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REVIEW ARTICLE

EDIBLE INSECTS AS A SOURCE OF HIGHLY DIGESTIBLE PROTEIN AND OTHER SELECTED NUTRIENTS IN HUMAN NUTRITION

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ABSTRACT

With the global population growing and the availability of traditional protein sources decreasing, insects are the subject of intensive scientific research as an alternative food source. Species recognized as safe for consumption by EFSA include the mealworm (*Tenebrio molitor*), the migratory locust (*Locusta migratoria*), the house cricket (*Acheta domesticus*), and the glossy mealworm (*Alphitobius diaperinus*). The aim of this article is to assess the nutritional value of approved insects and analyze their role in the daily human diet. The study was based on a review of the scientific literature in electronic databases: PubMed and Google Scholar. The search covered publications from 2015 to 2025. Review papers, research papers, and legal acts covering species that have been approved for marketing and included in the EU List of Novel Foods were included. Edible insects are characterized by a high-quality nutritional profile, characterized by a basic profile of unsaturated fatty acids, chitin, and minerals such as iron, zinc, magnesium, phosphorus, and selenium, as well as B vitamins. The main benefits of entomophagy include nutritional benefits, the ability to replenish nutritional and micronutrient deficiencies, and lipid profiles, as well as the additional burden of nutrients through food culture. Despite the many benefits, the main barriers to entomophagy remain, including food neophobia and safety concerns. Entomophagy, from a dietary, health and environmental perspective, may be a promising alternative to animal products, thanks to its attractive content of micro- and macronutrients.

Keywords: *entomophagy, novel food, edible insects, alternative protein, diet, health, nutritional value*

INTRODUCTION

Global population growth is an escalating issue, resulting in an increased demand for food and natural resources. According to the United Nations projections, the global population will exceed 9 billion by 2050, creating numerous challenges and constraints regarding environmental sustainability [1]. Feeding the entire population in the face of dwindling natural resources poses a challenge, making the search for alternative food sources a worthwhile endeavor. Food consumption and production – particularly the conventional production of meat and meat products – are associated with significant issues, such as high greenhouse gas emissions, intensive use of land and water resources, and biodiversity loss [2]. Animal-based products are a primary source of highly digestible protein, which is essential for the proper growth, development and functioning of the human body. Edible insects offer a promising solution to this problem, serving as a valuable alternative to conventional animal products and a source of high-quality protein [3].

The main barrier to introducing edible insects to the market remains the psychological factor, which is particularly pronounced in European countries. The intentional consumption of insects in Europe often meets with strong public opposition, as insects are viewed as pests rather than food – unlike in Asian cultures [4].

Until recently, entomophagy – the consumption of insects – was a practice primarily associated with the dietary traditions of Asian societies, where insects have been an integral part of the diet since prehistoric times, whereas in other parts of the world, their consumption was merely occasional [1]. Interest in insect consumption in Western countries is steadily growing, driven largely by expert publications from international organizations – specifically reports from the FAO (Food and Agriculture Organization) – that

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highlight the potential of insects as a food source [4]. Currently, more than 2,000 species of edible insects are consumed worldwide, most commonly belonging to the orders *Coleoptera* (beetles), *Lepidoptera* (butterflies and moths), *Hymenoptera* (bees, wasps, and ants), *Orthoptera* (locusts, crickets, and grasshoppers) and *Hemiptera* (true bugs) [1].

