lancet Commission which set out to analyse how we could obtain a healthy diet for 10 billion people in 2050 using sustainable agricultural production (Willett et al., 2019). They recommend diets consisting largely of a diversity of plant-based foods, low amounts of animal-sourced food containing unsaturated rather than saturated fats, and limited amounts of refined grains, highly processed food and added sugars.

When it comes to the composition of the daily diet, many studies have shown that consumers with high organic consumption have dietary habits that are more in line with the official recommendations (involving higher consumption of vegetables and fruits combined with a lower consumption of meat) than consumers with lower levels of organic consumption (Denver and Christensen, 2015; Christensen et al., 2020). A meta-analysis by Massey et al. (2018) found that consumers typically perceive organic food products as not only good for the environment and for animals, but also healthier and safer to consume than non-organic alternatives. Here, the characteristics healthy and safe are seen as private goods as the characteristics only benefit the individual that consumes the product, whereas the environment is seen as a public good since environmental improvements can benefit a large number of individuals – also individuals that do not consume the product (Kolstad, 2011). Also, organic consumers are typically more concerned about ethical issues such as the environment and animal welfare (Leonidou et al., 2022; van Doorn and Verhoef, 2015). An interesting twist was reported in Wier et al. (2008), in that organic consumption was higher

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among respondents who considered organic production to be not just better for the environment and animal welfare but also healthier and of better quality. Hence, while organic products were associated more strongly with public good characteristics, it was mainly consumers who associated those products with private good characteristics who actually purchased them. In the present study, we investigate whether these findings carry over to perceptions and the consumption of plant-based alternatives. We also ask to what extent organic consumption can be a marker for more positive attitudes towards plant-based alternatives. With an average organic budget share of around 13% in 2021, Denmark is one of the countries in the world with the highest organic consumption (Trávníček et al., 2023). Organic products are labeled with the EU organic logo and often also with the Danish national logo (which is the Danish letter 'Ø') – both labels are well-known among the consumers (YouGov, 2016).

Encouraging more people to follow the official dietary guidelines is now a political goal in a majority of countries around the world, and more than 100 countries have developed food-based dietary guidelines (FAO, 2021). Moreover, dietary recommendations focus increasingly not only on improving human health but also on reducing our climate footprint (WHO, 2021). However, in general the transition to eating less animal-sourced and more plant-based foods is slow. Tools that can be used to accelerate the process include information-based as well as fiscal interventions. For example, the Danish Council on Climate Change has suggested a number of food-related instruments that will help Danes to reach the country's climate goal: 1) food with low climate impact must be accessible and identifiable; 2) more and more easily accessible information must be made available to consumers about the climate impact of food choices (possibly with a climate impact label); 3) there should be economic incentives to choose food with lower climate impact; and 4) the social norm should evolve so that the default in the public (and private) sphere is to offer dietary choices with little animal-based products that are rich in plant-based ingredients (Danish Council on Climate Change, 2021). The fourth proposal, in particular, is novel. In making it, the Danish Council has taken the concept of carnivorism (in which animal-based diets are seen as the sub-conscious default choice) and sought to present it as being not just another target of criticism of the lifestyle in Western societies voiced by NGO's but a political instrument suggested by experts in the field.

Regardless of whether information-based or fiscal instruments are in the pipeline, we need to know more about consumer perceptions of the plant-based protein alternatives now available on the market. In the present study, we seek to enhance this knowledge by eliciting consumers' perceptions and the consumption of plant-based alternatives to meat and milk.

Several studies based on stated preferences have suggested that around half of the consumers in the Northwestern Europe are prepared to reduce the consumption of red meat (Denver et al., 2022; Nevalainen et al., 2023; de Boer and Aiking, 2022) – and that this tendency often is linked to concerns about climate changes. The study by Denver et al. (2022) distinguished between consumers with a high and a low organic consumption and found that the first-mentioned group was more likely to report a reduction in the intake of red meat. Recent qualitative studies by Collier et al. (2021) and White (2022) found that consumers in New Zealand and Sweden, respectively, highlight the social aspect of reducing meat consumption, but they also reported considerable variability among consumers. In particular, they found that, whereas some consumers felt that the transition to eating less meat would be eased if meat substitutes were to mimic the appearance or taste of meat, others believed that this would only increase the urge to compare meat-based and plant-based products, and that since this would take the focus away from the qualities of plant-based products per se, it was in effect a barrier to the transition. A study by Bryant et al. (2019) examined the purchase intention regarding plant-based meat and clean meat (also denoted cultured meat) among consumers in China, India and the USA. The results revealed that in a somewhat skewed sample with over-representation of urban, well-educated, high-income consumers, the consumers in China and India were more likely than Americans to purchase plant-based and clean meat.

We continue this line of investigation. In comparison with Collier et al. (2021) and White (2022), we narrow down the analysis, as we focus on two specific products in order to control the context in which consumer preferences are elicited: plant-based alternatives to *minced beef* and *cows' milk*. At the same time, we broaden the empirical framework. Instead of relying on qualitative focus group interviews, we use a consumer survey that enables us to analyse how common different perceptions are among Danish consumers.

