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Research Article

EVALUATION OF INSECT-BASED FOOD ACCEPTANCE BY REPRESENTATIVES OF POLISH CONSUMERS IN THE CONTEXT OF NATURAL RESOURCES PROCESSING RETARDATION

Joanna Kostecka[1], Karolina Konieczna[1], Luis M. Cunha[2]

[1] Faculty of Biology and Agriculture, University of Rzeszow, Cwiklinskiej 1b St., 35-601 Rzeszow, Poland, e-mail: jkosteck@ur.edu.pl, vespillo1@gmail.com

[2] Faculty of Science, University of Porto, Portugal, e-mail: lmcunha@fc.up.pt

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ABSTRACT

Food production, based on intensive farming, contributes to high and constantly increasing pollution of soils and other environmental resources. Given this, search for non-conventional sources of animal protein seems justified. The present study was designed to examine opinions of selected Polish consumers related to their acceptance of insect-based food as an alternative source of nutrients. The assessment of attitudes towards alternative sources of nutrients was based on the survey developed at the Faculty of Science, University of Porto in Portugal. Representatives of Polish consumers in the region of Podkarpackie generally did not show open-mindedness towards incorporating insect-based food into their diet. Majority of the respondents, however, recognized the importance of food sector operation based on respect for natural resources. Therefore, it seems important that consumers be informed about the advantages of production or use of insect biomass originating from natural ecosystems. This may contribute to increased acceptance for alternative sources of protein, which consequently may lead to reduced environmental pressure of traditional livestock farming and to retardation of ecosystems transformation and loss of biological diversity.

Keywords: insect-based food, acceptance, survey, retardation

INTRODUCTION

Ecological hazards do not only constitute a problem for urban agglomerations but are also faced by rural areas. Today food production is largely based on intensive farming, a system oriented towards a maximum profit achieved in return for large amount of work and significant financial expenditures. The widespread use of highly effective machines, cultivation and growing methods, mineral fertilizers and crop protection agents to a large extent contributes to high and constantly increasing pollution of soils and damage of other environmental resources.

Hence, contemporary agriculture is faced with a great challenge, on the one hand related to meeting the needs of the growing human population and on the other hand linked with efforts aimed at improving the quality of the natural environment which encounters human impacts associated with food production and particularly with animal farming. Damage resulting from animal production poses threat to all environmental resources, including flora and fauna. It is estimated that if meat-free lifestyle became common worldwide, it would be possible to prevent over 60% of loss in biological diversity; e.g. in Australia in the course of the recent 20 years as much as 91% of all the trees which were cut down were removed to ensure pastures for animals.

According to Gerwin [2016] animal farming is responsible for over 50% of soil erosion worldwide, which leads to desertification. More than 65% of human infectious diseases are transmitted by animals. Livestock production engages 70% of all the farming lands and occupies 30% of the ice-free surface

of our planet. Two hectares of land are needed to provide food for one meat-eating individual, yet the same two hectares could sustain healthy lifestyle of 80 vegans. According to Stockholm International Water Institute, agriculture consumes 70% of water, majority of which is used for production of meat.

According to estimates reported by Mroczek [2015], livestock and animal waste generate at least 51% of all greenhouse gases. These issues were also discussed by de Vries and de Boer [2010] who focused on the environmental impact of food sector, in terms of the areas occupied by livestock farms, production of greenhouse gases and energy consumption. They assessed production processes yielding 1 kg of edible protein (Fig. 1) from animals with the highest economic significance (chicken, pork and beef) as well as milk, in comparison to mealworm (*Tenebrio molitor*) (representative of the class of insects).

Although production of protein from *Tenebrio molitor* involves higher energy consumption than in the case of milk and chicken production, these values are exceeded by energy use in pork and beef processing. Yet, production of protein from insects leads to far lower emissions of greenhouse gases, while accessibility of land used for food production is one of the most strictly defined factors determining sustainable nutrition.

The United Nations Environment Programme (UNEP) and the European Commission call for reducing meat consumption. They jointly published a report calling for radical change in the way economy uses natural resources. We must remember that around one billion people worldwide suffer from hunger; over 90% of them live in developing countries, mainly in rural areas. Contrary to a common belief, the phenomenon of famine is not caused by insufficient quantity of produced food but by its maldistribution [Gerwin 2011]. In the light of these problems, search for non-conventional sources of animal protein seems justified. The use of food obtained from invertebrates could provide beneficial dietary option in the context of sustainable development of the world.

