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EDIBLE INSECTS AS A POTENTIAL PRODUCT FOR ACHIEVING GLOBAL FOOD SECURITY. PART 1

S u m m a r y

Background. The use of edible insects as a food source for humans creates numerous demographic, environmental, economic and ethical challenges for societies. The consumption of food containing edible insects in its composition requires, first and foremost, its acceptance by consumers. The aim of the study was to determine whether the attitudes and intentions of young consumers in Poland (Generation Z) toward foods containing edible insects (fresh, frozen, dried, powdered ones, e.g., meal) in their composition can affect concerns about food security and environmental sustainability worldwide. In preparing the questionnaire, a set of statements adapted from scientific publications by other authors was used. The survey questionnaire included items (15) relating to: attitudes toward insect food (4), intentions to purchase food from insects (4), the willingness to pay a higher price for food containing insects, the production of which takes into account care for the environment (1), concern for food security (4) and environmental sustainability (2). During the survey, the respondents expressed the level of approval to or disapproval of all items included, using a five-point Likert scale.

Results and conclusions. Based on the survey carried out among young people, it can be concluded that the acceptance of foods containing edible insects in their composition as a solution, or support, to the problem of global food insecurity is related to attitudes and intentions to consume and purchase foods containing edible insects in their composition (fresh, frozen, dried, powdered ones, e.g. meal). Understand-

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ing young consumers' intentions to consume food containing edible insects combined with their experiences with edible insects is the most effective way to encourage consumers to purchase and consume new foods . The results obtained can contribute to efforts to promote the legitimacy of producing new foods containing edible insects in their composition.

Keywords: sustainable development, entomophagy, attitudes to food and nutrition, willingness to consume, Generation Z in Poland

Introduction

Food insecurity affects approx. 2 billion people worldwide [25]. The use of edible insects as a source of food for humans, due to global population growth, increasing demand for animal protein and rising costs of its production, as well as food insecurity in some regions of the world and increasing environmental pressure, has become an issue of global importance in recent years. Achieving environmentally sustainable food security is now one of the greatest global challenges [3, 7, 16]. From the point of view of ensuring food security, a key issue is the production of sufficient quantities of wholesome protein, which is essential for the human body to properly function [30]. Alternatives to food as a source of protein from traditional livestock and plant production may include proteins derived from edible insects. As part of an initiative to fight world hunger and reduce the negative impact of animal farming on the environment, the European Union has developed a special strategy for action in this regard. Its goal is to gradually allow mass production of ingredients on the "novel food list," referring to alternative products that were not significantly used in food production in the EU before 1997. In 2017, the Commission's Implementing Regulation (EU2107/2470) of December 20, 2017, establishing the EU list of novel foods, in accordance with Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods, was published. An additional source of information on the status of specific ingredients is the European Commission's Catalogue of Novel Foods, which is an open document and successively supplemented with new products. In the EU, the Novel Food Catalog allows and lists four edible insects: the mealworm (*Tenebrio molitor* L.), the house cricket (*Acheta domestica* L.), the migratory locust (*Locusta migratoria*) and, from March 5, 2023, the larvae of the buffalo worm (*Alphitobius diaperinus* P.) [2]. In recent years, there has been a growing number of scientific findings on the potential use of edible insect preparations in the production of a range of food products, such as baked goods, confectionery, snacks or even hamburgers [4, 5, 9, 10, 12, 13, 14, 21, 22, 26, 33] and their acceptance by consumers [12, 13, 14, 35]. It seems that consumer acceptance, in particular, poses many challenges, especially within the so-called Western culture, where eating insects has unambiguously negative connotations. It is noteworthy, however, that a growing number of studies indicate great potential in this area,

especially among young people [7]. By age, consumers can be divided into groups or segments with strong homogeneous characteristics. The most well-known age distribution of consumers can be classified as Generation Baby Boomers, X, Y or Z, also known as multi-generational marketing, where a distinction is made between: Baby Boomers – born between 1946 and 1964; Generation X – born between 1965 and 1979; Generation Y (so-called millennials) – born between 1980 and 1994; Generation Z – born after 1995, often also referred to as Generation C ('connected') or the Post-Millennial generation [38]. The generation is considered to have been raised consciously, which is demonstrated by its representatives through their assertiveness and courage to fight for their rights. Generation Z is perceived to be very concerned about increasing environmental change, rising terrorism and terrorist attacks around the world, rising unemployment and income inequality [37]. As discussed in the literature, young adults in Poland (Generation Z) express the willingness to take a number of actions related to changing eating habits in order to improve the nutritional status of the body [28, 29]. The prevailing ambivalent attitude of students in Poland towards health or environmental concerns in terms of the willingness to consume edible insects [23] may lead to greater resistance or increased susceptibility to persuasion and influence. It is assumed that ambivalent attitudes are flexible and, depending on the context, can either help individuals to adapt better or prevent them from reaching satisfactory conclusions [32, 41].