Our aim was to study consumption and perceptions of plant-based products among different organic consumer groups in Denmark. To guide the analyses, we formulated three research questions (RQ) that together address Danish consumers consumption and perceptions of plant-based products in connection with two specific products: oat drink as a plant-based alternative to cows' milk and plant-based mince as an alternative to minced beef:

RQ1 How often do different organic consumer groups in Denmark consume oat drink and plant-based mince?
RQ2 What benefits do different organic consumer groups associate with oat drink and plant-based mince?
RQ3 To what extent can consumers' perceptions of plant-based alternatives and their own organic consumption be used to explain their consumption of oat drink and plant-based mince?

The data and the statistical method used to investigate the three research questions are described in Section 2, while results are presented in Section 3. The findings of the analysis are discussed in Section 4 and concluded upon in Section 5.

2. Materials and method

2.1. Materials

The research questions were investigated using data from a survey of a sample of Danish consumers. Data from 1000 respondents were collected in an online survey conducted in 2021 using COOP Analysis' pre-recruited web panel. The distribution of the sample was representative of the Danish adult population in respect of gender, age groups and the share of respondents living in the capital region. In the group of respondents higher education was overrepresented at the expense of respondents with other levels of education – something often seen in consumer surveys. We received the dataset in a pseudonymized form, so that it did not reveal any personal identifiable information.

2.2. Method

In order to investigate the relation between organic consumption, on the one hand, and perceptions and the consumption of oat drink and plant-based mince, on the other, we grouped the respondents in accordance with their stated organic consumption. Following the approach used in Christensen et al. (2020), we used the following question for each of three product groups to obtain robust estimates of organic consumption: 'Now you have to distinguish between food products that are labeled with an organic logo and food products that are not labeled. Think of the last six months. How many servings of vegetables that you ate/servings of milk that you drank/servings of beef that you ate … were organic? We know it's hard to rate, but we're asking you to make your best assessment.' The response categories were: 0 out of 10; 1 out of 10; 2 out of 10; 3 out of 10; 4 out of 10; 5 out of 10; 6 out of 10; 7 out of 10; 8 out of 10; 9 out of 10; 10 out of 10; don't know. Responses were coded as numerical scores from 0 to 10 (with the value 0 assigned to the category '0 out of 10', the value 1 assigned to the category '1 out of 10', and so on). The scores were then summarized across product groups, and the

organic purchasing frequencies for all three products were aggregated into a single average frequency. If a respondent did not consume all of the products (e.g. a consumer who avoids beef) or answered 'don't know', the overall frequency was based on the remaining products or product. The organic frequencies were used to group the respondent into the following four organic consumer groups:

- light-users: Frequencies up to 10%
- medium users: Frequencies of 11–55% inclusive
- heavy users: Frequencies of 56–75% inclusive
- super users: Frequencies above 75%

In total, 60 of the 1000 respondents did not state their organic consumption for any of the products, either because they did not consume any of the products or because they answered 'don't know' when asked about their organic consumption. As it was not possible to group these respondents in a meaningful way, they were removed from the sample.

In the survey, as we have said, we focused on two types of plant-based product: oat drink and plant-based mince. We included oat drink as this is the plant-based drink most commonly consumed in Denmark. As the market share of plant-based mince is substantially lower than that of plant-based drinks, with large variety in ingredients (e.g. peas, soy, beet-root, lentils, beans) we tested perceptions of the more generic item plant-based mince without specifying which of the various types sold in supermarkets it was.

To address RQ1 – concerning the respondents' consumption of oat drink and plant-based mince – we presented two questions:

How often do you use oat drink? You need to think about what you drink, put in your coffee/tea, use for baking and cooking, etc. Tick the statement that suits you best.

How often do you eat plant-based mince? Remember that plant-based mince can be eaten in many different forms. Tick the statement that suits you best.

The response categories for the two questions were: Never; Less often than every 3 months; Once every 3 months; Once a month; 2–3 times a month; Once a week; Several times a week; Daily; Don't know.

In the analysis, we grouped the respondents according to whether they had tried using the products. Specifically, for each of the paired products we distinguished between respondents who stated that they had never tried the product and those stating that they had tried it at least once. We denote these categories as 'Never' and 'Have tried using it'. In total, 27 respondents answered 'don't know' in relation either to their use of oat drink or their use of plant-based mince. They were removed from the sample. As a result, the final sample contained 913 respondents. In total, 50% of the respondents were female, 32% lived in the Capital region and 16% had higher education of five years or more. Furthermore, 27% of the respondents belonged to the age group 18–34 years while 38% and 35% belonged to the age groups 35–54 years and 55–74 years, respectively.

To address RQ2 – concerning perceptions of the plant-based alternatives – we asked the respondents to consider nine statements about the two products. The questions were formulated as follows:

- What do you associate with oat drink as compared with milk? Even if you do not use milk or oat drink yourself, we would very much like to hear what you associate with the products.
- What do you associate with plant-based mince as compared with minced beef? Even if you do not eat beef or plant-based mince yourself, we would very much like to hear what you associate with the products.

