



## Insects as food – The impact of information on consumer attitudes

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### ABSTRACT

In western cultures, the consumption of foods based on animal sources is high and thus not sustainable. It is highly important to find alternative protein sources having a comparable nutritional content to traditional products of animal origin and, at the same time, a lower impact on the environment. Nutritional aspects and energy are important for physically active persons and insects as a replacement of traditional protein sources may be a possibility. The aim of this study was to investigate the attitudes of physically active consumers towards insects as food and whether these attitudes were affected by information about nutrition and sustainability.

Half of the 123 recruited physically active adult consumers received information about the nutritional content and sustainability of insects as food, while the other half did not. All 123 consumers answered the same questionnaire which consisted of three parts: Demography, Sustainability and Health, and Attitudes towards insects as food.

In both groups, approximately 35–40% of the consumers would consider eating insects. The attitudes were slightly below neutral; however, it seems that attitudes would be more positive if the consumers could be convinced that insects as food are good for health and environment, as well as tasty. A comparison between the two consumer groups showed no significant difference concerning attitudes towards insects as food. However, the group who received information was significantly more concerned about an adequate intake of nutrients. This shows the complexity of food attitudes, where many factors must be taken into account.

### 1. Introduction

A growing population, together with current trends in food consumption, are major threats to our planet and contribute to global environmental degradation (Willet et al., 2019). It is, therefore, necessary that food production and diet are improved for the benefit of the planet and for our future health. In most western cultures, the consumption of foods originating from animal sources exceeds the recommended level. Excessive intake of products based on red meat has a negative effect on the climate due to greenhouse gas emissions during their production (Willet et al., 2019).

Research has shown that the risk of health problems, such as cardiovascular disease and colorectal cancer, increases with a larger intake than recommended of red meat and charcuterie (De Smet and Vossen, 2016; Foley et al., 2011). Alternative protein sources are, therefore, needed to be able to feed the growing population in a sustainable way. These alternatives should have a comparable nutritional content to traditional products of animal origin and, at the same time, a lower impact on the environment (Meyer and Reguant-Closa, 2017).

The importance of an adequate nutritional intake is considered different in different groups. It has been shown that a balanced diet providing sufficient energy and nutrition, especially proteins, is

considered important by most people doing physical exercise (Rodriguez et al., 2009). Traditionally, foods of animal origin, i.e. meats, eggs and dairy products, are often highly valued as protein sources for physically active persons, since they contain all the essential amino acids and important micronutrients (Placentino et al., 2021; Alparslan and Nevin, 2020; Bianco et al., 2011). Thus, it is of high interest to examine physical active persons for their interest in alternative protein sources.

Insects are eaten regularly as part of the diet in approximately 120 countries (Gedrovica, 2019; Berg et al., 2019). In the western world, however, insects are more rarely accepted as food, despite their good nutritional content and limited environmental impact (Gedrovica, 2019). In addition to a high protein content, insects contain unsaturated fats, vitamins and minerals (Wendin and Nyberg, 2021; Austuti Apri and Komalasari, 2020). The main reasons for not eating insects are often based on social and cultural aspects, such as disgust and neophobia (Wendin and Nyberg, 2021; Wilkinson et al., 2018). However, some consumers may consider eating insects out of an interest for the environment and for their health (Nyberg et al., 2020).

Research has shown that information and knowledge about nutrition and environmental factors may positively change consumers' attitudes towards insects as food (Gedrovica, 2019). However, tastiness has been shown to be of greatest importance (Wendin et al., 2021). On the other

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hand, by providing information on insects as food, other research has shown that increased knowledge does not lead to any significant difference when it comes to disgust and neophobia (Hartmann et al., 2015; Verbeke, 2015). Taking into account the high interest of nutrients, especially proteins, among physically active persons we hypothesize that information about new protein sources may have impact on physical active consumers' attitudes towards nutritional and environmental factors, as well as insects as an alternative protein source are of interest.

