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Towards more environmentally sustainable diets? Changes in the consumption of beef and plant- and insect-based protein products in consumer groups in Finland

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ABSTRACT

This study investigated consumers' self-reported past changes and future intentions to change the consumption of beef and alternative, plant- or insect-based protein products. A survey of 18–79-year-old consumers in Finland ($N = 1000$) was analysed with latent class analysis, and five consumer clusters were identified. The largest cluster (37%) consumed beef, but no alternative protein products; three clusters incorporated alternative protein products in their diets in different ways (in total 55%); and one cluster did not consume beef or alternative proteins (8%). In total 27% of the respondents intended to reduce the consumption of beef in the future, whereas 26% planned to increase the consumption of plant-based and 24% planned to increase the use of insect-based protein products. Multinomial logistic regression indicated that the use of alternative proteins was associated with higher health and sustainability motives, and lower food neophobia. The results suggest that demand for new, more sustainable proteins and protein innovations will grow in the future.

1. Introduction

Food production and consumption substantially contribute to many environmental problems, particularly climate change, but also loss of biodiversity, pollution of water resources and excess use of water and land (Springmann et al., 2018). Meat, and especially beef, is a significant source of greenhouse gases and a cause of other environmentally harmful impacts. Transitions to less environmentally damaging diets include diminishing the use of beef and substituting it with more sustainable options (Mathijs, 2015; Springmann et al., 2018), such as plant- and insect-based proteins (Dobermann, Swift, & Field, 2017).

Large majorities of North American and European populations eat meat. In 2016–2018, citizens in the EU countries ate on average 65 kg meat (beef, pork, poultry, sheep) per capita, which was much higher than the global average 35 kg (OECD/FAO, 2019). In Finland meat consumption has remained at around 77–81 kg per capita in the 2010's (Luke, 2020). With the many positive cultural meanings and established practices of eating meat, it has proved challenging to reduce meat consumption (Latvala et al., 2012; Mathijs, 2015). However, flexitarianism – reducing meat consumption while not totally giving it up (Springmann et al., 2018) – is arousing increasing interest (Latvala et al., 2012; Ruby, 2012).

At the same time, plant-based proteins have increased their popularity in the Nordic countries, where new products based on soy, fava beans, pea protein and oats have entered the market during recent years. Market research estimates that the value of global plant protein market will grow by more than 7% a year in 2021–2026 (Mordor Intelligence, 2021). In Finland, the annual growth rate of the market for plant-based foods has been 16% in 2017–2021 (Makery, 2019). Insect-based protein products are a more recent development, and in the EU, the regulatory framework on novel foods has only recently unambiguously allowed the selling of certain insect species as human food (Mancini, Moruzzo, Riccioli, & Paci, 2019). Compared to plant-based proteins, the market of insect-based foods has remained smaller, but it is expected that in 2018–2023, the global market for edible insects will grow by 25% yearly (Guiné, Correia, Coelho, & Costa, 2021).

While vegan and vegetarian products increasingly enter the market, the acceptability of meat alternatives varies among consumers (Hartmann & Siegrist, 2017). As substitutes for meat, Western consumers more readily accept plant-based proteins than insects. The acceptability of edible insects in Europe, Australia and North America is low, and not many consumers have yet tasted insect foods (see Lammers, Ullmann, & Fiebelkorn, 2019; Wilkinson et al., 2018; Woolf, Zhu, Emory, Zhao, & Liu, 2019). However, during the 2010's consumers have become more

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positive about eating insects (Mancini et al., 2019) and see environmental (Wilkinson et al., 2018) and nutritional (Hartmann, Shi, Giusto, & Siegrist, 2015) benefits in insect eating.

Earlier studies have shown that certain sociodemographic characteristics are associated with the willingness to give up meat and to adopt alternative proteins. Women are more willing to reduce meat eating (Hartmann & Siegrist, 2017; Lemken, Spiller, & Schulze-Ehlers, 2019) and to eat plant-based alternatives (Siegrist & Hartmann, 2019), but insects are more preferred by men (Piha, Pohjanheimo, Lähteenmäki-Uutela, Křečková, & Otterbring, 2018; Wilkinson et al., 2018). The young are more likely to try new plant-based protein alternatives (Clark & Bogdan, 2019) and to change their diets towards plant proteins (Vainio, Niva, Jallinoja, & Latvala, 2016) than older people. Some studies also suggest that the young more readily accept insects as food (Laureati et al. 2016; Verbeke, 2015). The highly educated are more likely to eat no meat (Vinnari, Mustonen, & Räsänen, 2010), to accept plant-based meat alternatives (Siegrist & Hartmann, 2019), and willing to consume insect products (Cicatiello, De Rosa, Franco, & Lacetera, 2016; Lammers et al., 2019). People living in urban or capital areas are more likely not to eat meat (Vinnari et al., 2010) or beef (Vainio et al., 2016), to favour plant-based diets (Graça, Godinho, & Truninger, 2019), and to be more willing to eat insect-based foods (Vartiainen, Elorinne, Niva, & Väisänen, 2020).

The willingness to try new foods is associated with some key eating motives. The pleasure of eating meat is a key barrier to reduce or give up its use (Fehér, Gazdecki, Véha, Szakály, & Szakály, 2020; Pohjolainen, Vinnari, & Jokinen, 2015), and 'taste driven' consumers are usually meat eaters (Apostolidis & McLeay, 2016). Healthiness is one of the most important motives in following plant-based diets (Miki, Livingston, Karlsen, Folta, & McKeown, 2020), consuming meat substitutes (Siegrist & Hartmann, 2019; Vainio, 2019), and interest in insect eating (Verbeke, 2015). Heavy-users of meat substitutes value the naturalness of foods more than others (Hoek et al., 2011), and natural concerns are important for those undergoing a dietary change towards plant proteins (Vainio et al., 2016). Ethical and environmental motivations are significant for the users of plant-based protein alternatives (Hoek et al., 2011; Vainio, 2019) and those who are ready to adopt insects as a meat substitute (Verbeke, 2015). Today also meat consumers consider animal welfare as important (Estévez-Moreno, María, Sepúlveda, Villarroel, & Miranda-de la Lama, 2021; Sonoda, Oishi, Chomei, & Hirooka, 2018), but a belief that red meat is environmentally friendly is a barrier to reducing its consumption (Vainio, Irz, & Hartikainen, 2018). Food neophobia has been found to be an important barrier to the consumption of plant-based meat substitutes (Hoek et al., 2011) and of insects (Hartmann et al., 2015; Verbeke, 2015). In addition, high prices of alternative plant proteins may be a barrier to use them (Clark & Bogdan, 2019; Mäkiniemi & Vainio, 2014).