The nine statements (S1–S9) were formulated so that they were either positively or negatively oriented to the plant-based alternatives: 'Oat drink/plant-based mince is healthier (S1)', ' … is worse for the climate (S2)', ' … is more harmful to wildlife and plants (S3)', ' … is an ethically better choice (S4)', ' … tastes worse (S5)', ' … is more popular in my family and circle of friends (S6)', ' … is more expensive (S7)', ' … is new and exciting (S8)', ' … has a longer shelf life (S9)'. To improve readability, the wordings of the negative statements as well as the responses were reversed in the presentation and analysis of the results. That is, it was stated that 'oat drink/plant-based mince … is *better* for the climate (S2)', ' … is *less* harmful to wildlife and plants (S3)', ' … tastes *better* (S5)', ' … is *cheaper*' (S7). Hereafter, the six response categories were coded as: 'totally disagree' = 1, 'partly disagree' = 2, 'neither agree nor disagree' = 3, 'partly agree' = 4, 'totally agree' = 5, 'don't know' = missing value. To examine the respondents' perception of the two products, we excluded missing values and estimated average scores and 90% confidence intervals for each of the statements concerning oat drink or plant-based mince. Thus, the higher the average score, the more the respondents agreed with the statement. In particular, a score above 3 indicates that the respondents on average tended to agree with the statement, while a score below 3 suggests that they on average disagreed. We report the differences between the statements as significant at 0.1 level, if the confidence intervals did not overlap.

In order to facilitate presentation of the results we reduced the six original response categories to three groups: a group of responses positively oriented to plant-based alternatives, a group of responses negatively oriented to plant-based alternatives, and a group of 'don't know' responses.

In particular, the group of *positively oriented* respondents included all those who had agreed, at least partly, with the statement. The group of *negatively oriented* respondents, by contrast, included all those who had answered 'neither agree nor disagree' or disagreed, at least partly, with the statement. For each of the nine statements a third group contained respondents who answered 'don't know'.

To address whether respondents with different levels of organic consumption had different perceptions of oat drink and plant-based mince, we estimated the shares of respondents in each of the four organic user groups, as well as the shares of all respondents, belonging to the positively oriented group. In order to investigate whether the shares of positively oriented respondents in the four user groups differed significantly from each other, we did a logistic estimation for each statement and product. In particular, the dependent binary variable was 1 if the respondents belonged to the positively oriented group and 0 otherwise. The four user groups were included as explanatory dummy-variables, with light-users as the reference group (the logistic approach is described more detailed in the section below). Differences between the groups were reported as significant at 0.1 level, if the 90% confidence intervals for the odds-ratio estimates did not overlap.

In addressing RQ3 – about the extent to which consumers' perceptions of plant-based alternatives and their own organic consumption can be used to explain their consumption of oat drink and plant-based mince – we were inspired by the statistic model used by Hosmer et al. (2013). We used two logistic regression models to estimate odds-ratios for the consumption of each of the plant-based alternatives. In the analysis, the dependent binary variable, y, took the value 1 if the respondent had tried using the product and 0 if the respondent had never tried using it. In the present context, an odds-ratio above (or below) 1 for an explanatory variable indicates that the variable has a positive (or negative) statistically significant impact on consumers' likelihood of belonging to the group 'have tried using it'. We assume that there is a linear relationship between the predictor variables and the log-odds of the event that $y = 1$. This relationship between the dependent variable and the explanatory variables can be written in the following mathematical form:

$$\log \frac{P(y=1)}{1-P(y=1)} = \beta_0 + \boldsymbol{\beta}_1 \boldsymbol{x}_1 + \boldsymbol{\beta}_2 \boldsymbol{x}_2 + \boldsymbol{\beta}_3 \boldsymbol{x}_3 \quad \text{(I)}$$

where β_0 is a constant, and $\boldsymbol{\beta}_1, \boldsymbol{\beta}_2, \boldsymbol{\beta}_3$ are vectors of parameters to be estimated related to the three vectors of explanatory variables, $\mathbf{x}_1$, $\mathbf{x}_2$, $\mathbf{x}_3$.

The first vector, $\mathbf{x}_1$, represents the nine statements concerning different characteristics of the plant-based alternatives. For each statement, dummy variables represent respondents in the positively oriented group as well as respondents who answered 'don't know' to the statement, while the negatively oriented group is used as a reference group. The four organic user groups are represented by three dummy variables for medium users, heavy users, and super users, respectively, in the vector $\mathbf{x}_2$, with light-users as the reference group. A vector of socio-demographic dummy variables, $\mathbf{x}_3$, is included to control for respondents' gender, level of education, place of residence and age. Specifically, the variable Education took the value 1 if the respondent had a higher education of five years or more and 0 otherwise, and the variable Capital region took the value 1 if the respondent lived in the Capital Region of Denmark and 0 otherwise. Finally, two dummy variables represented respondents in the age groups 18–34 years and 35–54 years, respectively (respondents in the age group 55–74 were used as reference). Separate estimations for each of the plant-based products were performed using the software SAS 9.4, and odds-ratios were listed as significant at 0.1 level if the 90% confidence interval did not contain the value 1.

3. Results

3.1. Results addressing RQ1

Fig. 1 shows how often, on average, the respondents used oat drink and plant-based mince. For both products, 71% of the respondents stated that they had never used the product and 29% that they had used the product at least once in a while. It can be seen that very few of the respondents were using either of the two plant-based products regularly.

Table 1 shows the shares of respondents in the four user groups who had tried using the two plant-based alternatives. The table suggests that there is a gradual increase in consumption of both types of plant-based product as organic consumption increases. In particular, the super users had tried using the products to the greatest extent, with 38% and 45% having used oat drink and plant-based mince, respectively. For comparison, only 9% of the light users had used oat drink, and 8% of them had used plant-based mince.

3.2. Results addressing RQ2

Fig. 2 shows the respondents' perceptions of the alternative products we presented them with. It suggests that the respondents had largely similar perceptions of oat drink and plant-based mince. Many considered the plant-based alternatives as better for the climate, less harmful to wildlife and plants, and an ethically better choice. Moreover, many respondents associated oat drink (but not plant-based mince) with longer shelf life. On the other hand, few respondents perceived the plant-based products as having a better taste, being cheaper, or being popular among families and friends. In particular, the respondents on average assigned a score around 2 to these characteristics which indicated that on average, the respondents did not link the products with these characteristics.