Under Regulation (EU) 2015/2283 of the European Parliament and of the Council, edible insects – whether as whole organisms or as food derived from their parts – are classified as "novel food" defined as "food that had not been consumed to a significant degree by humans in the Union" [5]. The Regulation mandates that placing novel food products on the market requires a formal safety assessment and authorization from the European Commission [5]. These provisions apply to edible insects and insect-derived products, encompassing whole organisms or parts thereof (e.g., legs) as well as derivatives such as extracts or protein isolates. Edible insects may only be placed on the market following the successful completion of the authorization process, primarily due to the lack of a history of safe consumption within the European Union prior to May 15, 1997. This procedure entails a risk assessment conducted by the European Food Safety Authority (EFSA), which considers factors such as potential allergenicity, microbiological contamination, and risks associated with rearing, handling, processing, and storage. Additionally, in 2015, EFSA published a scientific opinion on the use of insects as food and provided a list of insect species that could serve as potential food sources for both humans and animals [6]. Based on European Commission implementing decisions, the following have been authorized for the market: dried yellow mealworm larvae (*Tenebrio molitor)*; dried and frozen migratory locust (*Locusta migratoria*); house cricket (*Acheta domesticus*); and frozen and dried lesser mealworm larvae (*Alphitobius diaperinus)* [7].

The aim of this article is to present edible insects authorized for the market as an alternative source of high-quality protein and minerals in the human diet, and to evaluate their nutritional value and potential for human consumption. Additionally, the paper discusses the potential benefits of insect consumption – including high digestibility, amino acid profile, micro- and macronutrient content – and outlines prospects for utilizing entomophagy as part of a sustainable food system.

MATERIALS AND METHODS

This article was prepared based on a literature review and current legal acts.

Literature selection criteria

This publication was prepared based on a review of the scientific literature in electronic databases: PubMed and Google Scholar, using the following keyword combinations, in both English and Polish: "edible insects", "novel food", and "entomophagy". The search covered publications from 2015 to 2025. Peer-reviewed scientific articles – comprising both original research and reviews – were selected for analysis. The primary inclusion criterion was a focus on the nutritional value, consumer safety, and legal regulations concerning edible insects. The analysis covered publications in Polish and English. Popular science articles and opinion pieces were excluded from the review.

Analysis of legal acts

The legal status of edible insects was determined based on official legislative databases: EUR-Lex (for European Union law) and ISAP (for Polish law). All documents were analyzed in their current wording, reflecting the legal status as of 2026. The key legal bases are:

1. Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods [5],
2. Commission Implementing Regulation (EU) 2017/2470, establishing the Union list of novel foods, together with subsequent acts authorizing specific species [7].

Scope of the species analysis and its rationale

This study deliberately focuses exclusively on insect species that have been officially authorized for the EU market and included in the Union list of novel foods. This decision to narrow the scope stems from three reasons:

- Real-world market relevance: The article addresses the situation in Poland and the EU; therefore, describing species used only in Asia, for example, would be purely theoretical.
- Consumer safety: Species on the EU list have undergone detailed toxicological and allergenic assessments by EFSA, making them safe and viable ingredients in food products available in stores.
- Legal currency: The EU list is continuously updated with new decisions, allowing for a presentation of the actual, practical legal status of entomophagy in Europe.

NUTRITIONAL VALUE OF EDIBLE INSECTS

The nutritional value of insects varies widely. The biochemical composition of their tissues – including protein and lipid content – depends not only on the

insect's origin or developmental stage but also on the type of feed used [1, 3].

Human nutrition requires dietary diversity; however, products based on edible insects could provide optimal amounts of protein and energy [3]. Edible insects are particularly valued for their high protein content [1]. For the house cricket and the migratory locust, the protein content in dry matter exceeds 60%, which translates to approximately 15-25 g of protein per 100 g of fresh weight [8]. These values are very similar to those of conventional meat from livestock, where the average protein content ranges from 20 to 26 g per 100 g of product [1]. Due to their high protein content, edible insects can be considered an attractive alternative to traditional animal-based products (Table 1). Protein content is closely dependent on the insect's developmental stage [9]. The pupal stage is characterized by the lowest protein content, whereas the adult form has the highest [3].

Edible insect-based products can serve as a potential substitute for traditional meat products, falling into the category of alternative protein sources. By definition, these are protein sources that have not previously been used – or have been used only to a limited extent – for human or animal nutrition [8].

