Consumer acceptability of insect flour as an ingredient in bakery products

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Abstract

Nowadays, the bakery market is affected by the current economic situation, the lack of cereals, the economic difficulty of growing crops and the global food crisis. In the recent period, there have been changes in consumer preferences for bakery products consumption, as well as changes in consumer lifestyles related to food consumption regarding the health, sustainability, and environmental protection. In the following years the bakery industry can be significantly affected by the production of fresh and durable bakery products from insect flour, the production of which is efficient, economically advantageous, and in addition, the consumption of insect flour, which is rich in nutritional components, positively affects consumers’ health. The aim of the paper is to point out the acceptability of insect flour and bakery products made from insects by Slovak consumers, as well as to identify key motives and barriers to insect flour bakery products consumption. The aim of the paper was achieved by conducting a consumer survey, which was carried out in 2021 and 2022 in Slovakia (n=733 respondents). The collected data were evaluated and processed using mathematical and statistical methods. The research results showed that up to 70% of Slovak consumers are unaware of the existence of insect flour bakery products. On the other hand, 2.6% of Slovak consumers consumed insect flour bakery products. Furthermore, approximately 30% of consumers consider insect flour to be a suitable or acceptable substitute for classic flour, and 25% of Slovak consumers perceive insect flour as a possible alternative to classic flour in the future or as a long-term solution of bakery industry sustainability and drought problems. A positive finding was that 5.5% of consumers can imagine consuming insect flour bakery products in the future, and 37% of consumers would at least try these innovative foods. The main reasons for consuming are the health aspect, taste, and environment protection. The results further showed that more than half of Slovak consumers cannot imagine consuming insect flour bakery products in the future, and key barriers are habit of classic flour, fear of loss of appetite, or lack of information. The important motives for insect flour bakery products consumption are the taste and appearance similarity to bakery products made from classic flour and higher consumer awareness of insect bakery products consumption. Based on the results of the consumer study and the situation on the food market, it is desirable that Slovak consumers gradually become familiar with and informed about alternative eating and accept the possibility of consuming insect flour bakery products. The consumer study maps the current situation of consumer perception of insect flour bakery products in Slovakia and thus fills a research gap, because this issue has not yet been examined in Slovakia. Results
of this study can be a suitable basis not only for the scientific and research sphere, but also for bakery businesses and experts in the field of public health and food legislation.

**Keywords:** consumer, bakery products, consumer acceptability, consumer perception, insect flour

**JEL Classification:** Q13, M31, M39

1. Introduction

Nowadays, the bakery market reflects the changes in the economic, social and legal institutions countries (Kostyuchenko, Kosovan, Shaposhnikov & Martirosyan, 2019). Bread and other bakery products are consumed throughout the world due to they are one of staple foods (Mafu, Ketnawa, Phongthai, Schönlechner & Rawdkuen, 2022). However, the current market for bakery products is significantly influenced by consumers’ interest in healthy eating, pleasure and convenience in connection with their changing lifestyles, as well as aspects related to sustainability and environmental perspectives (Martínez-Monzó, García-Segovia & Albors-Garrigos, 2013; Strid, Hallström, Sonesson, Sjons, Winkvist & Bianchi, 2021). In connection with the new trends affecting the bakery products market, Mitelut, Popa, Popescu, and Popa (2021) emphasize that it is necessary to produce new innovative bakery products using various functional ingredients that will satisfy consumer demand for healthy foods. In this context, the enrichment of bakery products with other plant components with high nutritional value is becoming relevant (Martínez & Gomez, 2019). Nowadays, increasing consumer demands for health and sustainability can be fulfilled by legume flour as an ingredient in bakery products (Bresciani & Marti, 2019) or the use of oilseeds (flaxseed, chia, sunflower, pumpkin, sesame and poppyseed) in breads and other bakery products (De Lamo & Gomez, 2018). The enrichment of bakery products with defatted sunflower seed flour (Graso et al., 2019) and flaxseed flour (Codină, Istrate, Gontariu & Mironeasa, 2019) are other options to meet market requirements. In many studies, insect flour is mentioned as an ingredient for enriching wheat bread, and it is possible to use various edible flours, e.g. mealworm, buffalo worm, cricket (Kowalski, Mikulec, Mickowska, Skotnicka & Mazurek, 2022; González, Garzón & Rosell, 2019).