Table 1
Share of the respondents in four organic user groups who had tried using oat drink or plant-based mince.

User group	Respondents in group	Had tried using oat drink	Had tried using plant-based mince
Light	17%	9%	8%
Medium	40%	30%	26%
Heavy	22%	35%	37%
Super	21%	38%	45%

Note: Based on 913 respondents.

The results also highlighted the fact that many of the respondents had no clear perception of the products, as there was a common tendency for respondents to answer 'don't know' to the questions. In particular, many respondents (48% and 60%, respectively) did not know if oat drink or plant-based mince had a longer shelf life. On the other hand, fewer respondents (21% and 18%, respectively) did not know whether the products were more popular among family and friends. The shares of respondents who said 'don't know' to the statements can be seen in Appendix 1.

Fig. 3 (oat drink) and Fig. 4 (plant-based mince) show the shares of all respondents and the shares of respondents in the four organic user groups associating positive characteristics with the two alternative products. Note that to facilitate presentation only positive attitudes towards the plant-based products are represented for the respondents in these figures. For both products, we found that higher levels of organic consumption correlated with a more positive attitude towards the product characteristics. In particular, super users were more likely than light users to associate positive characteristics with the two alternative products. Neither heavy users nor medium users associated oat drink or plant-based mince as cheaper than the group of light users did. More medium users than light users considered oat drink as new and exciting while the difference between light and heavy users was insignificant. Moreover, we found no significant difference between the shares of light and medium users that considered the two alternative products as less

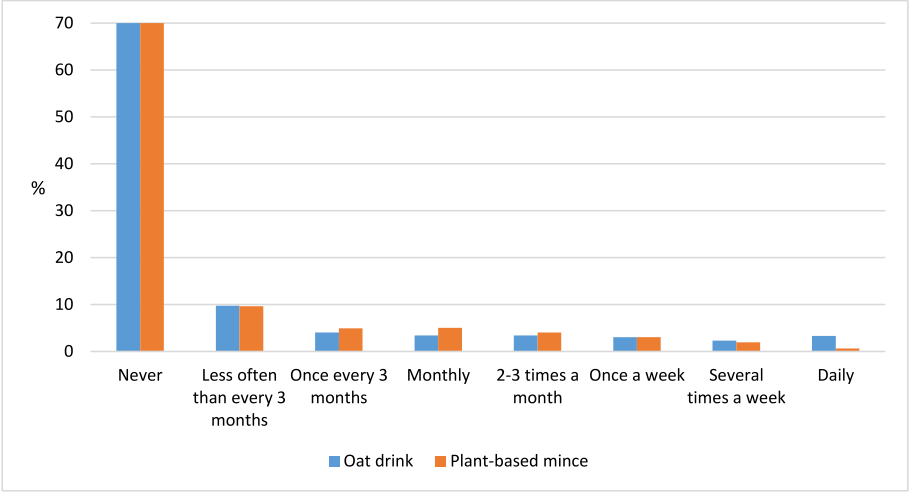

Fig. 1. Consumption of oat drink and plant-based mince by the survey respondents
Note: Based on 913 respondents.

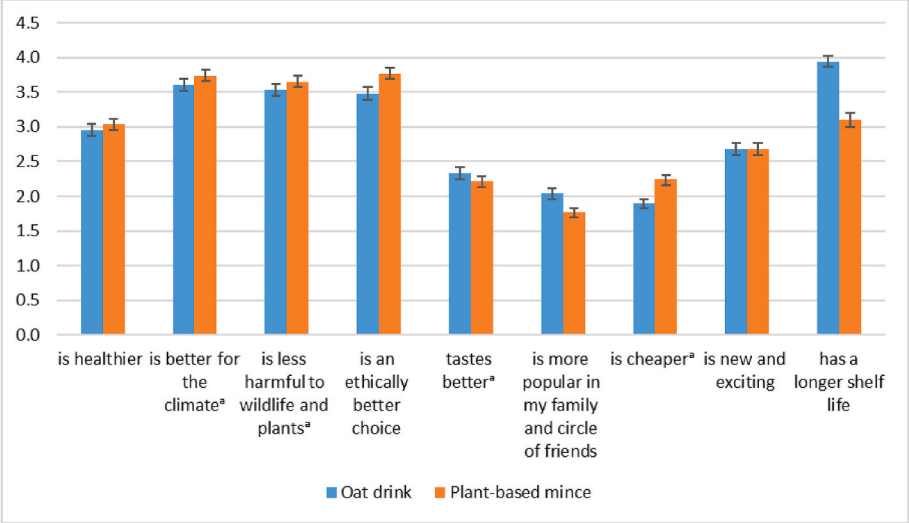

Fig. 2. Perceptions of oat drink and plant-based mince characteristics among the survey respondents (mean score of a five-point Likert scale and 90% confidence limits)
Note: [a] Indicates that the statement has been reversed for ease of presentation.