Hence, the purpose of the present study was to examine opinions of selected Polish consumers related to their acceptance of insect-based food as an alternative source of nutrients.

MATERIAL AND METHODS

The assessment of attitudes towards insect-based food was carried out with the use of the survey developed at the Faculty of Science, University of Porto in Portugal. In Poland the survey was completed by randomly selected consumers living in the Podkarpackie Region. For the needs of the analyses 210 responses were obtained from equally numerous groups of females (♀) and males (♂), representing the following age categories: 18–29, 30–55 as well as over 55 years. Each group comprised 35 individuals.

The surveyed individuals had completed higher education (57.1%), and out of these 25.8% had completed postgraduate studies. In the group of respondents with secondary education (41.5%), 32% reported they had started but failed to complete university education. The smallest group of the respondents had primary education (1.4%). Majority of the subjects lived in urban areas (77.6%), and the others represented rural population. The survey consisted of 6 closed

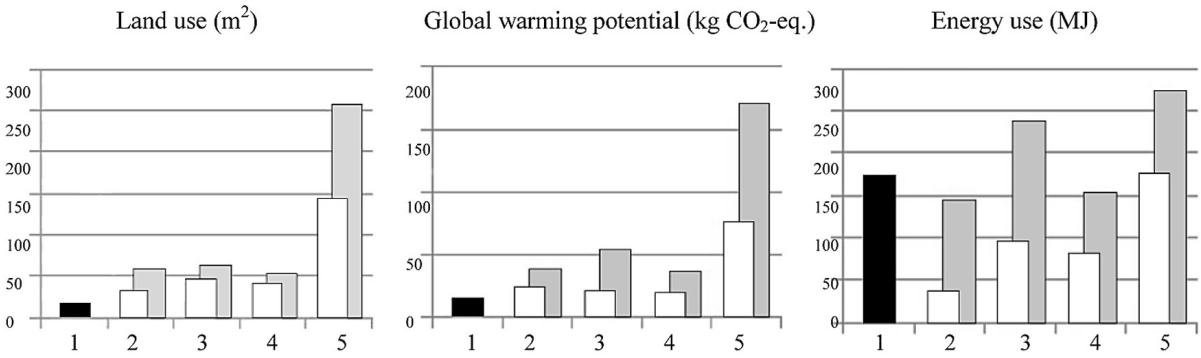

Figure 1. Environmental impact of food production due to the production of 1 kg of edible protein

Meaning of the number: 1 – Tenebrio molitor (black distinction), 2 – milk, 3 – pork, 4 – chicken, 5 – beef. The white bars are minimum values and the grey bars are maximum values found in the literature [after Oonincx and de Boer 2012]

questions and one open question. In questions: 1, 4 and 5 (Table 1) the respondents provided answers on a seven-point Likert scale. In questions 2 and 3 they were asked to choose a response reflecting their own preferences. The final question addressed to the subjects was an open-ended question asking the respondents to provide four examples. Each variant of response provided by the respondents was treated as one record. The acquired data were subjected to qualitative and quantitative classification, with the use of Microsoft Excel spreadsheet.

RESULTS AND DISCUSSION

Responses to the above questions are important in the context of natural resources processing retardation as well as conservation of ecosystems and biological diversity.

The first question was designed to find out the respondents' opinions concerning the importance of respect for natural resources in the context of food production. Results of this part of the survey are shown in Table 2.

Analysis of all the responses shows that for a majority of the survey participants it is important whether production and processing operations in food sector are carried out with respect to natural resources (so in compliance with the principles of sustainable development). On the whole the responses: "rather important", "important, and "very important" were selected by over 50% of the survey participants. On the other hand it is disturbing that in each question the variant "I have no opinion" was ticked by over 20% of the