Edible insects are a good source of protein and fatty acids [10, 12, 13, 14], and also provide many other nutritionally valuable nutrients, such as minerals (phosphorus, potassium, iron) and vitamins (in particular ascorbic acid, thiamine, riboflavin and niacin) [10]. The high nutritional value of edible insects means that products containing them, more broadly, could provide a valuable food source to help combat malnutrition and hunger worldwide [20]. In addition, it has been suggested that in the geographic regions where people particularly suffer from malnutrition and food insecurity, edible insects could contribute to a partial solution to this important problem [42]. However, the potential socioeconomic benefits of insect husbandry, particularly with regard to enhancing food security, need to be confirmed in future studies. It is important to remember that further research into the biology, ecology, habitat protection, nutritional requirements and control of their breeding conditions is needed to produce edible insect species for consumption. In addition, additional regulations and laws governing insects as a source of human food are needed to ensure greater investment, production (from small to industrial-scale farms) and trade in edible insects and their products [16].

The aim of the study was to determine whether the attitudes and intentions of young consumers in Poland (Generation Z) toward foods containing edible insects

(fresh, frozen, dried, powdered ones, e.g., meal) in their composition can affect concerns about food security and environmental sustainability worldwide.

Material and methods

Subjects

An empirical survey was conducted among students of five Polish universities coming from the following provinces: Kujawsko-Pomorskie (approx. 3 %), Małopolskie (approx. 23 %), Mazowieckie (approx. 6 %), Pomorskie (approx. 31 %), Podkarpackie (aprox. 3 %), Podlaskie (approx. 3 %), Warmińsko-Mazurskie (approx. 17%), Wielkopolskie (approx. 5 %), and in a percentage of less than 2 % (respectively) from Dolnośląskie, Zachodniopomorskie, Lubuskie, Świętokrzyskie, Lubelskie, Łódzkie, Opolskie. The survey was conducted using a specially designed questionnaire, by the indirect interview method, via an online platform in 2023. The questionnaire was validated by assessing the construct validity and estimating the reliability of the scales used using Cronbach's alpha coefficient. The α value obtained was 0.89, indicating good reliability. The study was approved by the University Research Ethics Committee of the Cracow University of Economics No. KEBN/71/0044/D24/2023.

In the research proceedings, 1,063 properly completed survey questionnaires were collected. All respondents gave voluntary, informed consent to participate in the study and were assured of its anonymity. The participants in the study were those who stated that they ate all food types and did not limit their consumption of meat or animal products. The persons who were vegetarians, vegans and those on a flexitarian diet were excluded from the study. During the research procedure, 1,087 survey questionnaires were collected, and 24 incomplete and incorrectly completed ones were eliminated: Seven persons did not agree to participate in the study (they did not complete the survey further), 15 persons refused to answer the question about gender, and two persons entered very large, unrealistic values in the age field. All respondents gave their free, informed consent to participate in the survey and were assured of its anonymity. The structure of the surveyed sample (N = 1,063 respondents) is presented in Table 1.

Table 1. Characteristics of the respondents serveyed
Tabela 1. Charakterystyka badanej grupy respondentów

Variables / Zmienne	N	% of total / % ogółu
Gender / Płeć		
Women / kobiety	649	61.05
Men / mężczyżni	414	38.95
Origin (Province) / Pochodzenie (województwo)		
Pomorskie	331	31.14
Małopolskie	247	23.24
Warmińsko-mazurskie	182	17.12
Mazowieckie	63	5.93
Wielkopolskie	48	4.52
Podkarpackie	31	2.92
Kujawsko-Pomorskie	30	2.82
Podlaskie	27	2.54
Śląskie	21	1.98
Zachodniopomorskie	19	1.79
Lubuskie	18	1.69
Świętokrzyskie	12	1.13
Lubelskie	10	0.94
Dolnośląskie	10	0.94
Łódzkie	9	0.85
Opolskie	5	0.47

Questionnaire and data analysis

In preparing the questionnaire, a set of statements adapted from scientific publications by other authors was used. The survey questionnaire included items relating to:

- Attitudes toward insect foods (4 items): "I think buying new insect food is a good idea", "I think buying new insect food is a wise choice", "I like the idea of buying new innovative insect food", "Buying new innovative insect food would be nice" [39].
- Intentions to purchase food from insects (4 items): "I would try dishes made from insects or with insect ingredients if I had the opportunity to do so", "I am interested in consuming dishes or foods/products made from insects in the near future", "I am willing to purchase "new foods" containing edible insects in their composition", "I

will make an effort to purchase foods containing insect protein in the near future" [11, 17].

