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Finnish consumers' intentions to consume insect-based foods

Vartiainen, O.[1], Elorinne[2,] A.-L., Niva, M.[3], and Väisänen, P.[4]

1) School of Applied Educational Science and Teacher Education, University of Eastern Finland, FI-80101 Joensuu, Finland; outivar@gmail.com

2) School of Applied Educational Science and Teacher Education, University of Eastern Finland, FI-80101 Joensuu, Finland; anna-liisa.elorinne@uef.fi

3) Faculty of Educational Sciences, University of Helsinki, P.O. Box 8 (Siltavuorenpenger 10), FI-00014 University of Helsinki, Finland; mari.niva@helsinki.fi

4) School of Applied Educational Science and Teacher Education, University of Eastern Finland, FI-80101 Joensuu, Finland; pertti.vaisanen@uef.fi

Abstract

Introducing and increasing the use of insect-based foods as an alternative source of protein has recently aroused academic and commercial interest in Europe. In this research, we examined Finnish consumers' intentions to consume insect-based foods in the near future. As a theoretical background we used Ajzen's Theory of Planned Behaviour (TPB), where individuals' intentions to change their behaviour are affected by their attitude (A), subjective norm (SN) and perceived behavioural control (PBC). The data was obtained by using an online questionnaire and convenience sampling. For measuring TPB-components a self-administered 58-item Likert-type questionnaire was used. Food neophobia (FN) was measured by using the Food Neophobia Scale. Respondents' (N = 564) intentions to consume insect-based foods were explained significantly (80%) by their A ($\beta = .749$, $p < .000$), SN ($\beta = .133$, $p < .000$), and PBC ($\beta = -.070$, $p < .001$), and gender ($\beta = .040$, $p < .033$). Food neophobia was negatively correlated with the intention to consume insect-based foods, $\rho = -0.501$, $p < 0.001$. We found that women, students, those under 25 years of age, those living in rural areas and those who had no earlier experience of eating insects had less intention to consume insect-based foods. Based on the respondents' perceptions of conditions for the consumption of insect-based foods, three clusters of consumers were identified; 'likely consumers' (44 %), 'potential consumers' (39 %) and 'unlikely consumers' (17%). Based on the findings, reasonable price and convenience are most important issues to potential consumers of insect-based foods.

Keywords: entomophagy, insect eating, theory of planned behaviour, acceptability

1. Introduction

Consumption of insect-based foods is currently promoted since it has been suggested that producing protein by farming insects inflicts dramatically less strain on the environment compared to that of farming cattle. This is because greenhouse gas emissions, land requirement and water use of insect rearing are smaller compared to cattle farming, and the feed conversion rate of insects is better than in other forms on animal production (Dobermann *et al*., 2017; Smetana *et al*., 2015; Van Huis *et al*., 2015). Insects are also suggested to provide a good source of several nutrients and to offer a means of assuring better food insecurity globally (e.g., van Huis *et al.*, 2013; van Huis *et al.*, 2015). In future scenarios, insects are seen as a realistic option also to Finnish consumers as a replacement of red meat as a protein source (Technical Research Center of Finland, 2014).

Western consumers face several challenges in adopting insects as food, since insects have not been part of Western food cultures. The acceptability of insect-based foods is strongly influenced by the cultural context, since food culture and ethnic background have been shown to be important factors affecting consumers' food preferences (Rozin, 1988). During recent years, consumers' knowledge of insects as food has increased and consumers seem somewhat more open than before to accept insect-based foods in their daily diet (House, 2016; Ramous-Eloudry, 2009). Despite the increased interest in insect-based foods many people in Western countries feel disgust towards them (Ruby *et al.*, 2015; Yüksel & Canhilal, 2018). Woolf *et al.* (2019) found that in the United States as many as 67% of a non-representative sample of respondents who had never eaten insects considered consumption of insects disgusting as compared to 35% of participants who had eaten insects. According to La Barbera *et al*. (2018), disgust stems from moral standards of culture, which define what is edible and what is not. In Western countries insects are still seen in most cases as a source of contamination and vectors for diseases (Deroy *et al*., 2015).

Compared to other alternative protein sources, consumers' evaluations are more negative for insect-based foods (Schösler *et al*., 2012). Gmuer *et al*. (2016) studied Swiss consumers' attitude towards snacks made from insects and found that the thought of eating insects may arouse negative feelings such as dissatisfaction, irritation, wonder and uneasiness. Among Swiss consumers, positive and negative emotional expectations towards snacks made from insects were determining factors predicting a willingness to eat them. A study conducted in Belgium showed that 46% of the respondents held a negative attitude to insect-based foods, although 78% were willing to taste these

foods (Caparros Megido *et al*., 2014). Similarly, Mancini *et al.* (2019) found that among Italian students, 'personal insect food rejection' (i.e., disgust to and negative taste and texture perceptions of insects) influenced intention to eat products containing insect flour.