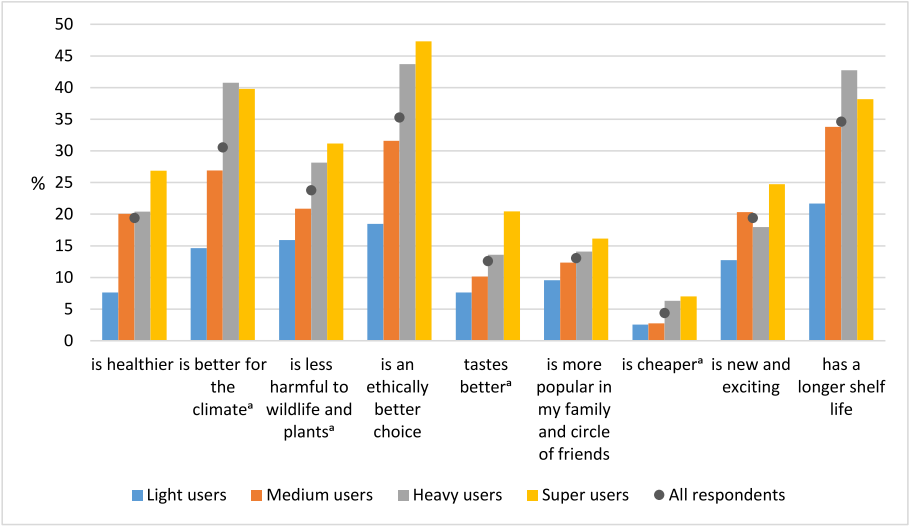

Fig. 3. Share of respondents associating oat drink with positive characteristics
Note: Based on 913 respondents. The figure shows percentages of all respondents as well as of respondents in the different user groups who agree, at least partly, that they associate the relevant characteristic with oat drink. [a] indicates that the statement has been reversed for ease of presentation.

harmful to wildlife and plants or as better tasting. All results from the logistic estimations of whether the user groups differed from each other in perceptions of oat drink and plant-based mince can be seen in Appendix 2.

3.3. Results addressing RQ3

Table 2 offers an indication of the extent to which attitudes towards the two plant-based products and degree of organic consumption, as well as socio-demographic factors, can be used to improve our understanding of the consumption of oat drink and plant-based mince. Specifically, it shows the results of the estimated logistic model that we applied to explain the likelihood of having tried using each of the two plant-based products.

Common to both plant-based products was the likelihood of consumption being higher among respondents who considered them to be healthier, tastier, cheaper, more popular in the family or circle of friends, or new and exciting, than their animal-sourced counterparts. The two products differed, however, where the effects of being an ethically better choice and having a long shelf life were concerned. In particular, we found a positive relation between having tried using oat drink and a perception that it is an ethically better choice (but no such relation for plant-based mince), just as we found a positive relation between having tried using plant-based mince and a perception that it has a long shelf life (but no such relation for oat drink). Only a few of the variables representing respondents who answered 'don't know' to the statements were significantly different from the reference group (the negatively oriented group). One of the few examples we found was that respondents who were undecided about whether the plant-based alternatives had a better taste than the animal-based counterparts were even less likely to have tried using the two plant-based products than the negatively oriented group.

We also found a positive relation between organic consumption and consumption of the two plant-based products. The odds that a super user

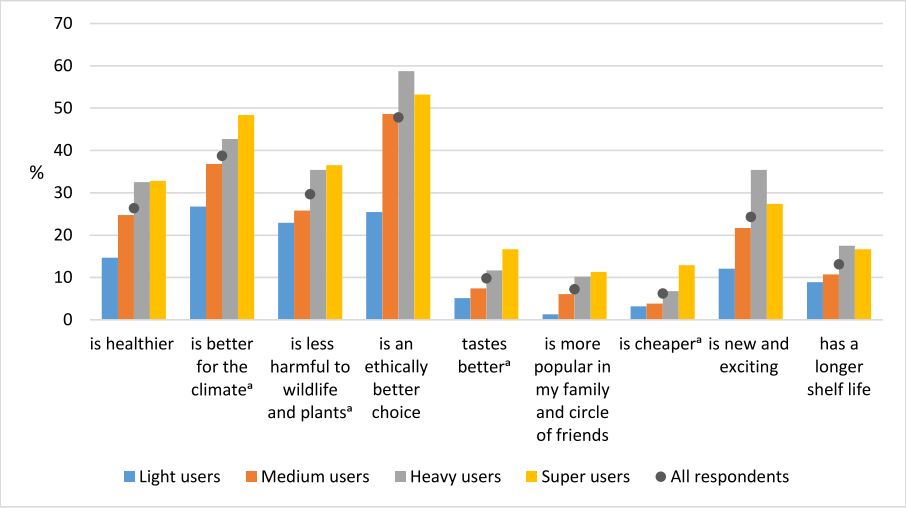

Fig. 4. Share of respondents associating plant-based mince with positive characteristics
Note: Based on 913 respondents. The figure shows percentages of all respondents as well as of respondents in the different user groups who agree, at least partly, that they associate the relevant characteristic with plant-based mince. [a] indicates that the statement has been reversed for ease of presentation.

Table 2
Results of the logistic estimation for oat drink and plant-based mince (point estimates for odds-ratio and confidence limits).