- The willingness to pay a higher price for food containing insects, the production of which takes into account care for the environment (1 item).
- Concern for food security (4 items) and environmental sustainability (2 items) (CFS & ES) resulting from the willingness to consume food with edible insects in it – Implementing the practice of consuming foods containing edible insects in their composition (fresh, frozen, dried, powdered ones, e.g. meal) can solve problems such as: 1. hunger and malnutrition (HM); 2. providing access to foods with high nutritional value (PC-FHNV); 3. high demand for protein sources (HD-PS); 4. providing access to foods with high concentrations of n-3 fatty acids (PC-FHCn-3FA); 5. sustainability in food production (SFP); 6. reducing greenhouse gas emissions (RGGE). The second, third and fifth items were adapted from Lim et al. study [19]. The other three were additional.

During the survey, the respondents expressed the level of approval to or disapproval of all items posted using a five-point Likert scale, where the values 1 to 5 mean: definitely no; no; I do not know/I have no opinion; yes; definitely yes [18].

The empirical material collected was presented in the form of a percentage distribution of the responses given and selected descriptive statistics, such as median, mean, standard deviation. In order to indicate statistically significant differences between mean values, an analysis of variance (ANOVA) and Tukey's test was applied using Tukey's test. The chi-square test with Yates' correction was conducted to determine the relationship between attitudes toward foods with edible insects in them and intentions to purchase such foods, as well as the willingness to pay more for foods with insects because of the environment, and concern for food security and environmental sustainability. Spearman's rank correlation analysis was used to determine the relationship (relations) between the independent variables (attitudes toward insect food, intentions to purchase insect food; the willingness to pay a higher price for food containing insects) and the dependent variable (concern for food security and environmental sustainability). A significance level of $p < 0.05$ was assumed for all statistical analyses, and calculations were performed using Excel 2000 and Statistica 13.3 (Tibco Software, Palo Alto, USA).

Results and discussion

Attitudes toward foods containing edible insects in their composition (fresh, frozen, dried, powdered ones, e.g., meal) proved to be a factor influencing statements related to concern for food security and environmental sustainability. The greatest polarization was observed in the negative and positive responses given to each statement included on the scale. Among those characterized by negative attitudes toward foods

containing edible insects in their composition, almost two-thirds of respondents answered "*no*" to all statements made on the scale of concern for food security and environmental sustainability. The respondents gave a negative response ("no") from 57.14 % (of the total respondents) to the statement: "*Food containing edible insects can provide demand for a source of protein*" to 65.55 % (of the total respondents) to the statement: "*Food containing edible insects can contribute to environmental sustainability*". On the other hand, the respondents having a positive attitude toward foods containing edible insects in their composition stated that they believed that consuming these foods would help solve world hunger and malnutrition (69.01 % of the total respondents), provide access to foods with a high concentration of n-3 fatty acids (76.61 % of the total respondents) and foods with high nutritional value, and meet a high demand for a source of protein (90.06 % of the total respondents) (tab. 2). The mean values of the scores obtained for the individual statements included on the scale of concern for food security and sustainability differed significantly in all groups of respondents differentiated by their stated attitudes toward foods containing edible insects in their composition. In the group with a declared negative attitude toward these foods, average values ranged from 1.92 to 2.21 points, in the group with an ambivalent attitude from 3.13 to 3.47 points, and in the group with a positive attitude from 3.87 to 4.29 points. A significant positive moderate correlation was observed between attitudes toward food containing edible insects and concern for food security and environmental sustainability, ranging from 0.42 for the statement on the impact of eating food containing insects on solving world hunger and malnutrition to 0.56 for the statements on sustainability in food production. In contrast, for the remaining statements, a significant positive strong correlation was observed between attitudes toward food containing edible insects and concern for food security and environmental sustainability, which ranged from 0.52 for the statement: "*Consuming foods containing edible insects in their composition (fresh, frozen, dried, powdered ones, e.g. meal) can solve problems such as ensuring access to foods with high concentrations of n-3 fatty acids and reducing greenhouse gas emissions*" to 0.56 for the statement: "*Consumption of foods containing edible insects (fresh, frozen, dried, powdered ones, e.g. meal) can have an impact on achieving sustainability in food production*" (tab. 2).

A previous study of a representative sample of an adult population found that the men who are more familiar with entomophagy pay more attention to the environmental impact of food, are convenience-oriented and are more willing to accept insects as a meat substitute. However, those with higher levels of food neophobia and disgust sensitivity and lower levels are less likely to eat insects [24]. Nonetheless, both studies showed that concern for environmental sustainability is very important for the population in Poland. Edible insects are generally rich in nutrients; they contain amounts of various nutrients such as protein, fat, fiber, vitamins and minerals that are comparable