Social context also affects the acceptability of eating insect-based foods. In their study Tan *et al.* (2015) observed that some research participants would not have tasted insect-based food without other participants providing sensory information and assurance that it was safe to eat. Hartmann *et al.* (2015) for their part found that subjective norm was a crucial factor in determining the desire to taste unprocessed insects. When participants considered insects as a primitive food they were more likely to reject them. Sometimes even if the taste of insect-based foods was regarded as acceptable, people were not ready to take insects into their diet as a staple food item. Reasons cited for this were, among others, the poor supply and quite high price of these food stuffs (Tan *et al*., 2015). Menozzi *et al.* (2017), instead, found that the subjective norm was not a statistically significant predictor of the intention to eat novel food products containing insect flour. One more challenge in adopting insects as a staple food ingredient among consumers is that people strongly connect several beneficial properties such as healthiness, good nutritional value and positive taste properties to meat (Verbeke, 2015) and may not be willing to substitute insects for meat.

Based on recent studies we know that men (Cicatiello *et al*., 2016; Menozzi *et al*., 2017; Sogari *et al*., 2019; Tan *et al*., 2016; Verbeke, 2015), younger people (Caparros Megido *et al*., 2014; Sogari *et al*., 2019), those having experience (Hartmann *et al*., 2015; Caparros Megido *et al*., 2016; Tan *et al.*, 2016; Woolf *et al.* 2018) and possessing know-how (Piha *et al*., 2016; Verbeke, 2015) of using insects as food are more willing than others to eat insects as part of the diet. However, some studies have found no effect, e.g., for age (Cicatiello *et al*., 2016) or gender (Tan *et al*., 2015). Research also shows that a high level of fear of new foods (food neophobia) decreases the willingness to eat insect-based foods (Hartmann *et al*., 2015; Mancini *et al.*, 2019; Piha *et al*., 2016; Sogari *et al*., 2019; Verbeke, 2015), although some studies have found only a minor effect of food neophobia (Tan *et al*., 2016).

According to a (non-representative) survey conducted in four European countries, Finnish consumers had a more positive attitude (70% of Finnish respondents were interested in insect foods) to insect-based foods than consumers in Sweden (under 40%), Germany (25%) and the Czech Republic (30%). Those under 45 years of age had the most positive attitude towards insect-based foods (University of Turku, 2017). The study also suggested that among Finnish consumers, foods containing insect flour are potentially more acceptable than whole insects (Piha *et al.*, 2016). The authors (Piha *et al*., 2016)

concluded that consumers in Northern Europe (Finland and Sweden) seem to be more positive towards insect-based foods than consumers in Central Europe (Germany and Czech Republic). One possible explanation for the regional differences is food culture. According to Piha *et al.* (2016), Northern European food cultures are regarded as less strong and mature than Central European food cultures, and therefore consumers in Northern Europe may be more prone to try new foods. Insect-based foods have also been recently widely discussed in Finnish the media (Arppe *et al.*, 2019), which may have driven consumers' attitudes to a more positive direction (Santaoja & Niva 2019).

Finnish consumers have had the possibility to buy insect-based foods only after September 2017, when the national authorities permitted the selling of insects as human food. As soon as insect-based foods appeared in shop shelves, the variety of products available was diverse, containing snack bars, bread, flour, convenience food, and frozen and dried whole crickets. Some of the products, such as a bread containing cricket flour aroused great interest among consumers and the media. However, later the interest has decreased, and many of the products have been withdrawn from the market (Arppe *et al.*, 2019; Santaoja & Niva 2019).

In this study we examine Finnish consumers' intentions to consume insect-based foods and how their intentions are affected by their attitude (A), subjective norm (SN) and perceived behavioural control (PBC). In addition, we analyse the role of demographic factors and individual characteristics known to influence the acceptance of insect-based foods and consumers' intentions to consume or not to consume such foods. We also examine what kind of consumer clusters can be identified based on their perceptions of the conditions to consume insect-based foods. Next, we outline the theoretical approach of the article, followed by methods and data.

Theoretical framework

The theoretical framework applied in this study to examine consumers' intentions to consume insect-based foods is based on Ajzen's (1991) Theory of Planned Behaviour (TPB) (Figure 1). According to Ajzen (1991), individuals' intentions to change their behaviour are a determining factor when predicting the possible change in actual behaviour. In the theory consumers' attitude (A), subjective norm (SN) and perceived behavioural control (PBC) in combination lead to the formation of behavioural intention.