Table 1. Survey questions

1. It is important that the food I eat on a typical day (*evaluation of all the issues in importance scale from 1–7*)*
a. Is packaged in an environmentally friendly way
b. *Has been produced in a way that animals have not experienced pain*
c. Has been produced in a way that animals' rights have been respected
d. *Has been prepared in an environmentally friendly way*
2. Please indicate the extent of your awareness about eating insects by all options that apply
□ *No, I have never heard of the eating of insects*
□ *I´ve heard that a few insects are edible*
□ *I´ve heard of the eating of insects in other cultures (i.e. African and Asian)*
□ *I´ve heard of the eating of insects at some restaurants*
□ *I have heard of the eating of insects but actually don´t know what it means*
□ *Yes, I have heard of the eating insects and I know what it means*
3. Please state your degree of exposure to edible insects: (*by selecting the most appropriate option*)
□ *I've never tried edible insects* □ *I've tried edible insects on a single occasion* □ *I've tried edible insects on a few occasions*
□ *I eat edible insects seasonally* □ *I eat edible insects regularly*
4. If someone offers you a meal or a snack based on (*evaluation of all the issues in importance scale from 1–7**)
a. Beef from animals fed with feed incorporating insects or insect protein
b. Pork from animals fed with feed incorporating insects or insect protein
c. Edible insects
d. Sushi
e. Protein bar with flour made out of cricket
f. Poultry from animals fed with feed incorporating insects or insect protein
g. Fish from animals fed with feed incorporating insects or insect protein
*5. Please express your degree of agreement on each of the following sentences in importance scale from 1–7**
a. I am offended by the idea of eating insects
b. The idea of insects makes me ill
c. Eating insects is disgusting
d. The idea of insects makes me nauseous
e. If an insect crawls on my favorite food I won´t eat it
6. If you know some, please list up insects that are considered as edible (4 examples):

* Answers to all the questions in issue were granted in Likert scale where: 1 – irrelevant, 2 – rather not important, 3 – little importance, 4 – I have no opinion, 5 – rather important, 6 – important, 7 – very important

Table 2. The significance of respect for the natural resources in the context of the production of food

Question 1: it is important that the food I eat on a typical day (evaluation of all the issues in importance scale from 1–7)*							
1. a. *Is packaged in an environmentally friendly way*							
Total	**6.7**	**6.2**	**16.2**	**20.5**	**16.2**	**11.0**	**23.3**
♀ (18–29)	5.7	8.6	17.1	22.9	11.4	20.0	14.3
♀ (30–55)	5.7	2.9	8.6	11.4	17.1	17.1	37.1
♀ (55+)	2.9	2.9	28.6	17.1	14.3	5.7	28.6
♂ (18–29)	14.3	14.3	8.6	22.9	25.7	5.7	8.6
♂ (30–55)	8.6	0.0	14.3	14.3	17.1	8.6	37.1
♂ (55+)	2.9	8.6	20.0	34.3	11.4	8.6	14.3
b. *Has been produced in a way that animals have not experienced pain*							
Total	**2.4**	**2.9**	**10.5**	**24.8**	**15.2**	**14.3**	**30.0**
♀ (18–29)	6.0	6.0	18.0	30.0	24.0	54.0	72.0
♀ (30–55)	2.9	0.0	8.6	17.1	8.6	20.0	42.9
♀ (55+)	0.0	2.9	14.3	25.7	25.7	0.0	31.4
♂ (18–29)	2.9	11.4	2.9	20.0	25.7	14.3	22.9
♂ (30–55)	5.7	0.0	5.7	22.9	11.4	17.1	37.1
♂ (55+)	0.0	0.0	22.9	48.6	8.6	8.6	11.4
c. Has been produced in a way that animals' rights have been respected							
Total	**4.3**	**3.3**	**12.9**	**21.4**	**19.0**	**15.2**	**23.8**
♀ (18–29)	5.7	2.9	8.6	20.0	17.1	25.7	20.0
♀ (30–55)	2.9	2.9	5.7	14.3	17.1	20.0	37.1
♀ (55+)	2.9	5.7	8.6	31.4	22.9	2.9	25.7
♂ (18–29)	5.7	2.9	14.3	20.0	25.7	14.3	17.1
♂ (30–55)	8.6	2.9	8.6	14.3	14.3	14.3	37.1
♂ (55+)	0.0	2.9	31.4	28.6	17.1	14.3	5.7
d. Has been prepared in an environmentally friendly way							
Total	**2.9**	**3.8**	**11.4**	**23.3**	**20.5**	**13.3**	**24.8**
♀ (18–29)	0.0	8.6	14.3	17.1	22.9	22.9	14.3
♀ (30–55)	2.9	0.0	8.6	14.3	5.7	14.3	54.3
♀ (55+)	2.9	2.9	11.4	31.4	22.9	5.7	22.9
♂ (18–29)	2.9	5.7	11.4	22.9	31.4	14.3	11.4
♂ (30–55)	8.6	2.9	8.6	14.3	17.1	14.3	34.3
♂ (55+)	0.0	2.9	14.3	40.0	22.9	8.6	11.4

* 1 – irrelevant, 2 – rather not important, 3 – little importance, 4 – I have no opinion, 5 – rather important, 6 – important, 7 – very important

respondents. The number of responses: "little importance", "rather not important" and "irrelevant" was in the similar range. It is difficult to explicitly determine reasons for such attitudes among the respondents, yet in the context of these findings it seems necessary to ensure education, implement principles of sustainable development, and amplify responsible teaching methods promoting ecology. Graphic interpretation of the overall summary of responses to the first survey question is shown in the form of radar charts, where the specific numbers correspond with the points of the importance scale (Fig. 2).