Unlike plant-based protein, insect-derived protein is a complete protein due to the presence of all essential amino acids, with threonine, valine, and tyrosine being the predominant ones [8, 9]. The content of essential amino acids in insects is generally high and, in many cases, comparable to levels found in traditional animal protein sources such as meat (Table 2). The digestibility of edible insect protein is similar to that of hen's egg protein, ranging from 77% to 98% [1, 8, 9].

The fat content of insects varies depending on the developmental stage and sex, ranging from approximately 4 to 25 g/100 g [1]. Larvae and pupae contain more lipids than adults; consequently, the caloric value is higher in younger individuals, ranging from approximately 80 to 200 kcal/100 g. Females contain more lipids than males, which also results in a higher caloric content [3].

Table 1. Protein content in selected types of edible insects* and meat

Species/meat type	Protein (g/100 g)
House cricket (*Acheta domesticus*)	15.4-17.5
Yellow mealworm (*Tenebrio molitor*)	25.0
Migratory locust (*Locusta migratoria*)	65.87
Lesser mealworm larvae (*Alphitobius diaperinus larvae*)	29.6
Pork (shoulder)	16.9
Poultry – turkey (breast)	19.2

* fresh weight

Source: Own elaboration based on [11, 15]

The lipid profile of edible insects is more favorable than that of poultry or fish fat. This is due to a higher content of polyunsaturated fatty acids (PUFA) – including linoleic acid, which is classified as an essential fatty acid – and monounsaturated fatty acids (MUFA), such as oleic acid. The highest content of this fatty acid was observed in the house cricket (*Acheta domesticus*) and the yellow mealworm (*Tenebrio molitor)*; in these species, the levels were significantly higher than in meat (Table 3) [1, 8, 9].

The ratio of polyunsaturated to saturated fatty acids (SFA) is an important indicator of fat quality, and its recommended value in the diet should exceed 40% of the amount of saturated acids. Fat from insect species such as house crickets (*Acheta domesticus*) and mealworms (*Tenebrio molitor*) have a more favorable ratio of polyunsaturated fatty acids to saturated fatty acids (PUFA/SFA) than most meats, except for chicken breast and drumstick (Table 3) [9]. Additionally, edible insects are characterized by high cholesterol content [1].

Edible insects are characterized by a low carbohydrate content compared to the meat of slaughter animals, but they contain large amounts of dietary fiber [9]. It largely occurs in the form of an insoluble polysaccharide – chitin, the content of which in edible insect tissues ranges from 11.6-137.2 mg/kg dry matter [1].

Table 2. Content of selected amino acids in selected types of edible insects* and meat

Species/meat type	Threonine (mg/100 g)	Valine (mg/100 g)	Tyrosine (mg/100 g)
House cricket (*Acheta domesticus*)	680	1050	1100
Yellow mealworm (*Tenebrio molitor*)	770	1280	1370
Migratory locust (*Locusta migratoria*)	1251	2700	3820
Lesser mealworm larvae (*Alphitobius diaperinus larvae*)	1276	1705	2513
Pork (shoulder)	966	927	622
Poultry – turkey (breast)	994	953	618

* fresh weight

Source: Own elaboration based on [11, 15]

Table 3. Comparison of the fatty acid group content in selected types of edible insects* and in meat

Fatty acids	House cricket (*Acheta domesticus)*	Yellow mealworm *(Tenebrio molitor*)	Migratory locust *(Locusta migratoria)*	Lesser mealworm larvae *(Alphitobius diaperinus larvae)*	Pork (shoulder)	Poultry – turkey (breast)
MUFA (g/100 g)	1.77	2.51	3.80	5.90	3.26	0.33
PUFA (g/100 g)	4.28	5.85	2.50	3.70	0.58	0.15
SFA (g/100 g)	2.51	2.32	3.60	3.50	2.74	0.22
PUFA/SFA ratio	1.70	2.52	0.69	1.06	0.21	0.68

* fresh weight
Source: Own elaboration based on [11, 16]

Table 4. Comparison of mineral and vitamin content in selected types of edible insects* and in meat