to other animal-based foods [8]. Importantly, edible insects have been identified as a good alternative allowing to meet the increasing demand for protein sources due to the growing world population [1]. In addition, insect farming is more sustainable and environmentally friendly than other protein sources [1]. The livestock sector has been identified as one of the main contributors to climate changes due to high greenhouse gas and ammonia emissions from cattle, pigs and poultry. Therefore, large-scale insect production has been suggested as an alternative to meet the growing demand for livestock due to the rapid growth of the global population, without significant environmental impacts [8]. However, there are various barriers to accepting insects as food in different populations around the world. Due to high levels of insect aversion, indicated mean values for food neophilia and sushi acceptance, and low familiarity and experience with edible insects, the probability of accepting new foods with edible insects in the Portuguese population was 33.2 % and in the Norwegian population it was less than 50 % [31]. Wilkinson et al. [40] reported that only 17.8 % of Australians were willing to accept insects as food [40], while another study in Belgium found that 19 % of the population was willing to accept insects as a meat substitute [43]. Research on consumer acceptance of insects as food has shown demographic variation in acceptance rates and identified several common objections and perceived benefits [15].

Research on attitudes toward edible insects among younger Australians (Millennials and Generation Z) found that there was low willingness of Australian consumers to accept edible insects as a meat substitute, mainly due to strong psychological barriers such as neophobia and disgust, combined with perceived threats to masculinity. Also, environmental and nutritional benefits, even when recognized, did not influence young consumers in Australia to consider insects as an alternative to traditionally eaten foods [34]. The low percentage of young Polish consumers (Generation Z) showing positive attitudes toward entomophagy (tab. 1) coincides with the results of other studies presented above. However, in the near future, as young people, both in Poland and in other countries around the world, become more aware of sustainability and climate change issues related to zoonotic food production (cattle, pigs, poultry), the impact of the potential benefits of insect consumption on their positive attitudes may increase. In addition, providing the opportunity to taste foods made from or with insects and associated positive sensory experience may increase the acceptability of insects as food. The introduction of new processed insect-based products can help familiarize young consumers with such new food options.

The intention to purchase food containing edible insects had a significant impact on all statements regarding the willingness to consume food containing edible insects with the intention of food security and environmental sustainability (tab. 3). Those who declared the willingness to purchase food containing edible insects on statements

Table 2. Acceptance levels (assessed on a five-point scale, from 1 – "*definitely no*" to 5 – "*definitely yes*") for different forms of concern for food security and environmental sustainability as a function of the young consumers' segmentation according to attitudes towards foods containing edible insects

Tabela 2. Poziomy akceptacji (oceniane na 5-punktowej skali, od 1 - "*zdecydowanie nie*" do 5 - "*zdecydowanie tak*") dla różnych form troski o bezpieczeństwo żywnościowe i zrównoważony rozwój środowiskowy jako funkcja segmentacji młodych konsumentów w zależności od postaw wobec żywności zawierającej jadalne owady

Statements - CFS & ES Scale****/ Stwierdzenia – skala CFS & ES	Attitudes toward foods containing edible insects / Postawy wobec żywności zawierającej jadalne owady																
	No / Nie			I have no opinion / Nie mam zdania			Yes / Tak			Chi2	Median / Mediana			Mean±SD / Średnia ±SD			Spearman's R/ R Spearmana
	[%]																
	N*	A	P	N	A	P	N	A	P		N	A	P	N	A	P	
HM	60.50	27.83	16.37	19.75	27.98	14.62	19.75	44.19	69.01	Chi2=140,57; df=4; p<0.01	2.00	3.00	4.00	2.16^{a}±1.29	3.16^{b}±1.06	3.87^{c}±1.10	0.42
PC-FHNV	62.18	18.35	4.68	20.59	31.04	7.60	17.23	50.61	87.72	Chi2=295.30; df=4; p<0.01	1.50	4.00	4.00	2.08^{a}±1.23	3.37^{b}±0.96	4.23^{c}±0.81	0.54
HD-PS	57.14	15.90	2.92	21.85	27.68	7.02	21.01	56.42	90.06	Chi2=278.82; df=4; p<0.01	2.00	4.00	4.00	2.21^{a}±1.27	3.47^{b}±0.95	4.29^{c}±0.72	0.53
PC-FHCn-3FA	61.34	19.11	4.68	25.21	43.58	18.71	13.45	37.31	76.61	Chi2=278.65; df=4; p<0.01	1.50	3.00	4.00	2.03^{a}±1.17	3.20^{b}±0.88	3.98^{c}±0.77	0.52
SFP	65.55	21.71	5.26	26.89	43.73	14.04	7.56	34.56	80.70	Chi2=339.42; df=4; p<0.01	1.00	3.00	4.00	1.92^{a}±1.10	3.13^{b}±0.93	4.02^{c}±0.83	0.56
RGGE	61.34	20.34	3.51	25.63	39.60	15.79	13.03	40.06	80.70	Chi2=288.41; df=4; p<0.01	2.00	3.00	4.00	2.06^{a}±1.18	3.23^{b}±1.00	4.15^{c}±0.85	0.52

Explanatory notes:

*N – negative attitude, A – ambivalent attitude, P – positive attitude - attitude scale towards food containing edible insects; ** Values marked with different letters in rows are significantly different p<0.05; *** bold values are statistically significant; **** Statements – CFS & ES Scale (Concern for Food Security and Environmental Sustainability Scale): HM – hunger and malnutrition, PC-FHNV – providing access to foods with high nutritional value, HD-

PS – high demand for protein sources, PC-FHCn-3FA – providing access to foods with high concentrations of n-3 fatty acids, SFP – sustainability in food production, RGGE - reducing greenhouse gas emissions.