Majority of the survey participants admitted they were aware of the fact that insects were consumed in the world (Fig. 3). Nearly $^{1}/_{3}$ of the subjects heard about the custom of eating insects in other cultures (27.8%), 23.9% were aware of the fact that there are a few edible species, and know that some restaurants serve dishes "made from insects" (18.7%). A small group of respondents (5.6%) admitted they had heard about eating insect but they did not know what it meant. Those who had never heard of eating insects constituted the smallest group (3.1%).

Question 3 (Fig. 4) related directly to the respondents' personal experience connected with the consumption of insects.

Vast majority of the participants reported they had never tried edible insects (89.5%). Among those who had consumed insects (10.5%) 7.2% tried this type of food only once. No respondents ticked seasonal or regular consumption of edible insects.

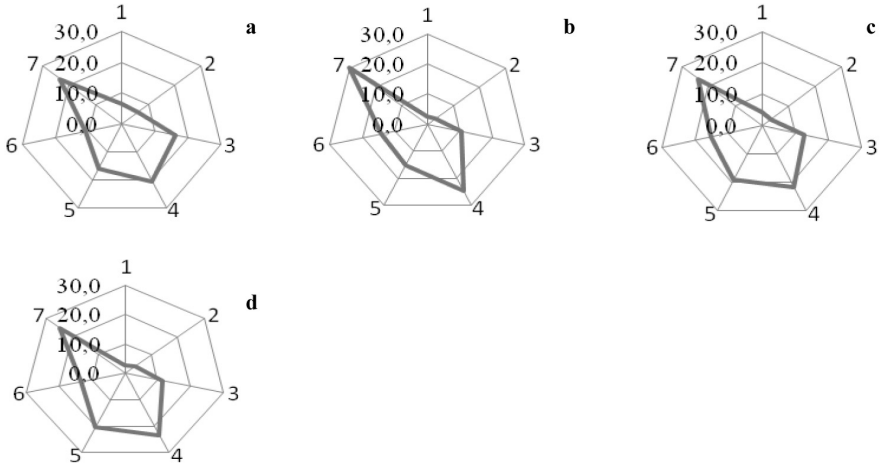

Figure 2. The structure of importance for the respondents: (a) a method for food packaging (b) production of a meal in a humane way; (c) respect for the animals' rights; (d) the production of food with respect for nature

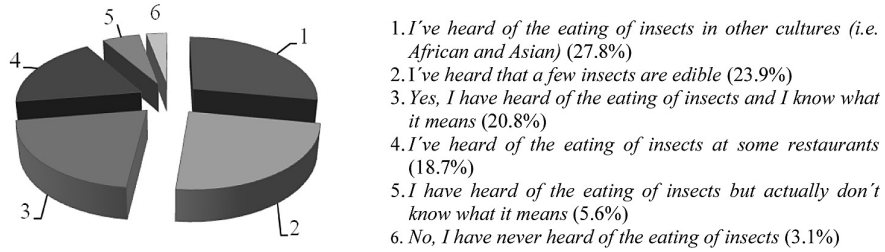

Figure 3. The results showing the respondents' knowledge related to eating insects

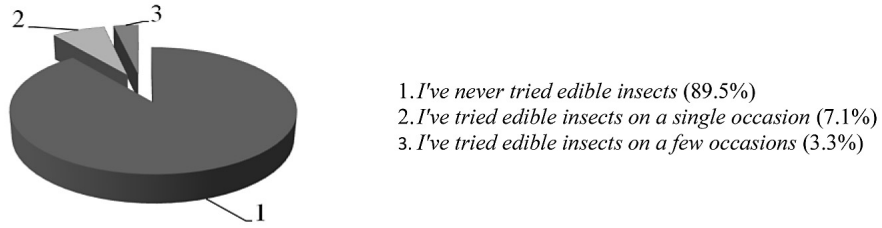

Figure 4. The respondents' attitude towards the consumption of insects

The subsequent question asked the respondents to define their acceptance of food products indirectly or directly connected with protein obtained from insects. The results are shown in Table 3.