Minerals and vitamins	House cricket (*Acheta domesticus)*	Yellow mealworm *(Tenebrio molitor*)	Migratory locust *(Locusta migratoria)*	Lesser mealworm larvae *(Alphitobius diaperinus larvae)*	Pork (shoulder)	Poultry – turkey (breast)
Calcium (mg/100 g)	36.6	42.9	29-31	45.0	4.1	2.0
Zinc (mg/100 g)	6.8	4.33-4.95	14-19	7.5	2.2	0.8
Copper (mg/100 g)	0.51	0.83	3.4-3.8	0.9	0.1	0.05
Manganese (mg/100 g)	0.89	0.32	0.33-0.35	0.4	0.01	0.01
Magnesium (mg/100 g)	22.6	62-92	53-55	68.0	15.6	35.0
Potassium (mg/100 g)	285.0	337.0	410-500	380.0	293.6	460.0
Sodium (mg/100 g)	110.0	53.7	82-110	115.0	50.0	47.0
Phosphorus (mg/100 g)	219.0	264-368	420-460	310.0	130.4	238.0
Iron (mg/100 g)	2.12	2.47	4.1-4.7	2.8	0.9	0.5
Vitamin C (mg/100 g)	1.8	1.8-9.9	-**	-**	0	0
Vitamin E (mg/100 g)	0.64	1.31-1.9	2.81-3.33	1.5	0.33	0.02
Vitamin B_1 (mg/100 g)	0.24	0.18	0.07-0.08	0.2	0.49	0.04
Vitamin B_2 (mg/100 g)	1.66	0.81-1.21	1.2-1.42	1.1	0.23	0.15
Vitamin B_{12} (µg/100 g)	0.87	0.47	0.62-1.21	0.6	0.57	0.70

* dry matter; ** no data available
Source: Own elaboration based on [10, 11, 16]

The content of minerals and vitamins varies depending on the species and order of the insect [1]. Regardless of the species and development stage, insects have a higher content of calcium, zinc, copper and manganese than meat. The minerals contained in insects have a high nutritional density in relation to their caloric value [3, 9]. However, maximizing the health benefits of consuming insects requires consuming them in their entirety. Due to the psychological barrier and consumer reluctance, it is recommended to serve them in powdered form as an ingredient of traditional food products [3].

Migratory locusts *(Locusta migratoria),* house crickets (*Acheta domesticus*) and mealworms (*Tenebrio molitor)* are a source of many macro and micronutrients, including zinc, magnesium, potassium, sodium, calcium, phosphorus, manganese and copper [1]. Edible insects are also a rich source of iron. The content of this element in insects can be compared with the content in traditional meat from farm animals (Table 4). For example, 100 g of mealworm (*Tenebrio molitor)* contains approx. 2.5 mg of this micronutrient, while pork or poultry provides on average approx. 0.5-1 mg of iron per 100 g of product (Table 4) [1]. It is worth noting that edible insects, regardless of their developmental stage or species, exhibit higher levels of tocopherol than meat and can serve as a source of vitamin C, which is virtually absent in conventional meat [3]. They also serve as a source of B vitamins, particularly riboflavin. Adult house crickets (*Acheta domesticus*) are the richest source of this vitamin [3, 9, 10]. Larvae of the mealworm (*Tenebrio molitor)* and the house cricket (*Acheta domesticus*) also contain cobalamin in amounts comparable to those found in meat (Table 4) [1].

HEALTH IMPLICATIONS AND DIETARY CHALLENGES

The high content of key micro- and macronutrients in edible insects offers numerous potential health benefits. Beyond addressing the challenges of a growing global population and potential food shortages – where insects could serve as an alternative food source – they can also be used to fortify diets with high-quality protein. This is particularly relevant for diets low in animal products but rich in cereal proteins, which often lack sufficient levels of essential amino acids – such as lysine, threonine, and tryptophan – all of which are abundant in insect meat [3]. Insects can also serve as a base for high-protein products used to enrich meals with protein that is highly bioavailable to the human body. Such high-protein products are primarily used in cases of wasting diseases or malnutrition, but also during weight loss, strength training and febrile illnesses. Understanding the nutritional composition of edible insects can aid in planning diets with specific energy values and formulating meals with precisely defined nutrient content, thereby contributing to overall improvements in human health and physical condition [3].