In the TPB, attitudes (A) are defined as either positive or negative perceptions and evaluations about the intended behaviour. Attitudes are determined by an individual's beliefs about the consequences of their behaviour and the intensity of these beliefs (Ajzen, 2005; Quine *et al*., 2000). Subjective norm (SN) describes the effect of social pressure on the intended behaviour. People generally tend to believe that people close to them either like or dislike their intended behaviour. If individuals believe that people close to them regard their intended behaviour as appropriate they experience more social pressure to change their behaviour. Perceived behavioural control (PBC) includes individuals' beliefs on their possibilities to put into practice the intended behaviour. It means the individual's perception of factors that either facilitate or prevent her/him from changing behaviour. These beliefs are based on earlier experiences or second-hand knowledge obtained from, e.g. friends, relatives, colleagues and social media. Typically, the more individuals have resources and possibilities, and the less they see obstacles to change their behaviour, the stronger is the PBC (Ajzen, 2005).

According to the theory, people plan their behaviour. If the intended behaviour change is expected to be beneficial, if there is social pressure to change the behaviour, and if there are no obstacles to adopt the intended behaviour, then individuals are more capable of changing their behaviour (Ajzen 2005).

At present, only one research report on Finnish consumers' attitudes towards insect-based foods exists (Piha *et al*., 2016; University of Turku, 2017). Although TPB is an established and widely used framework in consumer research and can thus be hypothesized to be relevant in the study of insect eating, according to our knowledge there are only two studies (Mancini *et al.*, 2019; Menozzi *et al*., 2017) applying Ajzen's (1991) TPB to measure the intention and the behaviour of eating insect-based foods. During the data collection of this research, insect-based foods were not allowed to be sold on the Finnish food market. Clearance for this was passed only a year after the data collection. Due to this, we were not able to measure behaviour but only intentions and factors affecting them.

2. Materials and Methods

Survey

The data were obtained by using a structured online questionnaire and convenience sampling. A request to respond was delivered by using the twitter science forum of the Finnish Broadcasting Company (YLE) (https://twitter.com/yletiede), the researchers' Facebook pages as well as the digital versions of two newspapers, of which one is focusing particularly on rural and agricultural issues

(https://www.maaseuduntulevaisuus.fi/) and the other on metropolitan issues and city life (https://www.city.fi/). Based on the number of daily visitors to these media, we expected that several thousand people would see the invitation to fill in the survey.

The invitation to fill in the questionnaire was open and achievable to everyone who saw it, so the respondents were free to decide by themselves whether to participate or not. We did not ask their names or any other details which would make the respondents identifiable, and in the beginning of the questionnaire the respondents were informed that their responses would be treated confidentially. Individual respondents cannot be identified based on the results. Based on the pilot study, the estimated time to fill in the questionnaire was 20 minutes. The questionnaire was open from 9/12/2016 to 27/2/2017 (11 weeks and four days). Altogether 649 consumers responded, and after eliminating incomplete responses, the final number of responses was 567.

Measurement

The first part of the self-administered questionnaire dealt with demographic factors such as gender, age, place of residence, and education. We also asked whether the respondents had tasted insect-based foods before. Before this question the respondents were informed about what is meant by insects: "Insects are invertebrate animals with a three-part body, three pairs of legs, compound eyes and one pair of antennae. Beetles, grasshoppers, flour mites, ants and their eggs, pupas and larvae, among others, are insects." Respondents' knowledge of insect-based foods and their know-how about eating and preparing food from insects were asked by using statements concerning the use of insects as a food ingredient. Fear towards new foods was measured by using Pliner and Hobden's (1992) validated Food Neophobia Scale (FN) consisting of ten items and using a seven-point Likert scale (1 = totally disagree, 7 = totally agree).

Respondents' intentions (I) to consume insect-based foods were asked by using three statements based on studies that have developed or applied TPB measurements in other research fields (among others Francis *et al.*, 2004; Shin & Hancer, 2016) and on earlier studies concerning consumers' outlook on insect-based foods (among others Verbeke, 2015). Respondents' attitudes (A) towards insect-based foods were asked with 30 statements, subjective norms (SN) in food behaviour with 14 statements, and perceived behavioural control (PBC) over their intended behaviour either to consume or not to consume insect-based foods with 11 statements. All statements were presented using a seven-point Likert scale (1= totally disagree, 7 = totally agree).

Respondents' perceptions of conditions to consume insect-based foods were operationalized as Healthiness (H), Safety (S), and Convenience and price (C). Healthiness and Safety both consisted of three statements about respondents' perceptions of conditions to consume insect-based foods provided that they are good for health (H) and safe to eat (S). Convenience and price consisted of four statements concerning the perception of conditions to consume insect-based foods provided that they are inexpensive and convenient (C). All statements were presented using a seven-point Likert scale (1 = totally disagree, 7 = totally agree).

Data analysis

The data were analysed by using SPSS Statistics Version 23. Some variables were reversed so that they measured respondents' answers to similar direction. The food neophobia (FN) scale was constructed by summing up the scores of the ten original items, where higher scores indicated higher neophobia on a scale from 10 to 70 points. Before summing up the scores, five items indicating neophilia were reverse coded to indicate neophobia.