Production of edible insect and insect flour is efficient, economical, eco-friendly, sustainable (Yazici & Ozer, 2021; Huis, Itterbeeck & Klunder, 2013). In addition, the consumption of insect flour is very healthy because this flour is rich in nutritional components, mainly proteins and is also good source of fatty acids. Insect flour improves the biological value of bread due to its high protein properties (Patel, Suleria & Rauf, 2019; Zieleńska, Pankiewicz & Sujka, 2021; Papastavropoulou, Koupa, Kritikou, Kostakis & Proestos, 2021). The results of the study conducted by Kowalski et al. (2022) indicated the possibility of using insect flour for bread production, because the enrichment of bakery products with insect flour contributes more to the health of consumers compared to the wheat alternative. For this reason, it is possible to assume that in the following years the bakery industry can be significantly affected by the production of bakery products from insect flour.

In order to expand the use of insect flour as an ingredient in bakery products, consumer acceptability of edible insect is necessary. Key motivating factors for the consumption of insect-based food products are health considerations, high nutritional values, strong sustainability awareness, or information related to origin, production and safety (Wendin & Nyberg, 2021; Legendre, Jo, Han, Kim, Ryu, Jang & Kim, 2019; Palmieri, Perito, Macri & Lupi, 2019; Barton, Richardson & McSweeney, 2020). On the other hand, studies conducted by Lammers, Ullmann and Fiebelkorn (2019); Sogari, Bogueva, and Marinova (2019), as well as Chang and Chen (2019) found that environmental and nutritional benefits would probably not have a positive effect on the consumption of insect-based products. In connection with the above, it is important to emphasize important psychological factors that influence consumer...
acceptability of insect consumption (Wendin & Nyberg, 2021). Neophobia and disgust are considered as the two main psychological factors for the rejection of insects as food or as ingredient in food products (De Carvalho, Madureira & Pintado, 2019). Other factors determining the acceptability of insects as food are sensory attributes, especially the appearance of products containing insects, social and cultural norms and peer influence or increased awareness and knowledge about insects as food. The mentioned aspects should eliminate barriers related to fear of consumption and disgust (Wendin & Nyberg, 2021).

In the context of the mentioned the aim of the paper is to point out the acceptability of insect flour and bakery products made from insects by Slovak consumers and also to identify key motives and barriers to insect flour bakery products consumption. Therefore, research paper tries to answer the following research questions:

1. Is acceptable insect flour as ingredient in bakery products?
2. What are the key reasons for consumption and non-consumption of insect flour bakery products?
3. What are the key motives for consumer acceptability of insect flour as ingredient of bakery products and their consumption?

2. Data and Methods

A questionnaire survey was conducted to identify consumer acceptance of insect flour as a new ingredient in bakery products with an emphasis on its use as a future substitute for wheat flour, possible future consumption of these bakery products, as well as the key reasons for consumption and non-consumption of bakery products made from insect flour. The consumer survey was carried out using the snowball method on a sample of 733 respondents. The survey was conducted in 2021 and 2022 in the Slovak Republic. Consumers involved in the questionnaire survey were divided according to eight socio-demographic criteria (gender, age, number of members in the household, place of residence, education, economic status, monthly income of the respondent, monthly income of the household) (Table 1).