Although an increasing amount of research on consumer preferences for alternative proteins has been carried out in recent years, it remains to be analysed how consumers combine different types of proteins in their diets and what kind of change processes are currently taking place. The objective of this study was to identify different groups of consumers based on self-reported changes in the consumption of beef and plant- and insect-based protein products. We focused on the following research questions: What kind of changes do consumers report in their consumption of beef and plant- and insect-based protein products, and which changes do they plan to make in the future? Moreover, what kind of consumer groups can be identified based on their self-reported changes? How are different sociodemographic backgrounds and eating motives associated with these changes?

2. Materials and methods

2.1. Data sample

The data were collected in 2018 by a commercial marketing research company in Finland, using an online questionnaire directed to the members of the company's online consumer panel. The members of the panel have given their consent to receiving email invitations to consumer surveys on various topics, and participation is always voluntary. The sample was formed using sampling quotas which represented the 18–79-year-old population living in mainland Finland (quotas for age, gender, residential district, and education). After two reminders, 16% (N = 1083) of the contacted panel members completed the questionnaire. The pre-defined target number of respondents was 1000, which is why the data provider randomly removed 83 participants from those respondent groups that were overrepresented. The final data thus included 1000 responses. Fairly low response rates are common in various types of Internet surveys (Dillman, Christian, & Smyth, 2014), including those that are well-representative of the population (e.g., the surveys reported by Gronow & Holm, 2019; Niva & Jallinoja, 2018).

The educational level and gender distribution corresponded quite closely to that in the general population (Appendix Table 1). Older respondents were somewhat over-represented in the data compared to population statistics. In total 4.4% of the participants reported to be vegetarians and 2.3% vegans; these proportions are comparable to those reported in Finnish earlier studies (Jallinoja, 2020; see also Niva & Jallinoja, 2018). Apart from age, the discrepancies between the data and the general population are minor and give reason to conclude that the data are reasonably representative of the Finnish population.

2.2. Measures

Changes in food consumption patterns. For these items, the question format used in previous studies was used to ensure comparability (Latvala et al., 2012; Vainio et al., 2016). The participants were first requested to indicate how their consumption of eight food items – beef, plant-based protein products (e.g., tofu; meat replacements made of oats, pea protein or fava bean protein; vegetable patties), insects and insect-based products, pork, poultry, fish, vegetables, and beans – had changed during the previous 2–3 years. The participants responded to the questions using a four-point nominal scale (1 = no consumption, 2 = consumption has decreased, 3 = consumption has remained stable, 4 = consumption has increased). Second, the participants were asked to indicate how they expected their consumption of these food items to change in the coming 2–3 years on the same 4-point scale (with future tense). These time frames were chosen because we wanted the respondents to reflect on their eating patterns a few years earlier and to speculate about the future, without asking them to identify exact times, which would probably have been difficult to remember or anticipate (cf. Latvala et al., 2012; Vainio et al., 2016).

Eating motives. The eating motives were measured as follows. All items in the scales are listed in Appendix Table 2, and they were evaluated on a 7-point scale (1 = fully disagree – 7 = fully agree). *Price* was measured using the scale by Lichtenstein, Ridgway, and Netemeyer (1993) and it included five items (α = 0.62). *Healthiness* was measured with the General health interest scale (GHI) by Roininen, Lähteenmäki, and Tuorila (1999) and it included seven items (α = 0.86). *Naturalness* was measured using the Natural product interest scale (NPI) by Roininen (2001) and it included six items (α = 0.83). *Pleasure* was measured with the scale by Bäckström, Pirttilä-Backman, and Tuorila (2004) and it included five items (α = 0.78). *Food neophobia* was measured using the scale by Pliner and Hobden (1992) and it included six items (α = 0.85). In addition, *Sustainability* was measured with three items measuring the perceived environmental and social sustainability and ethicalness of meat production and consumption (α = 0.86). The scales measuring each eating motive were formed by calculating the mean scores of the items. These mean scores were used in further analyses.

Sociodemographics. The following sociodemographic variables were included in the analyses: age (coded into 1 = 18–30, 2 = 31–45, 3 = 46–60 and 4 = 61–79 years of age), gender (1 = woman, 2 = man, 3 = other / do not want to answer), level of education (recoded into 1 =

basic, 2 = secondary, 3 = tertiary degree), and the size of the place of residence (1 = capital city area, 2 = other city with more than 100,000 inhabitants, 3 = city with 50,000–100,000 inhabitants, 4 = a city/municipality with less than 50,000 inhabitants).

Consumption frequencies of protein sources. Current self-reported consumption frequencies of beef; pork; poultry; fish; peas; legumes; tofu; other soy-based protein products; oat or fava bean based protein products; and tempeh, seitan, quorn or other plant-based proteins were asked using a seven-point response scale (1 = never, 2 = less than once a month, 3 = about once a month, 4 = a few times a month, 5 = once a week, 6 = many times a week or daily).

2.3. Statistical methods

Latent class analysis (LCA) with Latent Gold version 5.0 was used to identify consumer clusters with different patterns of change in the consumption of beef and plant- and insect-based protein products. The variables measuring the past and intended changes in the consumption of these three foods – six variables in total – were used to form the consumer clusters. In addition, the variables measuring the past and intended changes in the consumption of pork, poultry, fish, vegetables and beans were included as inactive covariates in the analysis.