	Oat drink			Plant-based mince		
Characteristics	Point estimate	90% confidence limits		Point estimate	90% confidence limits	
Respondents agreeing with the statements (respondents answering 'don't know' to the statements). Compared to standard milk/minced beef, oat drink/plant-based mince …						
is healthier	1.56* (1.00)	1.03 (0.60)	2.37 (1.68)	3.47* (1.71*)	2.31 (1.03)	5.21 (2.83)
is better for the climate[a]	1.26 (1.15)	0.78 (0.64)	2.05 (2.06)	1.01 (0.67)	0.64 (0.37)	1.60 (1.20)
is less harmful to wildlife and plants[a]	1.00 (0.91)	0.60 (0.53)	1.64 (1.56)	0.88 (1.58)	0.55 (0.94)	1.42 (2.68)
is an ethically better choice	1.58* (1.40)	1.04 (0.78)	2.40 (2.53)	0.74 (0.51*)	0.49 (0.27)	1.13 (0.97)
tastes better[a]	3.07* (0.18*)	1.92 (0.10)	4.90 (0.34)	2.28* (0.21*)	1.38 (0.13)	3.79 (0.35)
is more popular in my family and circle of friends	3.51* (1.27)	2.17 (0.64)	5.67 (2.52)	4.24* (1.23)	2.17 (0.66)	8.30 (2.32)
is cheaper[a]	2.84* (0.58)	1.39 (0.34)	5.84 (1.01)	2.19* (0.62)	1.20 (0.40)	4.01 (0.97)
is new and exciting	1.54* (1.58)	1.03 (0.76)	2.30 (3.32)	1.75* (1.77)	1.19 (0.96)	2.58 (3.28)
has a longer shelf life	1.17 (0.39)	0.75 (0.23)	1.83 (0.68)	1.71* (0.82)	1.05 (0.54)	2.78 (1.26)
Organic user groups						
Medium users	4.88*	2.60	9.18	3.71*	2.03	6.78
Heavy users	5.65*	2.90	11.00	4.95*	2.62	9.36
Super users	5.51*	2.78	10.92	7.93*	4.15	15.17
Socio-demographic characteristics						
Female	1.10	0.79	1.53	0.79	0.57	1.09
Living in Capital region	1.24	0.88	1.75	1.34	0.96	1.86
Having a higher education	0.90	0.59	1.37	1.60*	1.08	2.39
18–34 years	1.25	0.81	1.92	2.10*	1.38	3.19
35–54 years	0.84	0.56	1.26	1.17	0.79	1.73

Note: Based on 913 respondents. * indicate that the estimate is significant at 0.1 level. [a] indicates that the statement has been reversed for ease of presentation.

had tried using oat drink was 5.5 times higher than the odds that a light user had tried using them. Similarly, the odds that a super user had tried using plant-based mince was 7.9 times higher than the odds that a light user had tried using it.

The socio-demographic characteristics were in general not significantly related to having tried using the plant-based products. Exceptions here were seen in respondents in the youngest age group and respondents with a high level of education, both of whom had higher odds of having tried using plant-based mince.

4. Discussion

In this study, we investigated perceptions and the consumption of oat drink and plant-based mince among Danish consumers as alternatives to cows' milk and minced beef in order to identify barriers and drivers involved in a shift towards increased consumption of more plant-based diets.

Generally, we found very similar results for the two types of products. The survey results indicated that 71% of the Danish respondents in 2021 stated that they had not tried using oat drink or plant-based mince. This finding, of relatively low interest in the plant-based alternatives, is in line with The Danish Agriculture and Food Council (2022), who concluded that 68% of Danish consumers never buy plant-based alternatives to minced meat.

When we compared usage and perceptions of the two plant-based products, we identified substantial differences across different organic consumer groups. Consumption of both oat drink and plant-based mince correlated positively with organic consumption. For example, 90% of the organic light users stated that they never use the products, but only 60% of the organic super users stated this. The higher level of usage among respondents with higher organic consumption may reflect dietary habits that also generally involve more vegetables or higher levels of concern about, for example, the climate or animal welfare. This is in accordance with results from Denver et al. (2022) that suggested that consumers with a high organic consumption are more likely than other consumers to change their dietary habit in a more climate-friendly direction. This would also be in line with the study by White et al. (2022) based on semi-structured interviews in New Zealand. That study found that interviewees who reduce their meat consumption to a greater extent than those in a comparison group more often expressed concern about the environment and animal welfare, as well as about their own health. The correlation we found, between higher levels of organic consumption and having a positive orientation towards oat drink and plant-based mince, suggests that plant-based proteins with advantage can be produced organically if they are to appeal to consumer segments who eat

organic foods a lot. The extent to which it would increase trust in plant-based protein sources, and make them more appealing to new consumers, if they are produced organically, we leave for future studies to analyse.

Many of our respondents had a rather lukewarm attitude to the two plant-based products. Substantially more respondents belonged to the negatively oriented group than the positively oriented group on the questions whether the plant-based products were tastier, cheaper, or more popular in the family and circle of friends, than their animal-based counterparts. Smaller differences in negative and positive group membership were seen on the questions whether the plant-based products were healthier, more climate friendly, better for biodiversity, or an ethically better choice, than their animal-based counterparts. In other words, the respondents tended to attribute public good characteristics to the plant-based products - and less so, private good characteristics. Interestingly, in Moss et al. (2022) health benefits, sustainability and sensory characteristics are also identified as primary associations with plant-based milk alternatives, and in a Swedish study reported by Spendrup and Hovmalm (2022) it is concluded that consumers do not see advantages of plant-based mince alternatives over minced meat with respect to healthiness, protein content and cost (all of which can be categorized as private good characteristics).