The obtained responses suggest that the survey participants are rather sceptical about insect-based meals or even use of insects as animal feed. Why is it so? Perhaps this results from the poor awareness of both nutritional value of these invertebrates and the possibility to use insect protein in production of fodder, or perhaps it is linked with the stereotypically negative attitude to this class of animals in our culture. This may also be affected by the respondents' attachment to traditional food, visible in the lack of fondness for a dish made of raw fish. When it comes to consumption of sushi – 45.7% of the respondents expressed a positive opinion with regard to this type of snack, while 34.4% rejected this type of food.

Interestingly, the respondents' opinions related to feeding cattle or pigs with insect-based fodder were distributed in a similar way. In the first case positive attitude was expressed by 41.8%, and in the second case by 47.2% of the respondents. Lack of willingness to consume this type of meat was reported by 31.9% and 30.9% of the survey participants, respectively.

Slightly higher approval was expressed by the respondents for meat from birds (chicken 58.1%)

Table 3. Answers to question 4 of survey

If someone offers you a meal or a snack based on (evaluation of all the issues in importance scale from 1–7)*							
a. *Beef from animals fed with feed incorporating insects or insect protein*							
Total	**12.9**	**7.1**	**11.9**	**20.0**	**20.0**	**11.9**	**16.2**
♀ (18–29)	14.3	14.3	5.7	34.3	17.1	8.6	5.7
♀ (30–55)	17.1	8.6	11.4	22.9	14.3	11.4	14.3
♀ (55+)	22.9	2.9	8.6	25.7	22.9	5.7	11.4
♂ (18–29)	8.6	8.6	11.4	22.9	22.9	17.1	8.6
♂ (30–55)	8.6	5.7	17.1	11.4	28.6	8.6	20.0
♂ (55+)	5.7	2.9	17.1	2.9	14.3	20.0	37.1
b. *Pork from animals fed with feed incorporating insects or insect protein*							
Total	**11.4**	**7.1**	**12.4**	**21.9**	**16.2**	**12.9**	**18.1**
♀ (18–29)	11.4	11.4	8.6	37.1	8.6	14.3	8.6
♀ (30–55)	17.1	8.6	11.4	31.4	2.9	8.6	20.0
♀ (55+)	20.0	0.0	14.3	22.9	20.0	14.3	8.6
♂ (18–29)	5.7	14.3	11.4	22.9	17.1	17.1	11.4
♂ (30–55)	8.6	5.7	14.3	8.6	31.4	8.6	22.9
♂ (55+)	5.7	2.9	14.3	8.6	17.1	14.3	37.1
c. *Edible insects*							
Total	**31.4**	**18.6**	**12.9**	**17.6**	**6.7**	**7.6**	**5.2**
♀ (18–29)	51.4	11.4	11.4	17.1	0.0	2.9	5.7
♀ (30–55)	31.4	20.0	8.6	22.9	2.9	11.4	2.9
♀ (55+)	40.0	22.9	17.1	11.4	2.9	2.9	2.9
♂ (18–29)	17.1	20.0	14.3	17.1	17.1	11.4	2.9
♂ (30–55)	31.4	17.1	11.4	17.1	11.4	2.9	8.6
♂ (55+)	17.1	20.0	14.3	20.0	5.7	14.3	8.6
d. *Sushi*							
Total	**17.6**	**8.6**	**8.1**	**20.0**	**14.3**	**9.5**	**21.9**
♀ (18–29)	25.7	14.3	2.9	17.1	14.3	2.9	22.9
♀ (30–55)	22.9	5.7	14.3	20.0	11.4	5.7	20.0
♀ (55+)	22.9	5.7	14.3	11.4	20.0	17.1	8.6
♂ (18–29)	8.6	11.4	5.7	31.4	14.3	5.7	22.9
♂ (30–55)	17.1	8.6	5.7	17.1	11.4	14.3	25.7
♂ (55+)	8.6	5.7	5.7	22.9	14.3	11.4	31.4
e. *Protein bar with flour made out of cricket*							
Total	**34.8**	**16.7**	**12.4**	**15.7**	**10.0**	**6.2**	**4.3**
♀ (18–29)	45.7	17.1	11.4	11.4	5.7	5.7	2.9
♀ (30–55)	31.4	20.0	2.9	22.9	5.7	11.4	5.7
♀ (55+)	51.4	17.1	11.4	14.3	2.9	0.0	2.9
♂ (18–29)	22.9	11.4	5.7	25.7	25.7	5.7	2.9
♂ (30–55)	37.1	5.7	17.1	14.3	8.6	8.6	8.6
♂ (55+)	20.0	28.6	25.7	5.7	11.4	5.7	2.9
f. *Poultry from animals fed with feed incorporating insects or insect protein*							
Total	**12.9**	**7.6**	**6.7**	**14.8**	**13.8**	**14.3**	**30.0**
♀ (18–29)	14.3	14.3	8.6	20.0	20.0	8.6	14.3
♀ (30–55)	20.0	2.9	5.7	20.0	8.6	11.4	31.4
♀ (55+)	20.0	5.7	2.9	8.6	11.4	17.1	34.3
♂ (18–29)	8.6	8.6	8.6	31.4	14.3	14.3	14.3
♂ (30–55)	11.4	11.4	8.6	2.9	17.1	17.1	31.4
♂ (55+)	2.9	2.9	5.7	5.7	11.4	17.1	54.3
g. *Fish from animals fed with feed incorporating insects or insect protein*							
Total	**13.8**	**7.1**	**6.7**	**15.7**	**11.0**	**15.2**	**30.5**
♀ (18–29)	22.9	11.4	8.6	25.7	14.3	11.4	5.7
♀ (30–55)	17.1	5.7	2.9	22.9	11.4	11.4	28.6
♀ (55+)	22.9	0.0	5.7	8.6	5.7	14.3	42.9
♂ (18–29)	5.7	14.3	5.7	22.9	22.9	17.1	11.4
♂ (30–55)	8.6	11.4	14.3	5.7	5.7	20.0	34.3
♂ (55+)	5.7	0.0	2.9	8.6	5.7	17.1	60.0