LCA identifies unobservable clusters of individuals based on patterns in the observed variables (Magidson & Vermut, 2002). Alternative models ranging from a two-class model to a six-class model were estimated. It is recommended to select the model with the lowest BIC value, the lowest AIC value, and a non-significant *p*-value (Magidson & Vermut, 2004). If these values suggest different models, the one with the best interpretation should be chosen. The model with the lowest BIC value was the four-class model (BIC = 9617,841, AIC = 9249.759, Npar = 75, L^2 = 930.453, df = 925, $p = .44$), and the model with lowest AIC value was the five-class model (BIC = 9625.703, AIC = 9164.374, Npar = 94, L^2 = 807.068, df = 906, $p = .99$). The interpretation of the five-class model, namely the inclusion of the fifth class was considered as superior to the four-class model and therefore it was chosen. Based on the LCA results, each respondent was assigned into one of the five modal clusters. Sociodemographic variables and the past and future changes in the consumption of pork, poultry, fish, vegetables and beans were used as inactive covariates in the LCA, meaning that they were not included in the estimation of the model but that they provided useful descriptive information about the clusters.

In order to explore how eating motives differed between the consumer clusters identified in LCA, general linear model with deviation contrasts was used. This method compares the mean of the cluster to the mean of the whole sample.

Finally, to get a more in-depth understanding of how sociodemographic backgrounds and eating motives differed between consumer groups, we also conducted multinomial logistic regression analysis, which has been developed for analysing categorical dependent variables with more than two categories (Field, 2018). We used this method to compare the differences between the biggest consumer cluster (i.e., the reference cluster) and the other clusters.

3. Results

In the following, we first describe the respondents' reported past and intended changes in the consumption of beef and plant- and insects-based protein products (Section 3.1). We then proceed to presenting the clusters and their characteristics (Section 3.2), and finally the results of the multinomial regression analysis (Section 3.3).

3.1. Changes in the consumption of beef and plant- and insects-based protein products

A large majority of the respondents consumed beef, less than half consumed plant-based proteins and a small minority consumed insect-based foods (Table 1). More than a third reported to have decreased beef consumption during the past few years, and more than a quarter intended to decrease it in the future. The future intentions to increase the consumption of plant- and insect-based protein products were quite similar: about a quarter of the respondents intended to increase the consumption of these alternative protein products.

3.2. Clusters based on past changes and future intentions in the consumption of beef and plant- and insect-based proteins

The selected LCA model included five clusters based on the self-reported changes in past consumption of and future intentions to consume beef and plant- and insect-based protein products. The cluster sizes varied from 8.0% to 37.0% (Table 2).

A verbal summary of the clusters based on the consumption of beef and plant-based and insects-based protein products are presented in Table 3. The table also presents a summary of the differences between the clusters in terms of 1) past changes in and future intentions to change the consumption of pork, poultry, fish, vegetables, and beans, which were included as inactive covariates in the LCA, 2) sociodemographic backgrounds (also included as inactive covariates in the LCA), 3) the most often used sources of protein, and 4) the food choice motives. All detailed numerical information of these cluster differences are presented in Appendix Tables 3, 4 and 5.

The first and the largest cluster was named as *Established beef lovers* (37.0% of the respondents). Consumers in this cluster reported stable consumption of beef, and no consumption of plant- or insect-based protein products. This cluster had established patterns and typically did not intend to make any changes in the consumption of the three foods in the future. Also the consumption of pork, poultry, fish and vegetables was stable, and future intentions were similar. For beans, past consumption was stable or there was no use, and future intentions were similar. Poultry, pork and beef were the most often used protein sources. The cluster was dominated by men and their mean age was close to the average age of the respondents. Similarly to other clusters, secondary education was most prevalent and they mostly lived in big cities. The most important eating motives in this cluster were pleasure, price and naturalness.

The second largest cluster was named as *Alternative protein increasers* (25.5%). Most of them had reduced beef consumption and intended to decrease it also in the future. In contrast, the consumption of plant-based protein products had increased, and many intended to increase it in the future. A minority had eaten insect-based products before, but many intended to increase the consumption of insect foods in the future. The majority had reduced and intended to reduce the consumption of pork. The majority had increased and planned to increase the consumption of vegetables, and it was typical to intend to increase the consumption of beans. Despite the increase in the consumption of plant-based protein products, poultry, fish and beef were still the most often used proteins. This cluster was dominated by women, they were somewhat younger than the respondents on average and their main eating motives were sustainability, pleasure and naturalness.

The third cluster was named as *Established 'light' flexitarians* (20.3%). Most of these respondents reported no changes in the past 2–3 years in the consumption of beef or plant-based protein products, and no consumption of insect-based foods. Neither did the majority in this group intend to make changes in the consumption of these three foods in the future. However, in this cluster 45% were already consuming plant-based protein products (Table 2), and this is what differentiated their patterns from the *Established beef lovers* cluster. Moreover, they had stable patterns of consuming pork, poultry, fish, vegetables and beans. The most often used proteins were poultry, beef and pork. There were more men than women in this cluster, and the mean age was a little higher than the average. The most important eating motives were pleasure, price and naturalness.

The fourth cluster was named as *Beef-avoiding plant protein increasers*

Table 1
Current self-reported consumption, past changes and future intentions to change the consumption of beef, plant- and insect-based products ($N = 1000$).

	Proportion of respondents (%)				
	Currently consume	Have increased consumption in the past 2–3 years	Have decreased consumption in the past 2–3 years	Intend to increase consumption in the next 2–3 years	Intend to decrease consumption in the next 2–3 years
Beef	89.9	2.9	37.5	2.1	27.3
Plant-based protein products	44.4	20.0	4.9	26.3	3.3
Insect-based products	7.0	2.2	0.1	24.1	1.2

Table 2
The results of latent class analysis based on past changes and future intentions to consume beef, plant- and insect-based protein products (values are probabilities, range 0–1).