To uncover and identify the underlying relationships between the measured variables, seven scales were constructed based on the internal consistency of the variables and partly on the researchers' a priori hypotheses. Those variables were further composed to sum variables having Cronbach's alphas varying from 0.756 to 0.970 (table 1). The sum variables were used in statistical testing of mean differences (Mann-Whitney U-test and Kruskal-Wallis H-test). The relationships between the variables were measured either by Spearman's or Pearson's correlation. $P \leq 0.05$ was considered statistically significant. Cohen's r was used as an effect size index in the non-parametric Mann-Whitney U-test and Cramer's V in the Chi Square test. The effect size r was calculated using formula $r=z/\sqrt{N}$ (Fritz *et al.*, 2012).

Table 1. Constructed scales

Scale	Statement	M	SD	Reliability
Intention (I)		5.5	2.0	0.948
	I intend to consume insect-based foods when they are launched on the Finnish markets.	5.1	2.1	
	There is no way I am going to consume insect-based foods. (R)	2.3	2.1	

	I am not going to consume insect-based foods in any situation. (R)	2.1	2.0	
Attitude (A)		5.7	1.5	0.970
	To consume insects in food production is a good thing.	5.7	1.7	
	The entrance of insect-based foods into the market would be a good trend.	5.7	1.7	
	To consume insects as an ingredient should be promoted in food production.	5.6	1.8	
	To consume insects is wise.	5.3	1.7	
	To consume insects as food should definitely be approved in Finland.	5.9	1.7	
	I want to be a responsible consumer and consume insects since I know that eating them is sustainable.	5.1	2.0	
	I believe that insect-based foods can fit in my diet.	5.2	2.0	
	To consume insects does not suit humans. (R)	2.0	1.6	
	Insect-based foods are a bad thing. (R)	2.0	1.6	
	I don't want insect-based foods to enter food stores. (R)	1.9	1.7	
	To consume insects in food production is unnatural. (R)	1.9	1.6	
Subjective norm (SN)		5.4	1.3	0.898
	People I respect would consume insect-based foods.	5.8	1.5	
	People close to me probably find insect-based foods as enjoyable.	4.2	1.7	
	People important to me wouldn't mind if I consumed insect-based foods.	5.8	1.6	
	I would consume insect-based foods if dietary guidelines recommended eating them.	5.0	2.1	
	I would consume insect-based foods if my friends recommended eating them.	5.2	2.0	
	None of the people I respect are likely to consume insect-based foods. (R)	2.2	1.6	
	Insect-based foods cannot be approved to be a part of Finnish food culture. (R)	2.0	1.7	
	People important to me would worry if I consumed insect-based foods. (R)	2.4	1.7	
Perceived behavioural control (PBC)		4.9	1.3	0.756
	It is possible for me to avoid to consume insect-based foods in the future.	4.7	2.0	
	I can easily control that my diet doesn't contain insects.	4.5	2.1	
	I watch carefully what I eat.	4.7	1.7	
	I believe there is no way to avoid to consume insect-based foods in the future. (R)	3.6	2.1	
	I don't know how to check whether my diet contains insects. (R)	2.1	1.5	

	I don't pay attention to what I put in to my mouth. (R)	2.5	1.6	
Healthiness (H)		4.6	1.9	0.904
	I intend to consume insect-based foods if they are nutritionally better than meat.	4.6	2.1	
	I intend to consume insect-based foods if they have a beneficial effect on my health.	4.9	2.0	
	I intend to consume insect-based foods if official dietary guidelines recommend eating them.	4.4	2.0	
Safety (S)		5.0	1.9	0.919
	I intend to consume insect-based foods if they are free from pesticides.	5.1	2.1	
	I intend to consume insect-based foods since they are environmentally friendly.	5.1	2.1	
	I intend to consume insect-based foods if they are found safe by health authorities.	4.9	2.1	
Convenience and price (C)		5.0	1.9	0.941
	I intend to consume insect-based foods if they are cheaper than meat.	4.3	2.2	
	I intend to consume insect-based foods if they can be easily prepared as foods.	5.1	2.0	
	I intend to consume insect-based foods if one can prepare tasty foods from them.	5.3	2.0	
	I intend to consume insect-based foods if they are of good quality.	5.3	2.0	

R – Reversed item

Hierarchical regression analysis with the enter method was used to examine which factors explain consumers' intentions (I) to consume insect-based foods in the near future. The final model (N=564) was improved by eliminating 3 outlier cases (standardized residuals having an absolute value over 4).

K-means cluster analysis was used to classify respondents based on their perceptions of conditions to consume insect-based foods in terms of three summated scale variables Healthiness (H), Safety (S) and Convenience and price (C). Univariate ANOVA confirmed that these variables functioned well in classifying the respondents into different clusters ($p<0.001$).