Objaśnienia:

*N – postawa negatywna, A – postawa ambiwalentna, P – postawa pozytywna – skala postaw wobec żywności zawierającej jadalne owady; ** Wartości oznaczone różnymi literami w wierszach różnią się istotnie $p<0.05$; *** pogrubione wartości są statystycznie istotne; **** Stwierdzenia skali CFS & ES (Skala Troski o Bezpieczeństwo Żywnościowe i Zrównoważony Rozwój Środowiskowy): HM - głód i niedożywienie, PC-FHNV – zapewnienie dostępu do żywność o wysokiej wartości odżywczej, HD-PS – wysoki popyt na źródła białka, PC-FHCn-3FA – zapewnienie dostępu do żywność o wysokim stężeniu kwasów tłuszczowych n-3, SFP – zrównoważony rozwój w produkcji żywności, RGGE – zmniejszenie emisji gazów cieplarnianych.

Table 3. Acceptance levels (assessed on a five-point scale, from 1 – "*definitely no*" to 5 – "*definitely yes*") for different forms of concern for food security and environmental sustainability as a function of the young consumers' segmentation depending on the intention to buy food containing edible insects

Tabela 3. Poziomy akceptacji (oceniane na 5-punktowej skali, od 1 - "*zdecydowanie nie*" do 5 - "*zdecydowanie tak*") dla różnych form troski o bezpieczeństwo żywnościowe i zrównoważony rozwój środowiskowy jako funkcja segmentacji młodych konsumentów w zależności od intencji zakupu żywności zawierającej jadalne owady

	Purchase intentions/ Intencje zakupu																
	No/ Nie			I have no opinion / Nie mam zdania			Yes/ Tak			Chi^2	Median / Mediana			Mean±SD / Średnia±SD			Spearman's R/ R Spearmana
Statements - CFS & ES Scale****/ Stwierdzenia – skala CFS & ES	[%]																
	N*	A	P	N	A	P	N	A	P		N	A	P	N	A	P	
HM	47.19	30.05	19.92	26.12	25.78	18.01	26.69	44.17	62.07	Chi^2=86.64; df=4; $p<0.01$	3.00	3.00	4.00	2.52^a±1.28	3.13^b±1.10	3.64^c±1.14	0.34
PC-FHNV	46.35	19.28	9.58	28.65	29.37	12.26	25.00	51.35	78.16	Chi^2=206.01; df=4; $p<0.01$	3.00	4.00	4.00	2.50^a±1.26	3.35^b±0.99	3.97^c±0.94	0.46
HD-PS	44.66	15.70	6.13	27.81	25.56	12.26	27.53	58.74	81.61	Chi^2=224.61; df=4; $p<0.01$	3.00	3.00	4.00	2.56^a±1.26	3.48^b±0.94	4.10^c±0.87	0.49

PC-FHCn-3FA	47.75	19.51	8.43	33.43	44.39	22.99	18.82	36.10	68.58	Chi^2=219.24; df=4; p<0.01	3.00	3.00	4.00	2.40^a±1.18	3.16^b±0.87	3.80^c±0.90	0.46
SFP	50.56	23.31	8.81	33.99	43.95	21.84	15.45	32.74	69.35	Chi^2=244.85; df=4; p<0.01	2.00	3.00	4.00	2.33^a±1.18	3.06^b±0.93	3.81^c±0.93	0.48
RGGE	48.88	20.18	8.05	30.90	39.46	23.37	20.22	40.36	68.58	Chi^2=207.54; df=4; p<0.01	3.00	3.00	4.00	2.42^a±1.23	3.22^b±1.00	3.89^c±0.98	0.45

Explanatory notes:

*N – negative attitude, A – ambivalent attitude, P – positive attitude – the scale of intention to purchase food containing edible insects; ** Values marked with different letters in rows are significantly different p<0.05; *** bold values are statistically significant; **** Statements – CFS & ES Scale (Concern for Food Security and Environmental Sustainability Scale): HM – hunger and malnutrition, PC-FHNV – providing access to foods with high nutritional value, HD-PS – high demand for protein sources, PC-FHCn-3FA – providing access to foods with high concentrations of n-3 fatty acids, SFP – sustainability in food production, RGGE – reducing greenhouse gas emissions.