* 1 – irrelevant, 2 – rather not important, 3 – little importance, 4 – I have no opinion, 5 – rather important, 6 – important, 7 – very important

and fish (56.7%) fed in a similar way. In this case acceptance of insects as fodder provided to these animals possibly results from the fact that insects (as well as other invertebrates) naturally constitute an element of the diet in natural conditions and in various breeding systems (free-range farming in the case of poultry). Additionally, approval for insect-based fodder used to feed fish (and consequently for consumption of fish) was most frequently expressed by men over 55 years of age (a simple association with angling comes to mind).

The highest degree of disapproval (or the lowest level of acceptance) was expressed in responses to questions related to direct experience of consuming insects or products based on flour obtained from insects. 62.9% of the survey participants generally report reluctance towards dishes "made from insects", and 63.9% show the same attitude towards consumption of snacks made from cricket flour.

In question 5 the respondents were asked to evaluate the idea of eating insects (Table 4).

Those who had no opinion accounted for approx. 24% of the subjects while 26.7% of the respondents were more or less offended by the idea of eating insects; a significant group of the subjects (39.5%) admitted that the idea of eating insects made them feel ill. The thought of eating insects was disgusting for over 40% and nauseating for 39% of the survey participants. Over 47% of the respondents declared that they would not eat their favourite food if there were insects on it.

The final question, assessing the knowledge of edible insect species, was not answered at all by 45.7% of the subjects. 54.3% of the respondents provided an answer, yet majority of them gave only one example (23.3%). Two and three species were listed by 15.2% and 4.8% of the respondents, respectively. A complete answer containing four examples was provided by 10.0% of the surveyed individuals. More than 4 species of edible insects were listed by only two persons, who constituted 1.0% of the group.

Following an analysis, the responses provided to this question were classified into 33 categories. The examples did not always correspond with the systematics of insects (division into families, orders, species, etc.), yet it was suitable for assessing the respondents' knowledge (accuracy of the provided answers). The examples of edible insects most frequently provided in the responses included such taxonomic units as ants (17.6%) and crickets (16.7%) and larvae (15.9%). The first two responses are quite accurate yet the last one is rather problematic as it relates to a developmental pre-imago (or post-embryonal) stage observed in all insects, irrespective of metamorphosis type, so the term does not represent any specific systematic group of *Insecta* class.

A detailed analysis of the examples listed by the survey participants shows large discrepancy in the contents of the responses. Some of the answers are valid and accurate, like e.g. the aforementioned ants, crickets and scarabs (7.1%). The provided examples also include grasshopper (6.3%), locust (5.0%) and more specifically migratory locust (0.4%), caterpillar and termite (each 3.8%), cicada, cockroach, wasp (each 1.3%), aphid, bush-cricket (each 0.8%), water bug, true bug and bee (each 0.4%).