3. Results

Characteristics of Respondents

In this study 66.8% of the respondents were women and 33.2% were men (table 2). Respondents were 16-89 years old and 78.5% of them lived in a city area. In terms of education, over half of the respondents (58.9%) had Bachelor's or Master's level degree, which is higher than the 42% among 25-

64-year-old Finns (OECD, 2017). One or several special diets were followed by 45.1% of the respondents. Roughly one third (32.8%) had earlier experience of insects as food.

On the neophobia scale the mean score among the respondents was 26.3±10.6 (range 10-62). Men (25.5±11) were somewhat less neophobic than women (26.8 ±10.3), $U = 31630$, $z = -2.177$, $p < 0.05$, $r = 0.09$.

Table 2. Characteristics of respondents (n=567)

	% or Mean (SD)	n	Min	Max
Gender				
Female	66.8	379		
Male	33.2	188		
Age				
<25	12.9	73		
25-29	21.0	119		
30-39	25.2	143		
40-49	19.8	112		
>49	21.2	120		
Place of residence				
City area	78.5	445		
Rural area	21.5	122		
Education				
Student [1]	4.4	25		
Primary or lower secondary education	1.4	8		
Upper secondary education	28.4	161		
Bachelor's/Master's level	58.9	334		
Doctoral level	6.5	37		
Other	0.4	2		
Diet				
Omnivores[2]	74.3	421		
Following a special diet [3]	45.1	256		
Vegetarian diet [4]	25.7	146		
Semi-vegetarian diet [5]	17.1	97		
Lacto-ovo-vegetarian diet [6]	4.4	25		

Lacto-vegetarian diet [7]	0.5	3		
Vegan diet[8]	4.6	26		
Experience of insects as food				
Earlier experience	32.8	186		
No earlier experience	67.2	381		
Food Neophobia Scale [a]				
All	26.3 (10.6)		10	62
Female	26.8 (10.3)			
Male	25.2 (11.0)			

[1] A person accomplishing primary/lower secondary education or upper secondary education at the moment.

[2] Omnivores include those who have not reported following a vegetarian diet.

[3] Avoiding foods because of a medical condition such as allergy, lactose intolerance or diabetes, or because of individual lifestyle choices such as sports related diets or dieting.

[4] Semi-vegetarian, lacto-ovo-vegetarian, lacto-vegetarian, or vegan diet.

[5] Primarily vegetarian diet with occasional use of foods of animal origin.

[6] Vegetarian diet including milk and egg but not meat or fish.

[7] Vegetarian diet including milk but not meat, fish or egg.

[8] Vegetarian diet including no food of animal origin.

[a] Pliner & Hobden 1992.

Intention to consume insect-based foods

Statistically significant differences between sociodemographic groups were found in the intention to consume insect-based foods in the future. Women had less intention to consume insect-based foods than men, $U = 29307.0$, $z = -3.534$, $p < 0.001$, $r = 0.15$, and people living in rural areas had less intention than people living in city areas, $U = 21380.5$, $z = -3.693$, $p < 0.001$, $r = 0.16$. Statistically significant differences were also found between age groups, $\chi^2(4) = 17.879$, $p < 0.01$. Pairwise comparisons with adjusted p-values showed that respondents under 25 years of age had less intention to consume insect-based foods than 25-29 year-old respondents, $z = -3.470$, $p = 0.005$, $r = 0.25$, and 30-39 year-old respondents, $z = -3.656$, $p = 0.003$, $r = 0.25$. Statistically significant differences were found also between education levels, $\chi^2(5) = 31.257$, $p < 0.001$. Pairwise comparisons showed that students had less intention to consume insect-based foods than respondents who had taken upper secondary education, $z = -4.051$, $p = 0.001$, $r = 0.30$, Bachelor's/Master's level, $z = -4.711$, $p = 0.000$, $r = 0.25$, or Doctoral level, $z = -4.382$, $p = 0.000$, $r = 0.56$. Those with earlier experience of consuming insect-based foods had more intention to consume such foods in the future compared to those who

had no experience, U = 22089.500, z = -7.483, p < 0.001, r = 0.31. Moreover, Speraman's correlation revealed that there was a statistically significant and moderate negative correlation between food neophobia and intention to consume insect-based foods, ρ = -0.501, p < 0.001.

Pearson correlations showed the associations between intention, attitude, subjective norm and perceived behavioural control (Appendix A). The results showed that the respondent's positive attitude towards insect-based foods and a perception of positive attitudes to insect consumption by close people increase intention to use those foods. In addition, when respondents' perceived behavioural control, i.e. the ability to recognize insect-based foods, increases, the intention to use insect-based foods decreases.