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Total sample	Wald	p-value	R^2
Cluster Size	37.0%	25.5%	20.3%	9.3%	8.0%				
Cluster name	Established beef lovers	Alternative protein increasers	Established 'light' flexitarians	Beef-avoiding plant protein increasers	Beef reducers				
Past consumption									
Beef							189.17	0.000	0.44
No consumption	0.00	0.00	0.00	0.95	0.16	0.10			
Consumption has decreased	0.16	0.76	0.25	0.05	0.83	0.38			
No change	0.79	0.23	0.71	0.00	0.01	0.50			
Consumption has increased	0.05	0.01	0.04	0.00	0.00	0.03			
Plant-based protein products							104.94	0.000	0.41
No consumption	0.99	0.19	0.32	0.03	0.92	0.56			
Consumption has decreased	0.01	0.02	0.15	0.05	0.08	0.05			
No change	0.00	0.30	0.45	0.29	0.00	0.20			
Consumption has increased	0.00	0.49	0.08	0.63	0.00	0.20			
Insect-based products							22.56	0.030	0.04
No consumption	1.00	0.90	0.85	0.95	0.94	0.93			
Consumption has decreased	0.00	0.00	0.03	0.00	0.02	0.09			
No change	0.00	0.05	0.11	0.01	0.02	0.04			
Consumption has increased	0.00	0.05	0.01	0.04	0.02	0.02			
Future consumption									
Beef							187.07	0.000	0.56
No consumption	0.00	0.00	0.00	0.97	0.16	0.10			
Consumption will decrease	0.05	0.70	0.06	0.03	0.74	0.27			
No change	0.91	0.30	0.91	0.00	0.10	0.60			
Consumption will increase	0.04	0.00	0.03	0.00	0.00	0.02			
Plant-based protein products							122.02	0.000	0.62
No consumption	0.95	0.00	0.06	0.00	0.88	0.43			
Consumption will decrease	0.02	0.00	0.09	0.01	0.09	0.03			
No change	0.00	0.22	0.83	0.48	0.03	0.27			
Consumption will increase	0.03	0.78	0.02	0.51	0.00	0.26			
Insect-based products							170.90	0.000	0.17
No consumption	0.88	0.40	0.45	0.58	0.79	0.64			
Consumption will decrease	0.01	0.01	0.03	0.00	0.03	0.01			
No change	0.01	0.09	0.35	0.11	0.03	0.11			
Consumption will increase	0.10	0.50	0.17	0.31	0.15	0.24			

(9.3%). Typically they reported that they did not consume beef and that they did not plan to consume it in the future. In contrast, most of them reported having increased the consumption of plant-based protein products, and about half of them intended to increase it in the future (Table 2). Very few had consumed insect-based foods, and the majority did not intend to consume insects in the future (however, nearly a third did, see Table 2). For this cluster, it was most typical to have no consumption of pork and poultry, and future intentions were similar. The consumption of fish was divided between no use and stable consumption (Appendix Table 3). The consumption of vegetables had increased, and

Table 3
The dominating characteristics of the clusters based on the clustering variables, the inactive covariates, sociodemographic backgrounds, the most often used sources of protein, and the most important food choice motives.

Cluster number, size and name	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Total sample
	37.0% Established beef lovers	25.5% Alternative protein increasers	20.3% Established 'light' flexitarians	9.3% Beef-avoiding plant protein increasers	8.0% Beef reducers	
Clustering variables						
Past consumption						
Beef	No change	Decrease	No change	Does not use	Decrease	No change
Plant-based protein products	Does not use	Increase	No change	Increase	Does not use	Does not use
Insect-based products	Does not use	Does not use	Does not use	Does not use	Does not use	Does not use
Future consumption						
Beef	no change	decrease	no change	will not use	decrease	no change
Plant-based protein products	will not use	increase	no change	increase	will not use	will not use
Insect-based products	will not use	increase	will not use	will not use	will not use	will not use
Covariates						
Past consumption						
Pork	no change	decrease	no change	does not use	decrease	no change
Poultry	no change	no change	no change	does not use	no change	no change
Fish	no change	no change	no change	no change	no change	no change
Vegetables	no change	increase	no change	increase	increase	no change
Beans	no change	no change	no change	no change	no change	no change
Future consumption						
Pork	no change	decrease	no change	will not use	decrease	no change
Poultry	no change	no change	no change	will not use	no change	no change
Fish	no change	no change	no change	no change	no change	no change
Vegetables	no change	increase	no change	no change	increase	no change
Beans	no change	increase	no change	no change	no change	no change
The three most often used sources of protein	1. poultry 2. pork 3. beef	1. poultry 2. fish 3. beef	1. poultry 2. beef 3. pork	1. beans, legumes 2. peas 3. fish/soy-based	1. poultry 2. fish 3. pork	1. poultry 2. fish 3. pork
Sociodemographics						
Age (mean)	52.8	46.6	53.3	38.6	57.4	50.4
Gender	man	woman	man	woman	woman	woman
Education	1. secondary 2. basic	1. secondary 2. tertiary	1. secondary 2. tertiary	1. secondary 2. basic	1. secondary 2. tertiary	1. secondary 2. tertiary
Place of residence	big city	big city	big city	small city	big city	big city
The three most important eating motives	1. pleasure 2. price 3. naturalness	1. sustainability 2. pleasure 3. naturalness	1. pleasure 2. price 3. naturalness	1. sustainability 2. naturalness 3. healthiness	1. pleasure 2. price 3. naturalness	1. pleasure 2. price 3. sustainability

future intentions were divided between increasing and stable consumption (Appendix Table 3). The most often used proteins in this cluster were beans and legumes, peas, fish and soy-based protein products, and apart from fish, the consumption frequencies for animal proteins were low (Appendix Table 4). In this cluster there were more women than men, they were relatively young, and in contrast to the other clusters, their dominating place of living was a small city. Their main eating motives were sustainability, naturalness and healthiness.

The fifth and smallest cluster was named as *Beef reducers* (8.0%). A large majority of them had reduced the consumption of beef in the past, and intended to reduce it in the future. They had not consumed plant- or insect-based protein products and typically did not intend to increase the consumption of these products in the future. Most of them had reduced the consumption of pork during the last 2–3 years, and intended to decrease it in the future. Half of these consumers had not changed their consumption of poultry, and about one third had increased it (Appendix Table 3). Their vegetable consumption was stable or had increased, and in the future, the intentions were similar (Appendix Table 3). For beans, consumption was stable or there was no consumption, and no future changes were planned (Appendix Table 3). The most often used sources of protein were poultry, fish and pork. This cluster was dominated by women, they were older than the respondents on average, and their main eating motives were pleasure, price and naturalness.