Objaśnienia:

*N – postawa negatywna, A – postawa ambiwalentna, P – postawa pozytywna – skala intencji zakupu żywności zawierającej jadalne owady; ** Wartości oznaczone różnymi literami w wierszach różnią się istotnie p<0.05; *** pogrubione wartości są statystycznie istotne; **** Stwierdzenia skali CFS & ES (Skala Troski o Bezpieczeństwo Żywnościowe i Zrównoważony Rozwój Środowiskowy): HM – głód i niedożywienie, PC-FHNV – zapewnienie dostępu do żywność o wysokiej wartości odżywczej, HD-PS – wysoki popyt na źródła białka, PC-FHCn-3FA – zapewnienie dostępu do żywność o wysokim stężeniu kwasów tłuszczowych n-3, SFP – zrównoważony rozwój w produkcji żywności, RGGE – zmniejszenie emisji gazów cieplarnianych.

included on the scale of concern for food security and environmental sustainability were significantly more likely to answer "*yes*". The potential impact of consuming food containing edible insects in its composition on solving problems such as hunger and malnutrition was perceived by 62.07 % of the respondents, and on ensuring demand for protein sources by as many as 81.61 % of the respondents. On the other hand, those with a declared lack of intention to purchase food containing edible insects were significantly more likely than the others to answer "*no*" to all statements included on the scale of concern for food security and environmental sustainability (from 44.66 % for the statement on ensuring high demand for a protein source by food containing edible insects to 50.56 % for the statement on sustainability) (tab. 3).

The mean values of the scores obtained differed significantly among the three groups of respondents due to the stated intention to purchase foods containing edible insects in their ingredients. In the group characterized by no intention to purchase this type of food, the mean values ranged from 2.33 to 2.56 points, in the group with ambivalent intentions the mean values ranged from 3.06 to 3.48 points, and in the group that declared the willingness to purchase such food from 3.64 to 4.10 points. While young consumers in Poland declared the intention to purchase and consume insect food in the near future at a percentage greater than 60 %, cross-cultural studies showed that both Norwegian and Portuguese consumers declared that repulsion towards insects was the variable with the greatest negative impact on the acceptance of insects as food or feed. The reported level of disgust for insects was 76 % for Norway and 75 % for Portugal [31]. Lim [19] found a similar relationship among Malaysians, where insect consumption is historically documented. However, cultural and religious differences among Malaysians influenced the declared disgust toward entomophagy. It should be noted, however, that young Poles demonstrated the willingness to purchase and consume various forms of insect food (tab. 2), while in Norway and Portugal, food choice motivations such as convenience, health and ecological well-being had a minimal impact on the acceptance of insects as food and feed [31]. In addition, Ribeiro et al. [31] identified ideal profiles of consumers in Norway and Portugal accepting insects as feed: Norway – higher education, high (7 – "*Very important*") acceptance of sushi and high (7 – "*Very important*") scores for healthy food choices; Portugal – male, young (18 years old), high (7 – "*Very important*") acceptance of sushi and high (7 – "*Very important*") scores for food neophilia for Portugal. An analysis of the characteristics conducive to the acceptance of new products by Polish consumers in the 20 ÷ 44 age group showed that the degree of acceptance of new foods, including insects, seaweed and 3D printing technology, depended primarily on the taste, nutritional value and appearance of new food [27].

In addition, a survey of a representative group of adult Poles found that the acceptance of insects as an alternative to meat (general perspective) does not translate

into the willingness to buy and consume them (individual perspective). Polish consumers who declare the acceptance of insects as a meat substitute may not be willing to purchase insects for consumption [24].

The willingness to pay a higher price for food containing edible insects in its composition (fresh, frozen, dried, powdered ones, e.g. meal) proved to be a factor significantly ($p < 0.01$) influencing all tested items measuring concern for food security and environmental sustainability (tab. 4). This willingness was significantly higher in those with positive and ambivalent attitudes toward concern for food security and environmental sustainability (tab. 4). A very large percentage of respondents (almost 84 %) having positive attitudes said they were willing to pay a higher price for food containing edible insects in its composition (fresh, frozen, dried, powdered ones, e.g., meal) if the food had high nutritional value and was a response to ensuring the availability of protein sources. The mean values of the scores obtained were, for the most part, significantly different for the responses given to each statement by those showing positive attitudes toward concern for food security and environmental sustainability. Only for the statement "*Consuming food containing edible insects in its composition can have an impact on solving the problem of hunger and malnutrition in the world*" no significant differences were observed, as the mean values calculated from the answers given by the respondents displaying positive and ambivalent attitudes did not differ. The highest average values were obtained among those showing positive attitudes for the following statements: "*Consumption of foods containing edible insects (fresh, frozen, dried, powdered ones, e.g. meal)*" can: reduce greenhouse gas emissions, provide access to nutritious foods and provide high demand for protein sources (4.09 points, 4.12 points and 4.20 points, respectively) (tab. 4). Similar results were obtained in a previous survey of Polish consumers in the 20 to 44 age group [27]. That study revealed that consumers were quite skeptical of disruptive and radical nutritional innovations.