Hierarchical regression analysis of intention to consume insect-based foods was conducted with the enter method by using manually controlled stepwise procedure where we sequentially added variables to see the significant R change. We made analysis by using four different models. From background variables we used only gender in the model since it only had a minor significant correlation with intention (0.10). Gender was entered in Model 1, attitude in Model 2, subjective norm in Model 3 and perceived behavioural control in Model 4. Table 3 presents the results with intention to consume insect-based foods as the dependent variable.

Based on regression analysis in Model 4, A explained most of the respondents' intention (β=.749, p<.000). The other variables, gender (β=.040, p<.033), SN (β=.133, p<.000) and PBC (β=-.070, p<.001) had smaller, however, still statistically significant effects on respondents' intention to consume insect-based foods (table 3). Gender, A and SN were statistically significant positive predictors. Perceived behavioural control instead was a statistically significant negative predictor, i.e., the more respondents perceived control to avoid eating insects-based foods the less intention they had to eat insect-based foods. The regression model fit in the data, F (1, 563) = 571.238, p <.000, and explained 80% of the variance in intention to consume insect-based foods.

Multicollinearity analysis (see VIF-indices in table 3) shows that all values are under 5 which indicates only moderate correlations between explanatory variables and thus suggests that multicollinearity is not a problem in our analysis (Ringle *et al.*, 2015).

Table 3. Hierarchical Regression Analysis of intention to consume insect-based foods (N = 564).

Model summary

	Model 1				Model 2				Model 3				Model 4*			
	β	Std. error	p	VIF	β	Std. error	p	VIF	β	Std. error	p	VIF	β	Std. error	p	VIF
Gender	.010	.177	.010	1.000	.046	.081	.016	1.005	.044	.080	.021	1.006	.040	.080	.033	1.009
A					.887	.025	.000	1.005	.781	.048	.000	3.648	.749	.049	.000	3.884
SN									.124	.054	.001	3.654	.133	.054	.000	3.671
PBC													-.070	.031	.001	1.150
Adjusted R^2	.010				0.793				.797				.801			
ΔR^2	.012, p = .010				.782, p = .000				.004, p = .001				.004, p = .001			

*F (1, 563) = 571.238 , p <.000, R^2 = 80.1

Groups based on perceptions of conditions to consume insect-based foods

Respondents' perceptions of conditions to consume insect-based foods in the future were measured by the three summated scale variables Healthiness, Safety, and Convenience and price. Three consumer clusters were identified, 'likely consumers' (44%, n=251), 'unlikely consumers' (17%, n=97) and 'potential consumers' (39%, n=219). Differences between the clusters were statistically significant on each of the variables, $p < 0.001$ (table 4).

Respondents in the cluster 'likely consumers' valued healthiness, good nutritional value, safety, price and convenience of insect-based foods as factors that encourage them to consume insect-based foods. Respondents in the cluster 'unlikely users' didn't see themselves as insect-based food eaters in the future even if these foods were health promoting, nutritious, safe, convenient to use and affordable. Respondents in the cluster 'potential consumers' may be willing to consume insect-based foods if they are safe, cheaper than meat and easy to use. However, healthiness and nutritiousness of insect-based foods were only moderate conditions to consume insect-based foods.

Table 4. Final cluster centres of preferences to consume insect-based foods (N = 567).

Attitudinal intents to consume insect-based foods	Likely consumers (n = 251, 44%) Mean	Unlikely consumers (n = 97, 17%) Mean	Potential consumers (n = 219, 39%) Mean
Healthiness	6.25	1.37	4.24
Safety	6.49	1.38	5.03
Price and convenience	6.47	1.45	5.00

The Pearson's chi-square test (table 5) between socio-demographic factors and cluster memberships showed statistically significant differences between age groups, $\chi^2(8) = 18.191$, $p < 0.05$. It was found that 25-29-year-old respondents were more represented in likely consumers and less represented in unlikely consumers than expected.

For education, $\chi^2(6) = 34.748$, $p < 0.001$, students and those who had taken primary or lower secondary education were less represented in likely consumers and more in unlikely consumers than expected. Instead, those who had taken Bachelor's/Master's level were less represented in unlikely consumers than expected. The proportion of students and those who had taken primary or lower secondary education was smaller in likely consumers (12.1%) and larger in unlikely consumers

(45.5%) compared to those who had taken upper secondary education, Bachelor's/Master's level or Doctoral level. This finding supports our finding in pairwise comparison, that students had less intention to consume insect-based foods compared to those who had taken upper secondary education, Bachelor's/Master's level or Doctoral level.

Table 5. Cross-tabulation and Chi Square test between sociodemographic factors and cluster membership.