As regards eating motives, healthiness, naturalness and sustainability were relatively more important for *Alternative protein increasers* and *Beef-avoiding plant-protein increasers* than the respondents on average, and less important for *Established beef lovers* and *Established 'light' flexitarians*. Sustainability was also relatively less important for *Beef reducers*. Price was less important for *Alternative protein increasers*. In addition, pleasure was relatively less important for *Beef-avoiding plant-protein increasers*. *Established beef lovers* and *Beef reducers* were more neophobic and *Alternative protein increasers* were less neophobic than the respondents on average (Appendix Table 5).

3.3. Sociodemographic and eating motive differences between established meat lovers and the other clusters based on multivariate analysis

The multinomial logistic regression analysis on the differences and similarities of eating motives and sociodemographic characteristics between the *Established beef lovers* cluster (reference category) and the other clusters showed that health and sustainability were more important to all the other clusters compared to *Established beef lovers* (Table 4). There was a particularly large difference between *Beef-avoiding plant protein increasers* and *Established beef lovers*. In addition, pleasure was less important to *Beef-avoiding plant protein increasers* than to *Established beef lovers*. No statistically significant differences in price and naturalness motives were found. *Alternative protein increasers*, *Established 'light' flexitarians* and *Beef-avoiding plant protein increasers* were less neophobic than *Established beef lovers*.

Among *Established beef lovers*, there were relatively more older respondents (46–79-year-olds) than among *Alternative protein increasers* and *Beef-avoiding plant protein increasers*. Regarding gender, *Beef-avoiding plant protein increasers* were more likely to be women than *Established*

Table 4
The results of multinomial logistic regression: the comparison of each cluster to the *Established beef lovers* (reference cluster) in eating motives and sociodemographic variables.

	Alternative protein increasers (vs. Established beef lovers)		Established 'light' flexitarians (vs. Established beef lovers)		Beef-avoiding plant protein increasers (vs. Established beef lovers)		Beef reducers (vs. Established beef lovers)	
	b (SE)	Odds ratio	b (SE)	Odds ratio	b (SE)	Odds ratio	b (SE)	Odds ratio
Intercept	−3.55 (1.02)***		−1.28 (0.91)		−11.71 (1.77)***		−6.17 (1.40)***	
Eating motives								
Price	−0.16 (0.10)	0.85	−0.05 (0.09)	0.95	0.09 (0.15)	1.10	0.20 (0.13)	1.22
Health	0.43 (0.10)***	1.53	0.19 (0.09)*	1.21	0.71 (0.16)***	2.04	0.34 (0.13)*	1.40
Naturalness	0.12 (0.10)	1.12	0.02 (0.09)	1.02	0.14 (0.14)	1.15	0.18 (0.14)	1.20
Pleasure	−0.09 (0.10)	0.91	−0.10 (0.09)	0.91	−0.41 (0.15)**	0.67	−0.05 (0.13)	0.95
Sustainability	1.00 (0.09)***	2.73	0.30 (0.07)***	1.34	1.91 (0.18)***	6.74	0.30 (0.10)**	1.34
Neophobia	−0.51 (0.09)***	0.60	−0.35 (0.08)***	0.70	−0.38 (0.14)**	0.68	−0.04 (0.11)	0.96
Sociodemographics								
Gender (ref: man)	0.25 (0.21)	1.29	−0.15 (0.02)	0.86	0.96 (0.37)**	2.62	0.38 (0.28)	1.46
Age (ref: 18–30 years)								
31–45 years	−0.55 (0.38)	0.58	0.54 (0.42)	1.72	−0.57 (0.50)	0.57	0.60 (0.70)	1.83
46–60 years	−0.95 (0.36)**	0.39	0.30 (0.40)	1.34	−1.65 (0.50)***	0.19	0.18 (0.67)	1.19
61–79 years	−0.92 (0.37)*	0.40	0.48 (0.41)	1.61	−1.69 (0.55)**	0.19	0.99 (0.66)	2.69
Level of education (ref: basic)								
secondary	0.15 (0.30)	1.16	0.27 (0.25)	1.32	0.16 (0.49)	1.17	−0.05 (0.32)	0.95
tertiary	0.50 (0.33)	1.66	0.50 (0.29)	1.65	0.11 (0.57)	1.12	−0.44 (0.44)	0.64
Place of living (ref: big city)								
small city	−0.29 (0.24)	0.75	0.14 (0.22)	1.15	0.51 (0.36)	1.67	0.33 (0.32)	1.39
other municipality	−0.43 (0.29)	0.65	0.15 (0.25)	1.16	−0.70 (0.51)	0.50	0.10 (0.37)	1.10

Nagelkerke $R^2 = 0.533$.
Note: *** $p < .001$, ** $p < .01$, * $p < .05$.

beef lovers. No educational or place of living related differences were found.

4. Discussion

This study explored Finnish consumers' self-reported past changes and future intentions regarding the consumption of plant- and insect-based protein innovations and beef. The analysis revealed five consumer clusters with different consumption patterns suggesting that consumers adopt alternative protein innovations into their diets to various degrees and are variously engaged in processes of change.

Consumers in two clusters, *Established beef lovers* and *Established 'light' flexitarians*, reported stable consumption of beef. Together these two clusters comprised more than half (57.3%) of the respondents, and of all clusters, they reported the highest consumption frequencies of both beef, pork and poultry (Appendix Table 4). Consumers in the largest cluster, *Established beef lovers,* did not consume alternative protein innovations, whereas those in *Established 'light' flexitarians,* did. The *Established beef lovers* cluster was smaller than a similar cluster (48%) identified in a Finnish population survey in 2010 (Latvala et al., 2012). In addition, two clusters had reduced beef consumption (*Alternative protein increasers* and *Beef reducers*) and one cluster did not consume beef at all (*Beef-avoiding plant protein increasers*). These results give reason to suggest that a transition towards alternative proteins has strengthened during the past decade.