**2. Objective**

The aim of this study was to investigate the attitudes of physically active consumers towards nutritional and environmental factors, as well as towards insects as food and whether these attitudes were affected by information about nutrition and sustainability.

**3. Method and design**

Physically active Swedish consumers were invited to answer a questionnaire concerning attitudes towards insects as food via social media platforms such as Facebook or via Kristianstad University's website. Participation was anonymous and voluntary. To meet a power of 95% ( $N(0.95) = 96$ ), the goal was to recruit a minimum of 100 adult consumers to each group, consisting of men and women aged 18 years or older. The power calculation was based on the following equation:  $n = (\frac{Z\sigma}{E})^2$ , where n = number of participants, Z = 1.96 (for 95% power),  $\sigma$  = standard deviation from outcome variable, E = desired margin of error (McLaren et al., 2017). The study design was two equal groups of consumers, whereof one group received information and the other group did not. The consumers were randomly divided into two groups. One of the groups received a flyer with information about the nutritional content and sustainability of insects as food, which was sent with the questionnaire, please see appendix 1 for more information. The other group received only the questionnaire. Both flyer and questionnaire were subjected to a pre-test by three independent persons before launching. The web-based questionnaire was launched in April 2020. The software Eye Question, version: 4:11:62, The Netherlands, was used for data collection. The questionnaire consisted of the following three parts: 1. Demography, 2. Sustainability and Health, and 3. Attitudes towards insects as food. The questions and answer options are shown in Table 1. The consumers who had the flyer with information were asked to read the information prior to answering the questionnaire. The design of this study was inspired by a study by Verbeke (2015) who used a survey which was structured in a similar way. I. e., a survey where respondents were informed about the benefits of insects as food with a focus on nutritional content and ecological sustainability before answering the survey.

The collected data were processed using descriptive statistics. Only data from fully completed questionnaires were used for the statistical calculations. Mean values and standard deviations were calculated and Students t-tests were performed to compare the groups of consumers using Excel (Microsoft Office), significance level was  $p < 0.05$ .

**4. Results and discussion**

Consumer data from a total of 123 physically active Swedish consumers were obtained during the test period. A total of 141 consumers were recruited, 71 consumers received the questionnaire and a flyer with information, and 70 consumers received only the questionnaire. Of these, 67 participated in the group without information and 56 in the group with information. The gender distribution of both groups was fairly similar, with 1/3 men and 2/3 women. Almost half of the consumers belonged to the group aged 18–30 years and the second largest group was those aged 41–50 years. A major proportion, approximately 85%, ate all kinds of food and 15% were vegetarians. The consumers in

**Table 1**  
Questionnaire.

Demography		
No	Question	Answer Options
1	How old are you?	One Choice • Below 18 • 18-30 • 31-40 • 41-50 • 51-60 • 61 or older
2	What is your gender?	One Choice • Woman • Man • Neutral
3	How would you specify your diet?	One Choice • All kind of foods • Vegetarian • Vegan • Other
4	How many days per week do you exercise?	One Choice • Every day • 4-6 • 1-3 • Less than 1
Sustainability and Health		
No	Question/Statement	Answer Options
5	The food I eat should be organic	Scale
6	The food I eat should be locally produced	• Do not agree at all (1)
7	The food I eat should be mainly plant based	• Do not agree fully (2)
8	Food waste should be kept to a minimum	• Neutral (3)
9	The food I eat should be rich in protein	• Agree somewhat (4)
10	The food I eat should contain necessary minerals and vitamins	• Fully agree (5)
11	The food I eat should contain high quality fat	
12	I always plan what I will eat	
13	The food I eat is important for my physical activities	
Attitudes towards insects as food		
No	Question/Statement	Answer Options
14	Have you eaten insects?	One Choice • Yes • No • Maybe
15	Would you consider eating insects in the future, as a source of protein?	One Choice • Yes • No • Maybe
16	I would gladly buy food containing insects	Scale
17	I would like to eat toasted insects	• Do not agree at all (1)
18	I would like to use insect flour in different food products	• Do not agree fully (2)
19	I would like to eat insects included in a dish	• Neutral (3)
20	I would like to add insects to a drink, e.g. a smoothie	• Agree somewhat (4)
21	I would like to eat insects as snacks	• Fully agree (5)
22	I would never consider eating insects	
23	I might consider eating insects in a different form	
24	If you agreed with statement 23, please give examples	
25	I would consider eating insects if it was healthy	
26	I would consider eating insects if it was environmentally friendly	
27	I would consider eating insects if they were tasty	
28	I would never consider eating insects as a source of protein	
29	I might consider eating insects for other reasons	
30	If you agreed with statement 29, please give examples	