Another important finding in our study is that many respondents answered 'don't know' when asked to assess the characteristics of the two plant-based products. This high degree of uncertainty about the plant-based products could reflect the low level of consumption. It may even point toward a general lack of interest in this type of product. If the latter is true, and if increased use of plant-based products is a political, or a marketing goal, initiatives to increase interest in such products as oat drink and plant-based meat may be essential.

When it comes to drivers of the consumption of oat drink and plant-based mince, our findings suggest that such consumption is driven mainly by the expected private good characteristics of the products. Hence, the results suggest that consumers who use plant-based products do so because they perceive them as healthier, tastier, cheaper, more popular or new and exciting. For many of the respondents, at least, associating public good characteristics with the plant-based products did not appear to be an important driver of purchasing behaviour. This result is in many ways similar to the results obtained by Wier et al. (2008), who found that consumption of organic food was higher among respondents who considered organic produce to be healthier and of better quality. By contrast, while beliefs about environmental benefits and improved animal welfare were often associated with organic products, they were not drivers of increased organic consumption.

In a study by Carlsson et al. (2022) Swedish consumers stated that better labelling, lower price, better taste and higher visibility in stores were likely to increase their purchases of meat substitutes. In particular, this study found that labels indicating that the substitute had a lower climate impact, or was healthier, than the animal-based counterpart could increase the likelihood of subjects choosing it. In our analysis, one half and one third of the respondents considered oat drink and plant-based mince, respectively, to be expensive in comparison with the animal-based equivalents. Moreover, only small shares of the respondents perceived the two plant-based protein sources as healthier than animal-based alternatives. Even fewer regarded them as better tasting or as popular among family and friends. If parallels can be drawn between organic foods and plant-based proteins, then our results suggest that it may be necessary to in some way change consumer attitudes to the private good characteristics of the plant-based products (or improve the actual characteristics), so that they are more positive, in order to increase demand.

Our finding that popularity among family and circle of friends was a driver for buying the two plant-based products we investigated provides important input to policy makers. At any rate, the fact that only around 10% of our respondents stated that the plant-based products are popular among family and circle of friends may be interpreted as an indication that this kind of popularity is a barrier to consumption. With respect to socio-demography, we found that respondents with a higher education were more likely to use plant-based mince. This is in line with results obtained by Bryant et al. (2019). However, in contrast, we found no relation between living in the capital and the tendency to use either of the two products.

In the present study, we have investigated plant-based products with a high degree of similarity with the animal-based equivalents. However, White et al. (2022) found that similarity with meat-based products is important for some consumers buying the plant-based alternative but not others. They suggested that food researchers should try to identify which consumer groups find this kind of meat, and equally milk, similarity important – and ideally explain why.

Edenbrandt and Lagerkvist (2022) found that consumers with low levels of knowledge about the climate impact of food consumption tended to eat more meat, and in particular red meat, than other consumers. They also consumed fewer sustainability-labeled products, and purchased a lower share of health-labeled food products, than consumers with the highest level of knowledge. We found that, in general, the consumption of oat drink and plant-based mince by respondents who answered 'don't know' to the nine statements about the differences between the two plant-based products and their animal-based equivalents differed only marginally from that of the respondents from the negatively oriented group.

Taken together, our results indicate that the food-related instruments mentioned by the Danish Council on Climate Change in their consideration of how best to reach the Danish climate goal (i.e. instruments involving the provision of information on the climate impact of food choices, economic incentives to choose foods with lower climate impact, and initiatives designed to change of the social norm) are indeed likely to be among the most effective tools in reducing barriers to the shift to more plant-based diets. Our results also suggest, however, that increasing public consumption of plant-based, more sustainable, alternatives to meat will not be easy. If the political goal is to increase the consumption of these products, multiple initiatives are required to bring about the changes.

It is a limitation of our study that the results are based on just two products. Several studies have suggested that preferences for plant-based alternatives depends on the crop used. For illustration, a study by Cardello et al. (2022) showed that participants in general preferred full-fat cows' milk followed by a blended product containing oat, rice, coconut and soy milk. Unsweetened drinks made from either oat, rice or cashew nuts alone were the least liked. Niimi et al. (2022) tested how much consumers liked Bolognese sauces using different types of protein source. They found that a soy product was consistently liked the most and that an oat-based product was consistently disliked the most. Moss et al. (2022) investigated plant-based milk substitutes and found that participants focused upon the main ingredient in the plant-based milk alternatives, as well as the cost. Plant-based milk alternatives made from almond, oat, and pea were liked significantly more than alternatives made from cashews, but not more than coconut or soy alternatives. Our choice of products was guided by two main considerations. First, oat drink is the most popular milk alternative in Denmark. Second, plant-based mince is sold in many varieties and in low market shares so it was decided that as a 'generic' food-type it was the best starting point for analysing consumer perceptions. Future studies with more details of consumer preferences for different types of protein will indeed be valuable. There are also alternative methodological approaches that could have been used. In our analysis, the relation between use of oat drink and plant-based mince, respectively, and the perceptions of the individual characteristics of the alternative products, organic consumption and socio-demographic were of main interest. Consequently, we chose an approach were each of these items were included in the logistic model as explanatory variables. However, as suggested by a reviewer, it would also be very relevant to do a cluster analysis in which respondents with different perceptions of the individual characteristics

were grouped in clusters. We encourage future studies to follow this approach.

In our study, the similarity between the results for the two products was striking. Our finding of no substantial differences between the two products we examined is of real interest, we believe, but also the robustness of this result is now a topic for future studies.