Improvements in human health associated with the consumption of edible insects may stem from their higher levels of tocopherol and vitamin C – compared to animal meat – as well as their elevated riboflavin content. These properties make edible insects a valuable dietary component, particularly for supplementing daily intake in cases of deficiency. Individuals at particular risk of such deficiencies include heavy alcohol consumers and the elderly. Furthermore, insects are rich in cobalamin; deficiencies in this nutrient are observed in people suffering from type 2 diabetes, gastric disorders (primarily peptic ulcers and acid reflux), and intestinal diseases such as Crohn's disease or celiac disease [3].

Additionally, edible insects are a rich source of biologically active compounds, primarily antimicrobial peptides, chitin, and lauric acid. These substances exhibit immune-stimulating properties. In-depth studies on the composition and nutrient content of insects have revealed the presence of polyphenols and flavonoids [11]. These compounds are responsible for anti-inflammatory and antioxidant effects, as well as for eliminating or inhibiting the growth of microorganisms and bacteria. The high content of these compounds means that insects are used to enhance both the nutritional value and the antioxidant potential of the products to which they are added. Experimental addition of cricket flour to muffins resulted not only in a significant increase in protein content but also in reduced carbohydrate content and a lower glycemic index compared to muffins without the insect flour [12]. An increase in antioxidant activity and polyphenol levels was observed alongside the increase in added flour; furthermore, consumers rated the sensory qualities of the baked product positively.

Although edible insects contain many nutrients essential to the human body, particular attention is paid to the risk of allergies and the potential accumulation of pesticides and heavy metals in their tissues. It has been shown that consumers may develop allergies to chitin or proteases, as well as respiratory allergies or cross-reactions – primarily between insects and crustaceans (such as shrimp, snails, crabs, and shellfish), mollusks, and house dust mites. These are IgE-mediated reactions that can trigger characteristic symptoms within minutes of consumption – such as runny nose, asthma, hives, and angioedema – potentially leading to anaphylactic shock; therefore, proper labeling of products containing edible insects is crucial [13]. The international non-profit organization IPIFF (International Platform of Insects for Food and Feed) has published a guide proposing best practices for labeling products containing edible insects in the EU, in compliance with EU regulations on novel

foods (Regulation (EU) 2015/2283) and food labeling (Regulation (EU) 1169/2011). Key IPIFF labeling requirements include clearly identifying the insect species present in the product, providing information and warnings regarding allergens, ensuring ingredient transparency, and clearly communicating to the consumer the use and presence of ingredients derived from whole insects or insect parts. The organization focuses on ensuring that labels are transparent, legible, and easy for the consumer to understand.

Furthermore, a risk analysis of entomophagy must consider chemical hazards associated with the presence of heavy metals, PCBs, mycotoxins, and plant toxins in edible insects. High concentrations of these substances may result from bioaccumulation in insect tissues or from the presence of chemical compounds in rearing substrates and insect feed [14]. Microbiological hazards linked to the presence of microorganisms also raise concerns. In European Union countries, edible insect farming is conducted under strictly controlled conditions and in compliance with appropriate sanitary standards; consequently, the microbiological risk is significantly lower than in less developed countries. Insect processing relies primarily on heat treatment, as well as freezing, drying, or fermentation, followed by crushing, grinding, or pulverizing. While evisceration and/or heat treatment are recommended during processing to substantially reduce the risk of microbiological contamination, removing the viscera is practically impossible for most species. Further research and the development of insect processing techniques are required to significantly reduce microbiological contamination levels before insects are incorporated into food products [14].