As regards plant-based protein products, two clusters had not used them at all (*Beef lovers* and *Beef reducers,* in total 45.0% of the respondents). In contrast, two clusters, *Alternative protein increasers* and *Beef-avoiding plant protein increasers*, had increased the consumption of plant-based protein products. In total over one fourth of all respondents intended to increase the consumption of plant-based protein products in the future (Table 1), and they were mostly concentrated in these two clusters (Table 2).

Insect-based protein products had been consumed by a small minority (7%, Table 2) of the respondents. Insect consumption was most common among *Alternative protein increasers* and *Established 'light' flexitarians*, of whom 10–15% reported some consumption (Table 2). This is significantly lower than in consumer surveys conducted in the United States (Woolf et al., 2019), Australia (Wilkinson et al., 2018) and Germany (Lammers et al., 2019). However, almost one fourth of the survey respondents planned to increase the consumption of insects in the future (Table 1). In German and Italian consumer studies about a half of the respondents indicated an interest to try insect foods (Cicatiello et al., 2016; Lammers et al., 2019), suggesting that the willingness to consume insect-based foods may vary cross-culturally. It should also be noted that reporting an intention to increase consumption indicates a stronger commitment than reporting a willingness to try.

These results suggest that three clusters were in the process of changing their consumption of beef and plant- and insect-based protein products (*Alternative protein increasers, Beef-avoiding plant protein increasers* and *Beef reducers)*, whereas two of them were not (*Established beef lovers* and *Established 'light' flexitarians*) (see Tables 2 and 3). Despite this, a look at the use of various protein sources – including also other sources than beef and plant-based and insect-based proteins – revealed that in all clusters except *Beef-avoiding plant protein increasers*, the most used sources of protein were still animal-based (Table 3 and Appendix Table 4). This suggests that although we can see an ongoing change towards alternative proteins, the place of animal-based foods is not threatened at the moment, and that the ongoing change varies between different consumer groups.

Eating motives were associated with the changes that had been made in the consumption of beef and plant- and insect-based protein products. In particular, health and sustainability were more important to *Alternative protein increasers* and *Beef-avoiding plant protein increasers* than to the respondents on average (Appendix Table 5), and the multivariate analysis showed that compared to *Established beef lovers*, these motives were more important to all the other clusters (Table 4). This finding is similar to previous findings that the consumption of plant-based proteins (Miki et al., 2020) and insect-based proteins (Vartiainen et al., 2020; Verbeke, 2015) are associated with the personal importance of healthiness and sustainability. The multivariate analysis showed that the pleasure motive was less important to *Beef-avoiding plant protein increasers* compared to *Established beef lovers* (Table 4), suggesting that when motives relating to health and sustainability are strong enough, pleasure becomes relatively less important. However, it should be noted that in spite of the relative difference, pleasure was not insignificant to

Beef-avoiding plant protein increasers either (Appendix Table 5).

The multivariate analysis showed that food neophobia was higher among *Established beef lovers* and *Beef reducers* as compared to the other clusters (Table 4). As noted above, these clusters shared the characteristic that they did not consume and did not intend to consume plant- or insect-based proteins (Tables 2 and 3). This is also where they differed from all the other clusters. Here our findings support previous studies, which have found that food neophobia or reluctance towards new foods is associated with the avoidance of insects (Verbeke, 2015; Wilkinson et al., 2018) and plant-based meat substitutes (Hoek et al., 2011; Lemken et al., 2019).

The results concerning eating motives suggest that in the transition to more sustainable diets with alternative protein innovations, health, sustainability, pleasure and food neophobia form a whole in which the two former motives act as facilitators to change and the two latter as barriers (see also Fehér et al., 2020; Mancini et al., 2019; Pohjolainen et al., 2015). In policies advancing sustainable transition it is thus important, first, to strengthen the motives relating to health and sustainability, and second, to diminish the obstacles relating to pleasure and food neophobia. The information concerning the health and ecological effects of diets needs to be further developed to reach wide population groups, and alternative sources of protein should to be made more familiar to consumers. Here, information campaigns, education and nutrition policies by the public sector, publicity and recipe development in the media as well as marketing efforts by the food industry and retail trade may usefully support each other.

Regarding sociodemographics, there were some statistically significant differences in age and gender between *Established beef lovers* and the other clusters (Table 4). According to the multivariate analysis, *Beef-avoiding plant protein increasers* were more likely to be women compared to *Established beef lovers*. This finding supports previous studies that have found women to have more positive attitudes towards meat substitutes (Siegrist & Hartmann, 2019). Earlier studies indicate that men are more accepting towards edible insects, but such an association was not found in this study. A possible reason is that in our study the only cluster with some interest in increasing the consumption of insect-based protein products was the *Alternative protein increasers* cluster, in which the parallel interest in increasing the use of plant-based proteins potentially confounded the effect of gender.

Both *Alternative protein increasers* and *Beef-avoiding plant protein increasers* were less likely to be middle-aged or older than *Established beef lovers* (Table 4). This result supports earlier studies that have found the young to be more willing to consume plant-based proteins (Jallinoja, Niva, & Latvala, 2016; Vainio et al., 2016) and insects (Verbeke, 2015). Our results also imply that particularly those in a process of change towards alternative proteins are likely to be young. The results of the sociodemographic differences between the clusters suggest that age- and gender-based variations exist in the dietary transition towards more sustainable diets, and that policies supporting the change should target particularly men and the older generations. No differences between *Established beef lovers* and the other clusters were found in the level of education or the place of living, suggesting that in the Finnish context educational or urban–rural divisions are not very strong barriers in the transition towards more sustainable diets.

