NUTRITIONAL ASPECTS OF SOME NEW FOOD RESOURCES

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REVIEW

Abstract

Following the bibliographic investigation, significant conclusions about the nutritional features of the chosen dietary supplies were drawn. The results of the systematic study showed that although edible insects have long been a part of the human diet, some societies still have a strong distaste for eating them. The majority of edible insects are currently found in forest habitats (31% of edible insects are beetles; 18% are caterpillars; 14% are bees, wasps, and ants; 13% are grasshoppers and crickets; 10% are cicadas, plant insects, and scale insects; 3% are termites; and 2% are dragonflies). However, advances in mass rearing systems are beginning to show more and more promise in more countries.

According to the study, insects are a significant source of nutrition. The majority of edible insects have been found to offer a dietary source that is high in energy, protein, fats that are rich in essential fatty acids, and vitamins that are high in riboflavin, pantothenic acid, biotin, and folic acid. These findings highlight the potential significance of incorporating insects into human nutrition. Essential trace elements include magnesium, phosphorus, zinc, iron, selenium, copper, and iron. This breakthrough creates a great deal of opportunity for both developed and developing nations to connect traditional knowledge with contemporary science.

Keywords: edible insects, new food resources, nutritional.
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INTRODUCTION

The global agricultural and food system is a complex space with many interdependences and interconnections, involving many actors, processes, relationships, and even events that are difficult to predict. Both the agricultural system and the food system must evolve rapidly as complex relationships on traceability from farm to fork and various environmental and socio-economic factors become increasingly evident.

The growing global demand for meat and restrictions on available resources are driving the search for alternative sources of protein, and the sustainability of meat production is the subject of intense debate.

Although eating insects has always been a part of the human diet, certain tribes have a strong distaste for it. The majority of edible insects are harvested from forests, while many nations are pioneering the development of mass breeding programs. In both rich and developing nations, insects present a significant chance to connect traditional knowledge with contemporary research (Alvees et al, 2016; Berg et al, 2017).

Edible insects are an interesting alternative source of protein for both human and animal feeding, given their low greenhouse gas emissions, high feed conversion efficiency, low land use, and the ability to harness organic secondary flows into high-value protein products (Mariutti et al, 2021). Although more than 2,000 species of insects are eaten mainly in tropical regions, the role of edible insects in the livelihood and nutrition of populations in these countries is under threat (FAO, 2010; Ghosh, 2023). In the Western world, interest in edible insects is growing, and this is supported by concrete examples. In particular, aquatic insects are considered to have substantial potential for inclusion in human and animal nutrition (van Huis, 2016).

To meet the continued expansion of food demand in recent years, total food production must increase by around 70% by 2050 compared to 2009. In this context, the goal of this study was to characterize some new dietary resources, such as edible insects, and to shape the current state of the consumption literature, as well as the potential benefits and challenges of incorporating them into the diet.

MATERIAL AND METHOD

This work is a preliminary bibliographic study on various nutritional aspects of some of our food resources, and it proposes to investigate key aspects of these components as they become increasingly significant in human nutrition.

Based on chemical composition data obtained through the systematic analysis of a large number of articles from specialized

literature and the analysis of expert opinions relevant to the study, a detailed picture of the nutritional characteristics of our food resources, as well as the potential benefits and challenges of incorporating them into human diets, has been presented.

Materials that have served as the foundation for the development of solid knowledge and the establishment of a research foundation have been represented by scientific articles, books, or research reports that have been accessed both through the institution's own document repository, the Anelis Plus database, and through online access to scientific databases.

RESULTS AND DISCUSSIONS

New vs. conventional food resources. New food sources involve resources that have not been widely consumed, either because their consumption has historically been restricted to certain regions of the world or because they have recently emerged in the global retail space due to technological innovations. New food production systems reflect innovations or advances in pre-existing food technologies directly involved in the production of some of the new foods that find their way into the current context. Some of the new food sources and food production systems have been explored, describing both their benefits and their challenges (EFSA, 2015). Conventional food resources are food sources that have been consumed by communities and cultures over time and that usually have profound cultural and historical significance.

These resources are often adapted to the local environment and climatic conditions and are passed on from one generation to the next through traditional and conventional cultivation, fishing, or hunting practices (Zeltzin et al, 2021).

Local edible plants—certain wild or locally grown plants—are used in conventional cuisine to prepare dishes and drinks. Local animal products, such as meat, milk, eggs, and other products of animal origin, are often an integral part of the conventional diet. They can come from domestic animals raised in regions or from wild animals, depending on local availability and traditions. Certain cereal and legume crops, such as rice, wheat, corn, beans, or lentils, can often be fundamental to conventional diets in different parts of the world (FAO, 2022).