	Likely consumers (n = 251, 44%)		Unlikely consumers (n = 97, 17%)		Potential consumers (n = 219, 39%)		Total (n = 567, 100%)		p	V
	%	Std. residual	%	Std. residual	%	Std. residual	%			
Gender								$\chi^2(2)=2.599$	.273	.068
Female	42.5		18.7		38.8		100.0			
Male	47.9		13.8		38.3		100.0			
Age								$\chi^2(8)=18.191$	.020	.127
<25	35.6		24.7		39.7		100.0			
25-29	56.3	2.0*	9.2	-2.1*	34.5		100.0			
30-39	42.0		16.1		42.0		100.0			
40-49	48.2		15.2		36.6		100.0			
>50	36.7		23.3		40.0		100.0			
Place of residence								$\chi^2(2)=8.669$	.013	.124
City area	47.2		15.3		37.5		100.0			
Rural area	33.6		23.8		42.6		100.0			
Education								$\chi^2(6)=34.748$	.000	.175
Student and primary and lower secondary education	12.1	-2.8*	45.5	4.0*	42.4		100.0			
Upper secondary education	42.2		22.4		35.4		100.0			
Bachelor's/Master's level	47.9		12.3	-2.0*	39.8		100.0			
Doctoral level	51.4		8.1		40.5		100.0			
Diet										
Following a special diet	43.8		17.6		38.7		100.0	$\chi^2(2)=.089$	.956	.013
Vegetarian diet	41.8		18.5		39.7		100.0	$\chi^2(2)=.557$	.757	.031
Semi-vegetarian diet	51.1		4.1	-3.1*	44.3		100.0	$\chi^2(2)=13.918$	.001	.157
Experience of insects as food								$\chi^2(2)=43.964$	.000	.278
Earlier experience	59,7	3.2*	3.8	-4.4*	36.6		100.0			
No earlier experience	36.7	-2.2*	23.6	3.1*	39.6		100.0			

* > | 1.96 |

When considering diets, there were less semi-vegetarians in unlikely consumers than expected, $\chi^2(2) = 13.918$, $p < 0.001$. Earlier experience and cluster membership showed a statistically highly significant association, $\chi^2(2) = 43.964$, $p < 0.001$. Those with earlier experience of insect-based foods were more represented in likely consumers and less represented in unlikely consumers than expected; the situation was the opposite for those who had no earlier experience. Over half of those with earlier experience of insect-based foods were among likely consumers and a only small minority (3.8%) of

them were unlikely consumers. Interestingly though, nearly 40% of those who had no earlier experience of insect-based foods, were among likely consumers.

We also found that intention to use insect-based foods was lower among those living in rural areas than in city areas, $\chi^2(2) = 8.669$, $p < 0.05$. Nevertheless, most of those living in rural areas were among potential (42.6%) and likely (33.6%) consumers, yet to a lesser extent compared to those living in city areas.

4. Discussion and conclusion

Out of the respondents as many as 70% intended to consume insect-based foods in the future. This is in line with earlier research reporting that 70% of the interviewed Finns were interested in insect-based foods (University of Turku, 2017). Our results indicated that women, those under 25 years of age, those living in the countryside, those with no prior experiences of insects as food and those who scored higher in the neophobia index had less intention to consume insect-based foods in the future. For gender, these findings are in line with Cicatiello *et al*. (2016), Menozzi *et al*. (2017), Sogari *et al*. (2019) and Verbeke (2015), for age with Caparros Megido *et al*. (2014) and for experience with Hartmann *et al*. (2015), Caparros Megido *et al*. (2016), Tan *et al*. (2016) and Woolf *et al.* (2019). Also Hartmann *et al*. (2015), Mancini *et al.* (2019), Piha *et al*. (2016), Sogari *et al*. (2019) and Verbeke (2016) found that higher neophobia decreases willingness to eat insect-based foods.

Our results provide, however, a more nuanced picture than earlier studies in terms of consumers' preferences and intentions to consume insect-based foods. First, our results showed that all TPB factors, i.e. attitude, subjective norm and perceived behavioural control, as well as food neophobia, were statistically significant predictors of the intention to use insect-based foods. As regards PBC and FN, the findings support those of Mancini et al. (2019) (they did not include SN in their constructs). The finding is, however, opposite to Menozzi *et al*. (2017) who did not observe subjective norm predicting adolescents' intention to eat novel food containing insect flour. The reason for this difference may be that our respondents represented various age groups; McEachan *et al*. (2011) have found that the predictive ability of SN varies across age groups. Regression analysis showed that the attitude factor was a stronger predictor of intention than the two other factors.

Secondly, based on cluster analysis we found three consumer groups based on healthiness, safety, and price and convenience as preconditions to consume insect-based foods. Individuals in the largest group, 'likely consumers' (44% of respondents) were willing to consume insect-based foods provided they have good nutritional value, are safe, their prices are reasonable, and they are convenient to use. Interestingly nearly 40% of those who had no earlier experience of insect-based foods were likely consumers. Since according to Ajzen (1991), intention is the most powerful factor affecting possible behaviour change, we believe that this group is the most likely group to adopt and accept insect-based foods into their diet. Our finding is in line with the results of Menozzi *et al*. (2017) showing that beliefs of insect-based foods' positive effects on health significantly affect attitudes and intentions towards these foods.