The responses which in the context of entomophagy[1] are not fully accurate, yet are scientifically correct, include beetles (5.9%), mealworms (0.8%), butterflies (0.8%), flies (0.8), moths (0.4%), ant eggs (0.4%), scarab beetles (0.4%). Notably, we should also mention the general and seemingly symbolic classification of consumption of insects in various developmental stages taking into account the type of metamorphosis. Insects which are older in terms of phylogenesis, with incomplete metamorphosis (Hemimetaboly), like e.g. dragonflies, Orthoptera, water bugs and mayflies[2] in most cases are consumed in their adult form (imago). On the other hand the insects with complete metamorphosis (Holometabolism), such as beetles, lepidopterans, diptera, and hymenoptera, as a rule are consumed in their pre-imago stage (most often larvae, less frequently chrysalis) [Łuczaj 2005]. The above answers of the survey respondents suggest that insects are consumed in their adult form (imago), while in fact their larval forms are more often used as food: in the case of butterflies and moths these are caterpillars; in the case of beetles (including mealworms, scarab beetles and may bugs) these are mainly grubs; flies are most often eaten in the form of larvae in apodal, or frequently acephalic form, i.e. mag-

[1] Scientists have proposed a distinction between two, apparently synonymous terms, i.e. *insectivory* and *entomophagy*. According to Meyer-Rochow [2010] the term *insectivorous* is mainly used with reference to species or organisms of higher taxonomic order feeding mainly or exclusively on insects (e.g. order Insectivora). On the other hand the term entomophagy is used in the cases when insects are among many elements of diet possibly also including products obtained from plants and animals.

[2] Those orders of insects were listed which are most frequently represented in the human diet.

Table 4. Question 5 of questionnaire and emotional approach of respondents to the idea of eating insects

*Evaluation of all the issues in importance scale from 1–7**							
a. *I am offended by the idea of eating insects*							
Total	**22.4**	**13.8**	**13.3**	**23.8**	**9.5**	**6.7**	**10.5**
♀ (18–29)	31.4	8.6	11.4	25.7	14.3	0.0	8.6
♀ (30–55)	17.1	22.9	5.7	25.7	5.7	8.6	14.3
♀ (55+)	8.6	11.4	8.6	25.7	17.1	17.1	11.4
♂ (18–29)	28.6	14.3	17.1	22.9	5.7	2.9	8.6
♂ (30–55)	17.1	14.3	8.6	25.7	8.6	8.6	17.1
♂ (55+)	31.4	11.4	28.6	17.6	5.7	2.9	2.9
b. *The idea of insects makes me ill*							
Total	**19.0**	**13.3**	**11.0**	**17.1**	**13.8**	**10.5**	**15.2**
♀ (18–29)	25.7	8.6	8.6	25.7	14.3	2.9	14.3
♀ (30–55)	14.3	11.4	14.3	17.1	11.4	8.6	22.9
♀ (55+)	14.3	2.9	0.0	8.6	22.9	25.7	25.7
♂ (18–29)	25.7	14.3	14.3	17.1	14.3	5.7	8.6
♂ (30–55)	14.3	22.9	8.6	14.3	11.4	14.3	14.3
♂ (55+)	20.0	20.0	20.0	20.0	8.6	5.7	5.7
c. *Eating insects is disgusting*							
Total	**20.5**	**12.9**	**11.0**	**15.2**	**11.0**	**9.5**	**20.0**
♀ (18–29)	28.6	5.7	20.0	8.6	8.6	11.4	17.1
♀ (30–55)	14.3	11.4	5.7	11.4	17.1	5.7	34.3
♀ (55+)	14.3	2.9	0.0	14.3	14.3	25.7	28.6
♂ (18–29)	22.9	22.9	8.6	17.1	14.3	0.0	14.3
♂ (30–55)	17.1	14.3	14.3	20.0	5.7	11.4	17.1
♂ (55+)	25.7	20.0	17.1	20.0	5.7	2.9	8.6
d. *The idea of insects makes me nauseous*							
Total	**20.0**	**13.3**	**10.5**	**17.1**	**11.4**	**10.5**	**17.1**
♀ (18–29)	22.9	17.1	11.4	14.3	14.3	8.6	11.4
♀ (30–55)	11.4	8.6	11.4	25.7	11.4	5.7	25.7
♀ (55+)	14.3	2.9	0.0	11.4	22.9	22.9	25.7
♂ (18–29)	20.0	20.0	14.3	20.0	8.6	5.7	11.4
♂ (30–55)	11.4	14.3	14.3	25.7	5.7	11.4	17.1
♂ (55+)	20.0	17.1	22.9	22.9	8.6	2.9	5.7
e. *If an insect crawls on my favorite food I won´t eat it*							
Total	**19.5**	**12.4**	**11.4**	**9.0**	**8.6**	**11.0**	**28.1**
♀ (18–29)	17.1	2.9	14.3	14.3	5.7	8.6	37.1
♀ (30–55)	11.4	8.6	8.6	5.7	14.3	11.4	40.0
♀ (55+)	17.1	22.9	11.4	11.4	2.9	11.4	22.9
♂ (18–29)	20.0	17.1	8.6	14.3	11.4	14.3	14.3
♂ (30–55)	11.4	5.7	14.3	2.9	11.4	11.4	42.9
♂ (55+)	40.0	17.1	11.4	5.7	5.7	8.6	11.4