Some limitations need to be considered when interpreting the results. First, although the data is relatively well representative of the Finnish population, the response rate was relatively low, meaning that the sample probably represents the views of those people who are interested in food-related issues and are thus willing to use their time to respond. Second, consumers' self-reports are often affected by biases. For example, social desirability bias may have made the association between the sustainability motive and sustainable food choices appear stronger than it actually is (Chung & Monroe, 2003). Third, our measure of the sustainability motive was a combination of three items measuring the ethical, social and ecological aspects of meat and it was developed for this study. Although the measure worked well, it would have been beneficial to include more items to cover the relevant sustainability aspects in more detail. Fourth, we did not measure actual consumption of food and therefore could not assess to what extent alternative proteins actually replaced beef, or how substantial the changes were. However, asking about changes in actual consumption volumes presents its own problems, since changes in diets are often slow and people tend to forget soon what they have consumed. Studies carried out with different methods are needed to better understand how new protein innovations change diets.

5. Conclusions

By showing that meat consumption is reduced and that alternative proteins are adopted differently in various consumer groups, the results contribute to developing the understanding of how new protein innovations enter consumers' diets. The results suggest that the change starts more often among women and the young than among men and the elderly, and among those who are oriented towards health and sustainability and who are open to new foods. However, despite this ongoing change, the results also show that animal-based proteins still possess an important role in diets, even among those consumers who are transitioning towards less meat and more alternative proteins. If concerns about sustainability and health reach wider population groups, we can expect that the demand for new, more sustainable proteins and protein innovations will grow.

Currently, the consumption of plant-based protein products is more widespread compared to insect-based protein products. However, it is noteworthy that at the level of the whole data future intentions to increase the consumption of both types of alternative proteins were quite similar, although variations could be seen between consumer groups. Therefore, the consumption of insect-based protein products may catch up plant-based innovations in the future, if easy to use, tasty, healthy, sustainable and affordable insect-based alternatives enter the market. This change could take place within the wider development of alternative proteins, which will in the future probably also include foods produced by means of cellular agriculture. As the alternative protein sector develops, more research is needed on consumers' varying expectations, motives and practices in adopting new, more sustainable foods into their everyday eating.

Declaration of Competing Interest

The authors declare no conflicts of interest.

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Appendix A

Appendix Table 1
Gender, age and highest education level in the Finnish population in 2017 (Statistics Finland, 2018) and in the data sample ($N = 1000$).

	Finnish population (%)	Data sample (%)
Gender		
Women	50.5	49.8
Men	49.5	48.8
Other[1]	–	1.4
Age groups		
18–30	20.9	13.8
31–45	24.8	20.7
46–60	25.9	34.9
61–79	28.4	30.6
Highest education[2]		
Basic level	19.5	17.8
Secondary level	45.2	41.5
Tertiary level	35.4	40.8

[1] This is not reported by Statistics Finland.
[2] Among 20–74-year-olds.

Appendix Table 2
Items used for measuring eating motives, Cronbach's alphas and interpretation.

	Cronbach's alpha	Interpretation
Neophobia I am constantly sampling new and different foods (reversed). If I don't know what is in a food, I won't try it. I like foods from different countries (reversed). At dinner parties, I will try a new food (reversed). I am afraid to eat things I have never had before. I like to try new ethnic restaurants (reversed).	**0.849**	The higher the score, the higher is neophobia.
General health interest (GHI) I am very particular about the healthiness of food I eat. I always follow a healthy and balanced diet. It is important for me that my diet is low in fat. I eat what I like and I do not worry much about the healthiness of food (reversed). It is important for me that my daily diet contains a lot of vitamins and minerals. I take a notice how much groceries contain protein.[1] I avoid sugar.[1]	**0.864**	The higher the score, the higher is health consciousness.
Natural product interest (NPI) I do not eat processed foods, because I do not know what they contain. I try to eat foods that do not contain additives. I would like to eat only organically grown vegetables. In my opinion, artificially flavoured foods are not harmful to my health (reversed). In my opinion, organic products are not healthier than conventionally grown products (reversed). I do not care about additives in my daily diet (reversed).	**0.830**	The higher the score, the more important is naturalness of food.
Price I buy grocery shop at more than one store to take advantage of low price (reversed). I buy groceries at cheapest possible price (reversed). I buy expensive groceries, because they have better quality. When grocery shopping, I compare the prices of different brands to be sure I get the best value for the money (reversed). Generally speaking, the higher the price of a product, the higher the quality.	**0.623**	The higher the score, the more important is price.
Pleasure Eating is very important for me. I treat myself to something really delicious. Eating is a highlight of the day. For me, delicious food is an essential part of weekends. Taste is the most important aspect of food.	**0.775**	The higher the score, the more important is pleasure of food.
Sustainability If people in the world ate less meat, there would be enough food for everybody. To slow down climate change, meat consumption should be considerably reduced. Meat production is unethical.	**0.855**	The higher the score, the more important is the sustainability of food.

[1] New items not included in the original scale by Roininen et al. (1999).

Appendix Table 3
Sociodemographic characteristics and dietary patterns in the clusters and the total sample (the inactive covariate variables in the LCA; values are probabilities, range 0–1).