The second largest group 'potential consumers' represents 39% of respondents. Respondents in this group were willing to consume insect-based foods in the future if these foods are safe, easy to use, and cheaper than meat. As a relatively large group such potential consumers may significantly influence the future success of insect-based foods on the market. Since the most important factors in food choice among Finnish consumers are healthiness, pleasure, price and convenience (Konttinen *et al*., 2012), health promoting, convenient and reasonably priced insect-based foods may be attractive for 'potential consumers' to adopt into their daily diet. Lensvelt and Steenbekkers (2014) found in their study conducted in the Netherlands and Australia that particularly price and quality were factors affecting consumer acceptance of insect-based foods. Our results suggest that, at least when trying out insect-based foods for the first time, the willingness to experiment with new foods may be more influential than price. In Finland price is almost as important a factor in food choice as healthiness (Peltoniemi &Yrjölä, 2012), suggesting that in repeated consumption the price of insect-based foods is probably more important than in trial. Also House (2016) has emphasised that the factors affecting repeat consumption of insect-based foods are most probably practical and contextual, and thus different from those that motivate consumers to try out insect-based foods in the first place, such as curiosity and novelty.

The minority group, 'unlikely consumers'(17% of respondents) didn't see themselves to consume insect-based foods in the future even if these foods had high nutritional value, and were safe to eat, easy to prepare and cheap. More detailed analysis showed that nearly 70% of unlikely consumers were vegans who regarded consuming of insects as immoral, irresponsible, and unsustainable way to produce food (Elorinne *et al*., 2019).

Limitations of the study

The respondents differed from the general Finnish population in several respects causing some non-response bias in the results. This was expectable as we used a convenience sample. Respondents were mostly women, urban, highly educated, and a relatively high proportion reported following some form of a vegetarian diet. These factors may have different effects on the attitudes and intentions to consume insect-based foods. Generally, women have been found to be less likely than men to consume insect foods (e.g. Cicatello *et al*., 2016; Tan *et al*., 2016; Verbeke, 2015). The higher prices of insect-based foods are better affordable for the highly educated, who generally also have higher incomes (Sosa *et al*., 2015). The highly educated also more often try to eat healthy diets than others (Ovaskainen *et al*., 2013), and may thus also be attracted by the nutritional benefits of insects. As for vegetarianism, not enough is known about vegetarian attitudes to consume insect-based foods to evaluate in which direction the relatively large number of vegetarians in our sample may have affected the results.

Most respondents did not have any experience of insect-based foods. However, one third of the respondents had tasted insect-based foods. The proportion of those who had prior experience of insect-based foods is very high considering that, at the time of the data collection, the selling of insects as human food was not allowed in Finland. Probably those who had interest in the topic and earlier experience were more eager to participate in the study. The benefit of this is that the number of respondents interested to consume insect-based foods was large enough for us to detect some general characteristics of this group.

As to the robustness and generalizability of the regression model we must be cautious in interpreting the regression coefficients because there is some concern about the possible multicollinearity of the predictors as the biggest VIF-indices 3.884 for A and 3.671 for SN come close to threshold value 5.

Conclusions

Our research revealed three different consumer types as regards intended consumption of insect-based foods. Each of them highlighted different aspects in the intention process. Respondents' attitude itself predicted most of the intended consumption, however attitude and subjective norm were strongly inter-correlated having 75% of common variance. Based on the findings, reasonable price and convenience are important issues to potential Finnish insect-based food consumers. Insect food producers and marketers should be able to respond to these issues when bringing to market and pursuing to establish insect-based foods on consumers' dining tables. Furthermore, product development for insect-based foods is needed in which existing food cultures, classifications of

edibility and taste preferences are taken into account. In addition, now that plant-based meat substitutes are increasingly available for consumers all over the western world, manufacturers of insect-based foods must be able to convincingly argue for the added value of their products.

Further research on reasons to consume or not to consume insect-based food may give more specific information about what kind of insect-based foods are acceptable among consumers, and how various insect-based foods are used in different situations. Furthermore, in future research it would be beneficial to include all the components of the TPB, including the actual behaviour in addition to intentions, in a large scale survey study and test the validity of the Ajzen's model using structural equation modelling.

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Appendix A. Correlations between attitude (A), subjective norm (SN), perceived behavioural control (PBC) and intention (I)

	A	SN	PBC	I
A		.852 ***	-.352 ***	.890 ***
S			-.267 ***	.793 ***
PBC				-.372 ***

***p≤.001