* 1 – irrelevant, 2 – rather not important, 3 – little importance, 4 – I have no opinion, 5 – rather important, 6 – important, 7 – very important

gots; on the other hand the ant eggs, erroneously listed in the responses are in fact ant pupae.

Erroneous responses provided to the question related to edible insects included earthworms (2.1%), representing the phylum of Annelida and spiders (2.1%) classified as subphylum Chelicerata and phylum Arthropoda. Yet in the two groups of invertebrates it is possible to find numerous edible species.

The authors of the study do not clearly understand the following responses: roundworms (0.4%) and worms (0.4%). These terms can be understood in two ways. Firstly, the words are commonly used generally with reference to insects or other small invertebrates, without suggesting any specific species. Moreover, the terms carry negative, scornful meaning. On the other hand "roundworms" and "worms" represent various groups of invertebrates (subphylum Nemathelminthes and phylum Platyhelminthes), which include numerous species of parasites as well as human endoparasites.

An interesting example provided by one person was "gusano". The red and pink caterpillars of butterflies from the family Cossidae, representing the species of *Xyleutes redtenbachi*, are

inserted into bottles with tequila (Mexico). According to Łuczaj [2005] they are called *gusano rojo de maguey* and they are meant to prove fine quality of the beverage. If the alcohol has been diluted, the caterpillars will rot.

Agriculture related environmental hazards are most often linked with the type of farming operations or with the specific functioning of rural populations. The challenges result from e.g. incompetent use and faulty storage and disposal of pesticides, heavy fertilization with minerals, incorrect management of animal waste, faulty storage and transport of silage as well as plant waste. Therefore it is necessary to organize and promote sustainable agriculture which is expected, among others, to preserve high quality natural environment, to yield good crops and generate high and evenly distributed revenues, to ensure high safety of production, to produce safe food of fine quality, and to ensure benefits to human health and well-being. Insects stand out for high nutritional value, most notably including healthy protein, dietary fibre, beneficial fats, vitamins, and microelements. As reported by Piotrowski [1999] a Mexican study of 94 edible insect species demonstrated that energy value of 50% of these species was higher than in soybean, in 87% – higher than in maize, in 63% – higher than in beef; and in 70% of the species the calorific value was higher than in fish and peas. 95% of the insect species have higher energy value than e.g. wheat, rice and teosinte[3].

In comparison to vertebrate animals, insect farming requires significantly less space, shorter time, and lower energy and water consumption. The knowledge of these advantages, therefore, should be promoted.

CONCLUSIONS

1. Representatives of Polish consumers in the region of Podkarpackie generally did not show open-mindedness towards incorporating insect-based food into their diet. Approx. 30% of the respondents were offended by the idea of eating insects; a significant group (39.5%) claimed that the idea of eating insects made them feel ill. Eating insects was disgusting for over 40% and nauseating for 39% of the survey participants. Nearly 50% of the respondents declared that they would not eat their favourite food if there were insects on it.
2. For a majority of the survey participants it is important whether the broadly understood production and processing operations in food sector are carried out with respect to natural resources (in compliance with the principles of sustainable development).
3. In the light of the survey results it seems important that consumers be informed about the advantages of production or use of insect biomass originating from natural ecosystems. This may contribute to increased acceptance for alternative sources of protein, which consequently may lead to reduced environmental pressure of traditional livestock farming and to retardation of ecosystems transformation and loss of biological diversity.

[3] Teosinte – popular, local term for Mexican pasture grass, a wild variety of plant in the genus Zea.

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