Table 1: Socio-demographic profile of the sample

<table>
<thead>
<tr>
<th>Gender</th>
<th>Residence</th>
<th>Economic activity</th>
<th>Monthly income of respondent</th>
<th>Monthly income of household</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>260 35.5%</td>
<td>348 47.5%</td>
<td>313 42.7%</td>
<td>83 11.3%</td>
</tr>
<tr>
<td>Female</td>
<td>473 64.5%</td>
<td>385 52.5%</td>
<td>242 33.0%</td>
<td>366 49.9%</td>
</tr>
<tr>
<td>Age</td>
<td>18-25 years</td>
<td>28 3.8%</td>
<td>150 20.5%</td>
<td>388 52.9%</td>
</tr>
<tr>
<td>26-45 years</td>
<td>353 48.2%</td>
<td>Elementary education 230 31.4%</td>
<td>230 31.4%</td>
<td>317 43.2%</td>
</tr>
<tr>
<td>More than 45 years</td>
<td>150 20.5%</td>
<td>Higher education</td>
<td>150 20.5%</td>
<td>388 52.9%</td>
</tr>
<tr>
<td>Number of members in household</td>
<td>1 member</td>
<td>230 31.4%</td>
<td>253 35.1%</td>
<td>230 31.4%</td>
</tr>
<tr>
<td>2 members</td>
<td>154 21.0%</td>
<td>Student 303 41.3%</td>
<td>257 35.1%</td>
<td>14 1.9%</td>
</tr>
<tr>
<td>3 members</td>
<td>205 28.0%</td>
<td>Self-employed 47 6.4%</td>
<td>65 8.9%</td>
<td>23 3.1%</td>
</tr>
<tr>
<td>4 members</td>
<td>257 35.1%</td>
<td>Unemployed 14 1.9%</td>
<td>21 2.9%</td>
<td>23 3.1%</td>
</tr>
<tr>
<td>5 members</td>
<td>65 8.9%</td>
<td>Retired 23 3.1%</td>
<td>6 0.8%</td>
<td>11 1.5%</td>
</tr>
<tr>
<td>6 members</td>
<td>21 2.9%</td>
<td>Maternity leave 23 3.1%</td>
<td>6 0.8%</td>
<td>11 1.5%</td>
</tr>
<tr>
<td>More than 6 members</td>
<td>6 0.8%</td>
<td>Other 11 1.5%</td>
<td>6 0.8%</td>
<td>11 1.5%</td>
</tr>
</tbody>
</table>

Source: questionnaire survey
The main part of the questionnaire survey was to examine the key reasons for consumption and non-consumption of bakery products with the addition of insect flour. Consumers who would consume bakery products from insect flour in the future evaluated 6 possible reasons for consumption, namely moral aspect, health aspect, sustainability, environmental protection, taste and lifestyle. These reasons were rated on a Likert scale from 1 to 5, with 1 representing the least important reason for consumption and 5 representing the most important reason for consumption. Consumers involved in the questionnaire survey, who would not consume bakery products containing insect flour in the future, evaluated 7 potential reasons for non-consumption, namely habit of bakery products made from wheat flour, fear of loss of appetite, lack of information about insect bakery products, distrust of the new alternative diet, higher price, production process of insect flour and its products, absence of recipes for meals made from insect flour. These reasons were evaluated on a 5-point Likert scale, with 1 representing the least important reason for non-consumption and 5 representing the most important reason for non-consumption. In the research, we investigated differences in the assessment of the reasons for consumption/non-consumption of bakery products containing insect flour using the Friedman test and consequent post hoc pairwise multiple comparison test according to Nemenyi.

In addition to the aforementioned, the aim of the survey was to find out the main motives for the consumption of bakery products containing insect flour. Respondents evaluated 7 different motivational factors to consume these bakery products, namely taste as wheat flour, appearance as wheat flour, aroma as wheat flour, color as wheat flour, information about health aspect, information about production and information about sustainability and environmental protection. Potential motives were rated on a Likert scale from 1 to 5, with 1 representing the least significant motive and 5 the most significant motive. Based on the applied categorical analysis of the principal components, there were identified 2 latent components related to the identification of key motives for the future consumption of insect flour as a new ingredient in bakery products.

The data obtained by the questionnaire survey were evaluated using Microsoft Excel and statistically evaluated in the XLSTAT and IBMSPSS programs.