SUSTAINABLE DEVELOPMENT AND THE FUTURE OF DIETETICS

A diet that combines health-promoting and environmentally friendly qualities is known as the Planetary Health Diet. This nutritional model promotes the health of both people and the planet. It combines health benefits – such as a reduced incidence of lifestyle diseases – with environmental stewardship, primarily through the reduction of greenhouse gas emissions and the conservation of resources. It relies chiefly on plant-based foods while significantly limiting red meat and processed foods. The Planetary Health Diet not only benefits the human body but also supports ecological sustainability and the well-being of the planet.

An important aspect contributing to the "health" of the planet is the breeding of insects, which is more profitable and ecological, compared to cattle or poultry farming, but also safer, because insects pose a small risk of transmitting zoonotic diseases to humans. Insect farms take up over 200 times less space than farm animal farms, and additionally, the space where the farm can be located can be any, both internally and externally. Indoor breeding involves placing insect species in specially designed facilities, Outdoor rearing, on the other hand, is conducted using forest waste – such as sawdust – or in close proximity to old trees [11]. Furthermore, the insects are fed organic waste; this enhances the ecological profile of their rearing compared to traditional livestock farming, as it utilizes environmental waste and thereby reduces pollution. There is also a significant financial advantage: the insects' primary food sources – such as leaves, bran, and fruit or vegetable scraps – are regarded as waste by the agricultural industry, making them a low-cost raw material. The low technical and capital investment required to maintain a farm provides a socio-economic incentive that facilitates the inclusion of insects in diets within impoverished nations. Water consumption is another crucial factor; compared to crop cultivation or livestock farming, it is hundreds of times lower. Some insect species obtain sufficient water from fruits or vegetables, while others require only small amounts provided in a drinker. High greenhouse gas and ammonia emissions are among the primary environmental impacts of meat production, yet these are generated to a significantly lesser extent during the rearing of edible insects. Meat production accounts for approximately 20% of global greenhouse gas emissions and is a major driver of climate change; consequently, insect farming can be considered a particularly beneficial solution from an environmental perspective.

Given the ever-growing global population, a key advantage of edible insects is their highly efficient metabolism and ability to convert feed into protein. Insects assimilate nutrients more effectively, allowing them to generate significantly more biomass from dry feed than livestock; this makes them an attractive alternative to conventional meat. Producing 1 kg of beef protein requires 14 times more space and 5 times more water than producing 1 kg of insect protein. Available data indicate that insect farming is both ecologically and economically viable, contributing to sustainable food production [14].

Currently, the long-term impact of insect consumption on human health is not sufficiently understood. Existing reports focus on nutritional value, micro- and macronutrient content, and short-term safety. However, no studies have yet been conducted to evaluate the effects of regular insect consumption on metabolism, the cardiovascular system, or immunity. Literature emphasizes the need for further research on humans before insects become a common and approved ingredient of the daily diet.

CONCLUSIONS

Faced with rapid population growth and ongoing climate change, the search for alternative protein sources has become a necessity. In this context, edible insects represent a resource with immense potential, combining health, environmental, and economic benefits. Their production is far more efficient and places less strain on the environment than traditional livestock farming, making them a viable tool in the quest for global food security.

From a nutritional standpoint, entomophagy can serve as a significant source of high-quality protein – rich in essential amino acids (such as lysine and tryptophan) – as well as valuable fatty acids and fiber. Consequently, insects can perfectly complement plant-based diets and serve as a foundation for innovative high-protein products that help improve public health habits.