5. Conclusions

For health reasons as well as to reduce climate footprint, there are dietary recommendations from the authorities in many countries around the world encouraging people to reduce their consumption of animal-based food. To support such dietary recommendations, this study aimed to enhance the knowledge about consumer perceptions of the plant-based protein alternatives. Based on the analysis of a quantitative survey from 2021, answered by 1000 Danish respondents, the present study showed that 71% of Danes have not tried using oat drink or plant-based mince. In general, both of these products were associated primarily with public good characteristics (climate impact, biodiversity, ethical choice) – less so private good characteristics (taste, price, popularity among family and circle of friends). But while the plant-based products were associated with public good characteristics, it was private good features that were found to be linked to their consumption. Many respondents had no clear perception of the characteristics they associated with the two products. Finally, consumers who stated that they often bought organic foods were more likely to believe that benefits are attached to the plant-based products and more likely to state that they had tried using the plant-based products. Our findings point towards a number of ways to reduce barriers to consumption of oat drink and plant-based mince. Firstly, our results suggest that improving the taste, or changing people's expectations about it, and reducing price could be ways to increase consumption. Secondly, the strong correlation between the use of plant-based alternatives and their popularity among family and circle of friends points towards the importance of trying to affect the social norms. Thirdly, initiatives to improve public understanding of the ways in which plant-based and animal-based products differ are important, as many respondents were somewhat unclear about which characteristics they associated with the two products.

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CRediT authorship contribution statement

Sigrid Denver: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Funding acquisition. **Jonas Nordström:** Conceptualization, Methodology, Writing – review & editing, Funding acquisition. **Tove Christensen:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Funding acquisition.

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

The authors do not have permission to share data.

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Appendix 1

Table A1
Shares of respondents that say 'don't know' to the statements about oat drink and plant-based mince.

Compared to standard milk/minced beef, oat drink/plant-based mince …	Oat drink, don't know (%)	Plant-based mince, don't know (%)
is healthier	37	30
is better for the climate[a]	44	36
is less harmful to wildlife and plants[a]	50	44
is an ethically better choice	34	25
tastes better[a]	34	33
is more popular in my family and circle of friends	21	18
is cheaper[a]	33	40
is new and exciting	22	19
has a longer shelf life	48	60

Note. Based on 913 respondents. [a] indicates that the statement has been reversed for ease of presentation.

Appendix 2

Table A2
Results of the 18 logistic estimations for oat drink and plant-based mince (point estimates for odds-ratio and confidence limits)

Characteristics	User group	Oat drink			Plant-based mince		
		Point estimate	90% confidence limits		Point estimate	90% confidence limits	
Respondents agreeing with the statements. Oat drink/plant-based mince …							
is healthier	Medium	3.03*	1.77	5.19	1.91*	1.26	2.92
	Heavy	3.09*	1.75	5.47	2.81*	1.80	4.38
	Super	4.44*	2.53	7.80	2.84*	1.81	4.47

(*continued on next page*)

Table A2 (*continued*)

Characteristics	User group	Oat drink			Plant-based mince		
		Point estimate	90% confidence limits		Point estimate	90% confidence limits	
is better for the climate[a]	Medium	2.15*	1.41	3.26	1.60*	1.13	2.25
	Heavy	4.01*	2.59	6.22	2.04*	1.40	2.97
	Super	3.85*	2.47	6.01	2.57*	1.75	3.76
is less harmful to wildlife and plants[a]	Medium	1.39	0.92	2.11	1.17	0.81	1.69
	Heavy	2.07*	1.33	3.21	1.85*	1.24	2.73
	Super	2.39*	1.54	3.73	1.94*	1.30	2.89
is an ethically better choice	Medium	2.04*	1.39	3.00	2.77*	1.96	3.92
	Heavy	3.42*	2.27	5.16	4.16*	2.85	6.09
	Super	3.96*	2.62	6.01	3.33*	2.26	4.90
tastes better[a]	Medium	1.37	0.77	2.42	1.49	0.76	2.95
	Heavy	1.90*	1.05	3.45	2.46*	1.23	4.92
	Super	3.10*	1.74	5.53	3.73*	1.89	7.35
is more popular in my family and circle of friends	Medium	1.34	0.80	2.24	4.98*	1.46	16.95
	Heavy	1.55	0.89	2.70	8.79*	2.57	30.07
	Super	1.82*	1.05	3.17	9.86*	2.88	33.74
is cheaper[a]	Medium	1.08	0.40	2.90	1.22	0.51	2.91
	Heavy	2.58	0.99	6.71	2.22	0.92	5.32
	Super	2.87*	1.10	7.49	4.50*	1.96	10.33
is new and exciting	Medium	1.75*	1.12	2.74	2.01*	1.28	3.17
	Heavy	1.50	0.92	2.46	3.99*	2.50	6.37
	Super	2.25*	1.39	3.65	2.74*	1.69	4.46
has a longer shelf life	Medium	1.85*	1.28	2.67	1.23	0.72	2.10
	Heavy	2.70*	1.82	4.00	2.16*	1.25	3.75
	Super	2.23*	1.49	3.35	2.04*	1.16	3.59

Note: Each of the 18 models is based on 913 respondents. The binary dependent variable in each model takes the value 1 if the respondent is agreeing with the statement and 0 otherwise. The user groups are used as explanatory variables (reference: light users). * indicate that the estimate is significant at 0.1 level. [a] indicates that the statement has been reversed for ease of presentation.

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