3. Results and Discussion

The results of the consumer survey showed that about 70% of Slovak consumers have not heard about insect flour as novel ingredient in bakery products. Positive finding was that more than 25% consumers ever heard about this flour as possible ingredient and even 2.6% Slovaks consumed insect flour as ingredient in bakery products.

As already mentioned, that insect flour could by a real alternative to wheat flour in the future, the consumer survey was oriented on the consumer acceptability of insect flour as replacement of wheat flour. The results showed that 30% Slovak consumers accept insect flour and think that this flour is very appropriate due to its properties. We also identified that 25% perceive insect flour as a necessary ingredient in the bakery industry in the future considering health and sustainable aspects. On the other hand, 45% of Slovak consumer do not accept insect flour as a novel ingredient.

Consumer research has also focused on possible consumption of insect flour as ingredient in bakery products. We found that 5.5% consumers will consume insect flour and more than 35% of Slovaks would try bakery products with insect flour. On the other hand, almost 60% of Slovak consumer would not try and consume insect flour as ingredient in bakery products.

In the context of the possible consumption, we also identified key reasons for consumption and non-consumption of insect flour. Consumers who would consume bakery products containing insect flour rated possible reasons for consumption on a scale from 1 to 5, with 1 being the most important aspect
and 5 being the least important aspect. The results showed that bakery products with insect flour should be consumed due to health aspects, taste, environmental protection, sustainability, lifestyle, and moral aspect. Moreover, we also identified differences in evaluation of reasons using the applied Friedman test (p-value = <0.001). Subsequently, Nemenyi’s method and Demsar plot pointed out the differences between evaluating reasons of insect flour consumption (Figure 1).

**Figure 1: Reasons for consumption of bakery products from insect flour**

However, consumers who would not consume bakery products containing insect flour rated reasons for non-consumption on a scale from 1 to 5, with 1 being the most important aspect and 5 being the least important aspect. The results showed that there are some barriers for insect flour consumption and the key ones are habit for bakery products made from wheat flour, fear of loss of appetite, lack of information about insect flour, distrust in the new alternative diet, higher price, production process of insect flour and its bakery products, absence of recipes for meals made from insect flour. Differences in the evaluation of the reasons for non-consumption were confirmed by applying the Friedman test (p-value = <0.001). Consequent post hoc pairwise multiple comparison test according to Nemenyi pointed out the differences between evaluating reasons for non-consumption of bakery products from insect flour. These differences are shown by Demsar plot (Figure 2).

**Figure 2: Reasons for non-consumption of bakery products from insect flour**

Source: questionnaire survey
For the future acceptance of insect flour as an ingredient in bakery products, it is necessary to motivate consumers to consume it or at least to try it. Slovak consumers evaluate 7 possible motives for consumption. Based on the results it could be stated that key motives are taste and higher consumer awareness related to health effect and production. For a deeper analysis of the factors determining insect flour acceptability and consumption we used categorical principal component analysis and identified hidden relationships between the examined factors. We state the existence of two latent components namely “like a wheat flour” and “information”. The first component includes taste, appearance, aroma, colour, and second one includes information about health aspect, production and sustainability and environmental protection (Table 2).

Table 2: Motives for consumption of bakery products from insect flour

<table>
<thead>
<tr>
<th>Motives</th>
<th>1. Component</th>
<th>2. Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance as wheat flour</td>
<td>0,872</td>
<td>0,408</td>
</tr>
<tr>
<td>Colour as wheat flour</td>
<td>0,888</td>
<td>0,390</td>
</tr>
<tr>
<td>Aroma as wheat flour</td>
<td>0,838</td>
<td>0,467</td>
</tr>
<tr>
<td>Taste as wheat flour</td>
<td>0,711</td>
<td>0,600</td>
</tr>
<tr>
<td>Information about health aspect of edible insect flour</td>
<td>0,452</td>
<td>0,845</td>
</tr>
<tr>
<td>Information about production of edible insect flour</td>
<td>0,412</td>
<td>0,872</td>
</tr>
<tr>
<td>Information about sustainability and environmental protection</td>
<td>0,390</td>
<td>0,867</td>
</tr>
</tbody>
</table>