both groups were equally divided between exercising either 1–3 days per week or 4–6 days per week. Since the number of consumers in this study is fairly low, the power of study decreased below 95%, but remained above 90%, the results should be regarded as indications to be proven by future studies.

Concerning sustainability, there was a significant difference between the groups regarding one statement, where the group with information considered organic food as more important. For the other statements, both groups had relatively neutral attitudes. However, both groups considered keeping food waste to a minimum to be important, Table 2.

The groups differed significantly concerning all health statements, where the group with information expressed greater concern, Table 2. This may be due to higher momentary awareness from reading the information sheet, which is in line with earlier studies showing the importance of health information (Saba et al., 2019).

Attitudes of participants with and without information are given in the latter part of Table 2.

Less than 50% of the consumers had experience of eating insects, although it should be noted that a significantly larger proportion of the consumers in the group without information had eaten insects. This may, therefore, be considered as a confounding factor. In both groups, approximately 35–40% of the consumers would consider eating insects. This rather low percentage may be linked to the fact that feelings of disgust and neophobia as well as sociocultural and symbolic perspectives are commonly connected with insects as foods (Bataf and Peter, 2020; Gedrovica, 2019).

A comparison between the two consumer groups showed no significant difference concerning attitudes towards insects as food, meaning that the information given did not have an impact. The impact of information is debated where, for example, Cristino et al. (2022), who studied food neophobia, and Gedrovica (2019), who studied food opinions, suggest that information has a great impact on attitudes, while Hartmann et al. (2015) and Verbeke (2015), in their surveys, have shown that attitudes are based on culture and tradition. The attitudes reported here are slightly below neutral; however, it seems that attitudes would be slightly more positive if the consumers could be convinced that insects as food are good for their health, good for the environment, and are tasty. It should also be pointed out that the group who received information about insects as food was significantly more concerned about an adequate intake of nutrients than the group that did not receive any information. This shows the complexity of food attitudes, where many factors have to be taken into account, for example sensory experiences can be mentioned as a factor increasing familiarity and decreasing neophobia (Mancini et al., 2019; Barton et al., 2020; Woolf et al., 2019; Wendin and Nyberg, 2021; Wendin et al., 2021). In addition, the comments from the questionnaire suggested that insects should be “invisible” and could be added to different foods after grinding, e.g. as insect flour in bread, bars etc., which is in line with earlier studies (Hartmann et al., 2015).

One limitation of the study was the fairly low number of consumers included in the study, the low number decreases the power of the study, however the power is above 90% and the results indicate clearly that many factors have to be taken into account when studying attitudes towards insects as food. Another limitation is the recruitment of the participants which was based on so called snowballing which makes the questionnaire open to anybody who would like to respond and thus may imply great uncertainties in the constellations of the groups. No corrections for were done.