However, psychological factors remain the primary barrier to popularizing this "food of the future" in Europe. Consumer prejudices, food neophobia, and health safety concerns (e.g., allergy risks) contribute to the controversial perception of edible insects. A promising avenue for their widespread adoption in the food industry lies in the use of processed, inconspicuous forms such as insect flour – combined with ongoing education regarding novel foods. Although currently a niche component, they could become a key alternative to meat products in the future, making a tangible contribution to the well-being of generations to come.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. Browarek J. Wykorzystanie mąki z owadów w produkcji żywności [Use of insect flour in food production]. In: Materiały 51 Międzynarodowego Seminarium Kół Naukowych, Seminarium innowacyjnych rozwiązań w dobie pandemii. Aktualne Problemy Badawcze Tom 1. Nauki Biomedyczne i Techniczne.. Poznań: Wydawnictwo FNCe; 2022. p. 116-127. [in Polish].
2. Aidoo OF, Osei-Owusu J, Asante K, Dofuor AK, Boateng BO, Debrah SK, et al. Insects as food and medicine: a sustainable solution for global health and environmental challenges. Front Nutr. 2023;10:1113219. doi: 10.3389/fnut.2023.1113219.
3. Orkusz A. Owady jadalne – żywność przyszłości [Edible insects – Food of the future]. Nauki Inz Tech. 2021;1(38):42-55. [in Polish].
4. Bartkowicz J. Tri-City Consumers Attitudes towards Eating Edible Insects as an Alternative Source of Food. Handel Wewn. 2017;1(366):156-166.
5. Szeja N. Entomofagia – aspekty żywieniowe i psychologiczne [Entomophagy – Nutritional and psychological aspects]. Kosmos. 2019;68(3):489-501. [in Polish].
6. Regulation (EU) 2015/2283 of the European Parliament and of the Council of 25 November 2015 on novel foods, amending Regulation (EU) No 1169/2011 of the European Parliament and of the Council and repealing Regulation (EC) No 258/97 of the European Parliament and of the Council and Commission Regulation (EC) No 1852/2001. OJ L 327, 11.12.2015, p. 1-22.
7. EFSA Scientific Committee. Risk profile related to production and consumption of insects as food and feed. EFSA J. 2015;13(10):4257. doi: 10.2903/j.efsa.2015.4257.
8. Commission Implementing Regulation (EU) 2017/2470 of 20 December 2017 establishing the Union list of novel foods in accordance with Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods. OJ L 351, 30.12.2017, p. 72-201.
9. Wiza PL. Charakterystyka owadów jadalnych jako alternatywnego źródła białka w ujęciu żywieniowym, środowiskowym oraz gospodarczym [Characteristics of edible insects as an alternative source of protein in terms of nutrition, environment and economy]. Postepy Tech Przetw Spozyw. 2019;1:108-113. [in Polish].
10. Orkusz A. Edible Insects versus Meat-Nutritional Comparison: Knowledge of Their Composition Is the Key to Good Health. Nutrients. 2021;13(4):1207. doi: 10.3390/nu13041207.
11. Purkiewicz A, Browarek J. Owady jadalne – aspekt dietetyczny i poznawczy [Edible insects – dietary and cognitive aspects]. Zesz Nauk WSG Tur Rekr. 2023;44:113-128. [in Polish].
12. Zielińska E, Baraniak B, Karaś M. Antioxidant and anti-inflammatory activities of hydrolysates and peptide fractions obtained by enzymatic hydrolysis of selected heat-treated edible insects. Nutrients. 2017;9(9):970. doi: 10.3390/nu9090970.
13. Buczyłko K, Majsiak E, Wagner A. Alergia na owady nie-błonkoskrzydłe [Allergy to non-hymenopteran insects]. Alergia Astma Immunol. 2015;20(4):175-184. [in Polish].
14. Zarzyńska J, Zabielski R. Entomofagia – jedzmy owady? [Entomophagy – let's eat insects?]. Zycie Wet. 2022;97(3):164-169. [in Polish].
15. Nachtigall L, Grune T, Weber D. Proteins and Amino Acids from Edible Insects for the Human Diet – A Narrative Review Considering Environmental Sustainability and Regulatory Challenges. Nutrients. 2025;17(7):1245. doi: 10.3390/nu17071245.
16. EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA); Turck D, Castenmiller J, De Henauw S, Hirsch-Ernst KI, Kearney J, Maciuk A, et al. Safety of frozen and dried formulations from migratory locust (*Locusta migratoria*) as a Novel food pursuant to Regulation (EU) 2015/2283. EFSA J. 2021;2;19(7):e06667. doi: 10.2903/j.efsa.2021.6667.

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