Source: questionnaire survey

The results of a consumer study conducted in Slovakia showed that the consumption of insects as an ingredient in bakery products is not acceptable for Slovak consumers, as they do not know this innovative ingredient and its benefits. The results further showed that the majority of Slovak consumers would not consume insect flour, mainly due to lack of appetite and lack of information. On the other hand, consumers who would consume insect flour determined health, environmental aspect and taste as key reasons. The key motives for the acceptance of insects as food and their use in bakery products are mainly the similarity with wheat flour and increasing consumer awareness. Other consumer studies conducted in different countries also point to similar results. Burt, Kotao, Lopez, Koeppe, Goldstein, Samuel and Stopler (2019) found that it is acceptable for consumers to consume insects within food products where they are not directly visible and would provide high nutritional properties with good taste. Bogusz, Polak and Nowacka (2020) conducted consumer survey oriented to issues related to consumption of edible insects and products made with some insect-based ingredient, willingness and intention to consume them in the future, benefits, and risks of their consumption and its results showed that almost 70% of respondents are willing to consume products containing insects as one of the ingredients in the future, and approximately 80% of consumers would consume food products containing only insect protein. In this context, Mancini, Sogari, Menozzi, Nuvoloni, Torracca, Moruzzo, and Paci (2019) points to the fact that recently there has been a growing tendency to consume insects added in the form of powder or flour to many widely popular food products, especially bakery products and pasta. Bogusz et al. (2020) further identified that insufficient consumer awareness is one of the key reasons for consumers’ lack of interest in consuming edible insects and foods containing edible insects. Increasing consumer awareness of environmental and nutritional benefits contribute to acceptance of consuming edible insects and insect-based food in the future (Sogari et al., 2019; Mancini et al., 2019). Due to the nutritional composition of edible insects and the environmental benefits, it is possible that insects will become the food of the future or a new food, and 60% of consumers involved in the study conducted by Bogusz et al. (2020) agree with this statement. However, the taste of bakery products containing insect flour will be an important motivating factor, Awobusuyi, Pillay & Siwela 2020).
4. Conclusion

To conclude insect flour as a novel ingredient can affect the bakery industry in the future. Adding insect flour into bakery products brings many benefits. The production of insect flour is efficient, sustainable, and economic. Moreover, the consumption of insect flour positively affects consumers’ health because it is rich in nutritional components. However, the insect flour in our conditions do not have any tradition and consumers have the fear from consumption. Therefore, we conducted questionnaire survey related to consumer awareness of insect flour and we found that almost 3% Slovaks have ever consumed edible insect flour, but more than 70% of Slovak consumers have never heard about insect flour. The following finding was that for 30% of Slovak consumers is insect flour acceptable and 25% consumers perceive it as potential alternative ingredient in the future. More than 40% of Slovak consumers will try insect flour bakery products due to aspects of health and sustainability. Almost 60% of Slovak consumers will not consume insect flour bakery products and the key reasons are habit for bakery products made from wheat flour, fear of loss of appetite, or lack of information. Key motives for Slovak consumers are motive “like a wheat flour” and the second is motive of information. Based on the results of the consumer study and the situation on the food market, it is desirable that Slovak consumers gradually become familiar with and informed about alternative eating and accept the possibility of consuming insect flour bakery products. We also suggest eliminating barriers for insect flour bakery products consumption and also to appeal to food enterprises and initiate them to develop and produce bakery products with insect flour. In the future research it is necessary to monitor the developing situation on the market of insect flour bakery product, to monitor the developing situation on the market of insect flour bakery product, to examine current trends in insect flour consumption in other countries and also to monitor current legislative situation in the field of production and consumption of edible insects in the EU countries.

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References