According to the majority of consumers surveyed by Piwowar et al. [27], added value, such as a positive environmental impact, did not outweigh the sensory qualities of the new food and the economic aspect. In Europe, due to strict regulations and a higher degree of inertia in new food adoption, production, commercialization and consumption, edible insects are less developed compared to other regions of the world [36]. It is suggested that future research on the economic acceptance of edible insects should explore three important issues: "*Insect production can help increase family incomes in low-income areas*," 2. "*Insects provide protein foods at low prices*"; 3. "*Currently, areas in Asia-Pacific and Latin America account for more than half of the market for edible insects*" which are key to the acceptance of new foods by consumers worldwide [6].

Table 4. Acceptance levels (assessed on a five-point scale, from 1 – " definitely no" to 5 – " definitely yes") for different forms of concern for food security and environmental sustainability as a function of the young consumers' segmentation depending on the willingness to pay a higher price for food containing edible insects

Tabela 4. Poziomy akceptacji (oceniane na 5-punktowej skali, od 1 – "zdecydowanie nie" do 5 – "zdecydowanie tak") dla różnych form troski o bezpieczeństwo żywnościowe i zrównoważony rozwój środowiskowy jako funkcja segmentacji młodych konsumentów w zależności od ich gotowości do zapłaty wyższej ceny za żywność zawierającą jadalne owady

Statements - CFS & ES Scale****/ Stwierdzenia – skala CFS & ES	Willingness to pay/ Gotowość do zapłaty																
	No/ Nie			I have no opinion / Nie mam zdania			Yes/ Tak			Chi^2	Median / Mediana			Mean±SD / Średnia±SD			Spearman's R / R Spearmana
	[%]																
	N*	A	P	N	A	P	N	A	P		N	A	P	N	A	P	
HM	39.03	16.02	19.38	22.70	35.36	13.27	38.27	48.62	67.35	Chi^2=63.82; df=4; p<0.01	3.00	3.00	4.00	2.88^a±1.26	3.41^b±0.97	3.78^b±1.21	0.28
PC-FHNV	31.76	8.84	11.22	26.02	30.94	5.11	42.22	60.22	83.67	Chi^2=105.06; df=4; p<0.01	3.00	4.00	4.00	3.02^a±1.23	3.60^b±0.89	4.12^c±1.07	0.38
HD-PS	28.95	6.63	6.13	24.11	25.41	10.20	46.94	67.96	83.67	Chi^2=94.71; df=4; p<0.01	3.00	4.00	4.00	3.11^a±1.22	3.75^b±0.83	4.20^c±0.93	0.40
PC-FHCn-3FA	32.15	11.05	7.14	36.22	41.44	18.37	31.63	47.51	74.49	Chi^2=100.58; df=4; p<0.01	3.00	3.00	4.00	2.87^a±1.13	3.44^b±0.86	3.94^c±0.89	0.38
SFP	35.71	9.94	9.18	36.61	39.23	16.33	27.68	50.83	74.49	Chi^2=130.49; df=4; p<0.01	3.00	4.00	4.00	2.78^a±1.16	3.48^b±0.85	3.91^c±0.95	0.44
RGGE	33.68	8.29	6.12	33.16	38.67	17.35	33.16	53.04	76.53	Chi^2=120.194; df=4; p<0.01	3.00	4.00	4.00	2.88^a±1.22	3.58^b±0.90	4.09^c±0.96	0.43

Explanatory notes:

*N – negative attitude, A – ambivalent attitude, P – positive attitude – willingness to pay a higher price for food containing edible insects; ** Values marked with different letters in rows are significantly different p<0.05; *** bold values are statistically significant; **** Statements - CFS & ES Scale (Concern for Food Security and Environmental Sustainability Scale): HM – hunger and malnutrition, PC-FHNV – providing access to foods with high

nutritional value, HD-PS – high demand for protein sources, PC-FHCn-3FA – providing access to foods with high concentrations of n-3 fatty acids, SFP – sustainability in food production, RGGE – reducing greenhouse gas emissions.
Objaśnienia:
*N – postawa negatywna, A – postawa ambiwalentna, P – postawa pozytywna – gotowość do zapłaty wyższej ceny za żywność zawierającą jadalne owady; ** Wartości oznaczone różnymi literami w wierszach różnią się istotnie $p<0.05$; *** pogrubione wartości są statystycznie istotne; **** Stwierdzenia skali CFS & ES (Skala Troski o Bezpieczeństwo Żywnościowe i Zrównoważony Rozwój Środowiskowy): HM – głód i niedożywienie, PC-FHNV – zapewnienie dostępu do żywność o wysokiej wartości odżywczej, HD-PS – wysoki popyt na źródła białka, PC-FHCn-3FA – zapewnienie dostępu do żywność o wysokim stężeniu kwasów tłuszczowych n-3, SFP – zrównoważony rozwój w produkcji żywności, RGGE – zmniejszenie emisji gazów cieplarnianych.