	Established beef lovers	Alternative protein increasers	Established 'light' flexitarians	Beef-avoiding plant protein increasers	Beef reducers	Total sample
Sociodemographics						
Age (mean, years)	52.77	46.63	53.25	38.57	57.43	50.36
18–30	0.09	0.20	0.06	0.40	0.04	0.14
31–45	0.18	0.24	0.20	0.29	0.15	0.21
46–60	0.41	0.31	0.38	0.18	0.28	0.35
61–79	0.32	0.25	0.36	0.12	0.53	0.30
Gender						
woman	0.43	0.56	0.39	0.74	0.58	0.50
man	0.56	0.43	0.59	0.20	0.42	0.49
other/not mentioned	0.01	0.01	0.02	0.06	0.00	0.01
Level of education						
basic	0.24	0.12	0.15	0.24	0.16	0.19
secondary	0.57	0.49	0.56	0.56	0.58	0.55
tertiary	0.19	0.39	0.29	0.20	0.26	0.27
Place of residence						
other municipality	0.24	0.15	0.23	0.23	0.11	0.20
small city (under 100,000)	0.37	0.28	0.37	0.42	0.41	0.36
big city (100,000 or over)	0.38	0.57	0.40	0.35	0.48	0.44
Past consumption						
Pork						
No consumption	0.03	0.05	0.04	0.85	0.05	0.11
Consumption has decreased	0.18	0.66	0.31	0.13	0.51	0.35
No change	0.74	0.29	0.64	0.02	0.37	0.51
Consumption has increased	0.05	0.00	0.02	0.00	0.07	0.03
Poultry						
No consumption	0.03	0.02	0.02	0.64	0.04	0.08
Consumption has decreased	0.07	0.23	0.09	0.19	0.11	0.13
No change	0.67	0.47	0.72	0.13	0.50	0.56
Consumption has increased	0.24	0.27	0.18	0.33	0.34	0.23
Fish						
No consumption	0.05	0.01	0.04	0.32	0.04	0.06
Consumption has decreased	0.07	0.09	0.08	0.14	0.10	0.09
No change	0.60	0.51	0.59	0.36	0.47	0.54
Consumption has increased	0.27	0.39	0.29	0.17	0.38	0.31
Vegetables						
No consumption	0.02	0.01	0.00	0.00	0.01	0.01
Consumption has decreased	0.05	0.02	0.04	0.01	0.03	0.04
No change	0.60	0.33	0.59	0.46	0.47	0.50
Consumption has increased	0.34	0.65	0.37	0.53	0.49	0.45
Beans						
No consumption	0.40	0.12	0.13	0.09	0.38	0.24
Consumption has decreased	0.14	0.03	0.14	0.06	0.13	0.10
No change	0.41	0.55	0.63	0.46	0.42	0.50
Consumption has increased	0.05	0.31	0.10	0.39	0.08	0.16
Future consumption						
Pork						
No consumption	0.03	0.04	0.02	0.87	0.05	0.11
Consumption will decrease	0.14	0.66	0.19	0.10	0.52	0.31
No change	0.79	0.29	0.78	0.03	0.40	0.56
Consumption will increase	0.04	0.01	0.01	0.00	0.03	0.02
Poultry						
No consumption	0.02	0.03	0.01	0.65	0.05	0.08
Consumption will decrease	0.04	0.27	0.05	0.22	0.10	0.12
No change	0.82	0.60	0.84	0.13	0.71	0.70
Consumption will increase	0.12	0.10	0.10	0.00	0.15	0.10
Fish						

(*continued on next page*)

Appendix Table 3 (*continued*)

	Established beef lovers	Alternative protein increasers	Established 'light' flexitarians	Beef-avoiding plant protein increasers	Beef reducers	Total sample
No consumption	0.04	0.01	0.03	0.31	0.05	0.06
Consumption will decrease	0.01	0.06	0.02	0.13	0.07	0.04
No change	0.67	0.50	0.68	0.46	0.49	0.59
Consumption will increase	0.28	0.44	0.26	0.09	0.39	0.31
Vegetables						
No consumption	0.02	0.00	0.00	0.01	0.02	0.01
Consumption will decrease	0.01	0.00	0.02	0.00	0.03	0.01
No change	0.64	0.27	0.64	0.52	0.47	0.52
Consumption will increase	0.33	0.72	0.33	0.47	0.48	0.46
Beans						
No consumption	0.36	0.06	0.05	0.33	0.36	0.19
Consumption will decrease	0.07	0.02	0.08	0.01	0.10	0.05
No change	0.50	0.41	0.75	0.58	0.44	0.53
Consumption will increase	0.07	0.52	0.13	0.37	0.11	0.23

Appendix Table 4
Self-reported consumption frequency of different protein sources in the consumer clusters and in the whole sample (medians).

	Established meat lovers	Alternative protein increasers	Established 'light' flexitarians	Beef-avoiding plant protein increasers	Beef reducers	Total sample
Beef	4.60	4.30	4.54	1.15	3.52	4.24
Pork	4.76	4.25	4.50	1.20	4.44	4.36
Poultry	4.77	5.15	4.81	1.52	4.69	4.76
Fish	4.37	4.76	4.47	4.19	4.56	4.50
Peas	2.73	3.52	3.09	4.32	3.40	3.18
Beans, legumes	1.98	3.30	2.65	4.91	1.98	2.63
Tofu	1.16	1.79	1.60	3.89	1.15	1.50
Soy-based protein products	1.11	1.79	1.54	4.19	1.16	1.45
Oat or fava bean based protein products	1.08	2.18	1.69	4.04	1.18	1.55
Tempeh, seitan, quorn or other plant-based proteins	1.04	1.52	1.34	2.69	1.07	1.30

Response scale: 1 = never, 2 = less than once a month, 3 = about once a month, 4 = a few times a month, 5 = once a week, 6 = many times a week or daily.

Appendix Table 5
The importance of eating motives in the consumer clusters and in the total sample: means and standard deviations (in brackets) (N = 1000). Statistically significant differences between each cluster and the total sample: higher values are bolded and lower values are italicized.

	Established beef lovers	Alternative protein increasers	Established 'light' flexitarians	Beef-avoiding plant protein increasers	Beef reducers	Total sample
Price	4.53	*4.25****	4.36	4.59	4.68	4.44
	(1.14)	(1.06)	(1.06)	(1.02)	(1.05)	(1.10)
Healthiness	*3.69****	**4.47***	*4.09**	**4.78*****	4.51	4.13
	(1.29)	(1.11)	(1.23)	(1.15)	(1.27)	(1.28)
Naturalness	*3.89****	**4.56***	*4.14***	**4.85*****	4.55	4.25
	(1.26)	(1.26)	(1.27)	(1.48)	(1.00)	(1.31)
Pleasure	4.90	4.97	4.91	**4.65***	4.87	4.90
	(1.13)	(1.05)	(1.02)	(1.16)	(1.05)	(1.09)
Sustainability	*3.27****	**5.29*****	*3.90****	**6.35***	*3.94****	4.26
	(1.39)	(1.19)	(1.27)	(1.04)	(1.57)	(1.67)
Neophobia	**3.66*****	*2.80****	3.09	3.04	**3.65****	3.26
	(1.37)	(1.15)	(1.09)	(1.33)	(1.27)	(1.30)

Note: The values range between 1 (low importance) and 7 (high importance).
*** $p < .001$, ** $p < .01$, * $p < .05$.

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