### 5. Conclusions

In conclusion, this study showed that the attitudes of physically active Swedish consumers towards insects as food were not affected by information about positive nutritional and sustainability aspects. However, the group receiving information about insects as food was significantly more concerned about an adequate intake of nutrients than the

**Table 2**  
Results.

Question/Statement	Group without information (m ± std)	Group with information (m ± std)	Significance p<0.05
<i>Sustainability and Health</i>			
The food I eat should be organic	2.8 ± 1.3	3.3 ± 1.2	*
The food I eat should be locally produced	3.8 ± 1.3	3.5 ± 1.2	ns
The food I eat should be mainly plant based	2.6 ± 1.4	2.7 ± 1.4	ns
Food waste should be kept to a minimum	4.0 ± 1.4	4.1 ± 1.1	ns
The food I eat should be rich in protein	2.1 ± 0.7	3.1 ± 1.3	***
The food I eat should contain necessary minerals and vitamins	2.2 ± 0.6	3.1 ± 1.3	***
The food I eat should contain high quality fat	2.2 ± 0.7	2.8 ± 1.3	**
I always plan what I will eat	1.7 ± 0.7	2.2 ± 1.2	*
The food I eat is important for my physical activities	1.8 ± 0.7	2.4 ± 1.2	**
<i>Attitudes towards insects as food</i>			
Have you eaten insects?	44%	24%	***
Would you consider eating insects in the future, as a source of protein?	39%	36%	ns
I would gladly buy food containing insects	3.1 ± 1.6	2.9 ± 1.6	ns
I would like to eat toasted insects	2.4 ± 1.5	2.0 ± 1.5	ns
I would like to use insect flour in different food products	3.4 ± 1.6	3.3 ± 1.6	ns
I would like to eat insects included in a dish	2.9 ± 1.6	2.6 ± 1.5	ns
I would like to add insects to a drink, e.g. a smoothie	2.7 ± 1.5	2.3 ± 1.6	ns
I would like to eat insects as snacks	2.5 ± 1.6	2.0 ± 1.5	ns
I would never consider eating insects	2.2 ± 1.5	2.3 ± 1.5	ns
I may consider eating insects in a different form	2.8 ± 1.5	2.6 ± 1.4	ns
If you agreed with the statement above, please give examples	as flour in bread, bars, burgers etc.	as flour	
I would consider eating insects if it was healthy	3.3 ± 1.6	3.3 ± 1.5	ns
I would consider eating insects if it was environmentally friendly	3.3 ± 1.6	3.2 ± 1.4	ns
I would consider eating insects if they were tasty	3.6 ± 1.5	3.3 ± 1.5	ns
I would never consider eating insects as a source of protein	2.0 ± 1.4	2.4 ± 1.5	ns
I might consider eating insects for other reasons	2.4 ± 1.2	2.5 ± 1.3	ns
If you agreed with the statement above, please give examples	If healthy If sustainable If tasty	If low price If available Out of curiosity	

group who did not receive this information. This implies a complexity concerning food attitudes concerning insects as food and partly approves the hypothesis.

## Implications for gastronomy

Gastronomy is an interdisciplinary area and includes everything from farm to fork, including eating and attitudes as well as cultural, nutritional, and sensory aspects of all kind of foods. This paper describes a great complexity concerning attitudes to insects as food, further it shows the impact of information. This knowledge is of importance when developing insect-based foods.

## Statement for conflict of interest

The authors of this manuscript titled “Insects as food – the impact of information, sustainability, and physical activity on consumer attitudes” have financial research support from the Knowledge Foundation, Sweden, and the grant number is 20170141. There are no conflicts of interest.

## CRedit authorship contribution statement

J. Bengtsson: Writing - original draft, critically reviewing the manuscript, formal analysis, data collection and curation, conducted the questionnaire study. K. Wendin: Writing - review & editing, formal analysis, data curation. Both authors participated in the analysis of the data and the interpretation of the results. Both authors have given their approval of publishing this version and have agreed to be accountable for all aspects in the work.

## Declaration of competing interest

There are no conflicts of interest.

## Data availability

Data will be made available on request.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijgfs.2023.100754>.

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