Conclusions

1. This study aimed to determine attitudes and intentions to consume and purchase foods containing edible insects among young consumers in Poland. The survey gives a better understanding of the attitudes, intentions and needs of young food consumers in Poland and, as a result, provides them with the kind of information about food products containing insects or the products themselves that they expect.
2. The young consumers having positive attitudes toward the purchase of, and purchasing intentions for, foods with insects expect these foods to be a source of protein and n-3 fatty acids. These nutrients are crucial for Generation Z in Poland to attempt to purchase and consume foods containing edible insects that are new to them.
3. The promotion of foods containing edible insects to young consumers in Poland should be based on presenting their nutritional value and emphasizing the role of nutrients in ensuring the health of society.
4. In addition, issues related to ensuring sustainability in food production and reducing greenhouse gas emissions are important for young consumers. Young Poles show concern for food security and environmental sustainability, which correlates with attitudes and intentions to consume and purchase foods containing edible insects in their composition (fresh, frozen, dried, powdered ones, e.g. meal). Hence, food security and environmental sustainability efforts based on studying the willingness of young consumers (Generation Z) to consume "new foods" containing edible insects in their composition (fresh, frozen, dried, powdered ones, e.g. meal) should be based on reliable information about the products themselves, including their nutritional value, as well as creating opportunities to taste these products.
5. Understanding young consumers' intentions to consume foods containing edible insects combined with their experiences with them is the most effective way to encourage consumers to purchase and consume foods containing insects.
6. The results obtained can contribute to efforts to promote the legitimacy of producing new foods containing edible insects in their composition.
7. Future research should take into account several other factors, including: gender, age, ethnic, cultural and religious background and a level of education, food neophobia, the feeling of disgust, the price of a product, the form of insects proposed for consumption, and food safety, which may affect the acceptance of insects as food by consumers in Poland.

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OWADY JADALNE JAKO POTENCJALNY PRODUKT SŁUŻĄCY OSIĄGNIĘCIU BEZPIECZEŃSTWA ŻYWNOŚCIOWEGO. CZĘŚĆ 1

S t r e s z c z e n i e

Wprowadzenie. Wykorzystanie owadów jadalnych jako źródła żywności dla ludzi stwarza liczne wyzwania demograficzne, środowiskowe, ekonomiczne i etyczne dla wielu społeczeństw. Konsumpcja żywności zawierającej w swoim składzie jadalne owady wymaga przede wszystkim jej akceptacji wśród konsumentów. Celem badania było ustalenie, czy postawy i intencje młodych konsumentów w Polsce (pokolenie Z) wobec żywności zawierającej w swoim składzie owady jadalne (świeże, mrożone, suszone, sproszkowane np. mączkę) mogą wpływać na troskę o bezpieczeństwo żywnościowe i zrównoważony rozwoju środowiskowy na świecie. Badanie przeprowadzono za pomocą specjalnie zaprojektowanego kwestionariusza, w którym zamieszczono stwierdzenia (15) zaadaptowane z publikacji naukowych innych autorów odnoszące się do: postaw wobec żywności z owadów (4), intencji zakupu żywności z owadów (4), gotowości do zapłaty wyższej ceny za żywność zawierającą owady, której wytwarzanie uwzględnia dbałości o środowisko (1), troski o bezpieczeństwo żywnościowe (4) i zrównoważony rozwój środowi-

skowy (2 items). Respondenci podczas badania wyrażali poziom aprobaty lub dezaprobaty wobec wszystkich zamieszczonych pozycji, posługując się 5-stopniową skalą Likerta.

Wyniki i dyskusja. Na podstawie badań ankietowych przeprowadzonych wśród młodych ludzi można stwierdzić, że akceptacja żywności zawierającej w swoim składzie owady jadalne, jako rozwiązania lub wsparcia problemu globalnego braku bezpieczeństwa żywnościowego, jest związana z postawami i intencjami spożywania i zakupu żywności zawierającej w swoim składzie owady jadalne (świeże, mrożone, suszone, sproszkowane, np. mączki). Zrozumienie intencji młodych konsumentów do spożywania żywności zawierającej jadalne owady w połączeniu z ich doświadczeniami z jadalnymi owadami jest najskuteczniejszym sposobem zachęcania konsumentów do kupowania i spożywania nowej żywności. Uzyskane wyniki mogą przyczynić się do promowania zasadności produkcji nowej żywności zawierającej w swoim składzie jadalne owady.

Słowa kluczowe: zrównoważony rozwój, entomofagia, postawy wobec żywności i żywienia, intencja spożycia, pokolenie Z w Polsce