The nutritional characteristics of new food resources. Of the categories of new food resources, insects are an important source of nutrients, being adequate to meet the requirements of the human body, which underscores the potential importance of their integration into human nutrition (Bernard & Womeni, 2017; Tang et al, 2019).

The nutritional value of edible insects is extremely diverse due to the large number and variability of species. Nutritional values can vary considerably even within the same group of insects, depending on the stage of metamorphosis, the origin of the insect, and its diet (Kourimska, 2016). Also, the nutritional value may change depending on the processing and preparation before consumption (drying, cooking, roasting, etc.). According to Payne et al. (2016), the nutritional composition of insects shows a great diversity between species. The nutritional value score of greyhounds, palm goat larvae, and flour worms was significantly healthier than that of beef and chicken, and none of the six insect species tested was statistically less healthy than meat (Conway et al, 2024).

Most edible insects provide a sufficient energy and protein intake in the human diet while meeting the amino acid requirements (Rumpold et al, 2013; Zhou et al, 2022). Known for their high fat content and richness in essential fatty acids (Figure 1), insects are also important sources of essential trace elements such as Mg, P, Zn, Fe, Se, Cu, and Fe (Figure 2), as well as vitamins such as riboflavin, pantothenic acid, biotin, and folic acid (Figure 3) (Kourimska & Adamkova, 2016; Adamkova et al, 2016).

The systematic analysis of the bibliographic study on the nutritional aspects of selected food resources has highlighted that although edible insects have long been integrated into the human diet, there is still a certain aversion to their consumption in certain societies.

Currently, data show that most edible insects are obtained from forest habitats, but innovations in mass breeding systems are beginning to be increasingly promising in more and more countries.

Globally, the most commonly eaten insects are cockroaches (*Coleoptera*), with a share of 31%. This is not surprising, considering that this group comprises about 40% of all known insect species. The consumption of shrimp (*Lepidoptera*), especially popular in sub-Saharan Africa, is estimated at 18%. Bees, calves, and ants (*Hymenoptera*) ranked third with 14%, and these insects are common in Latin America. It is followed by locusts and greys (*Orthoptera*) with 13%; cycades, plant

insects, scallops, and true insects (*Hemiptera*) account for 10%; termites (*Isoptera*), 3%; libelules (*Odonata*), 3%; and flies (*Diptera*), 2%; and other species (5%) (Figure 4).

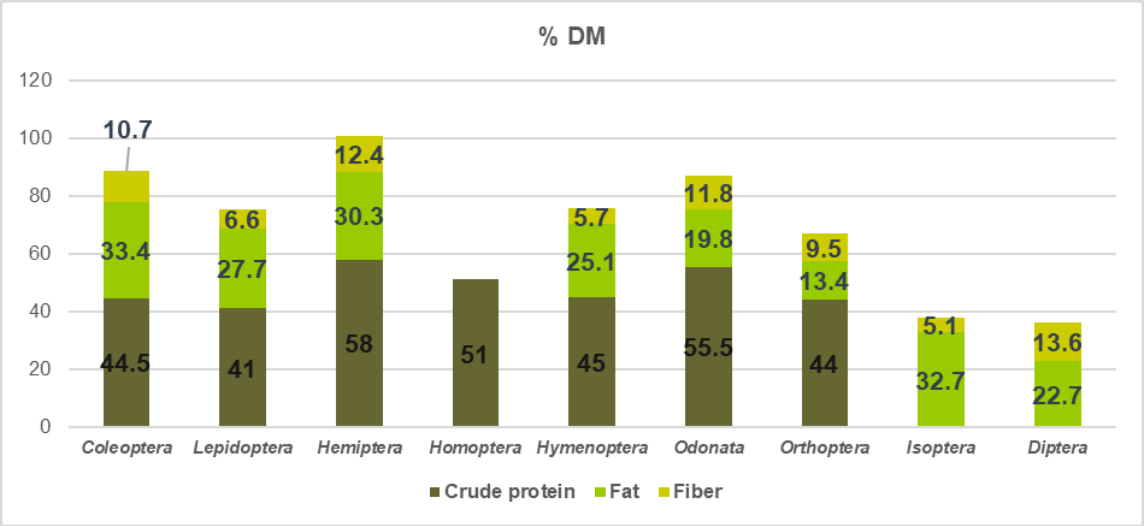
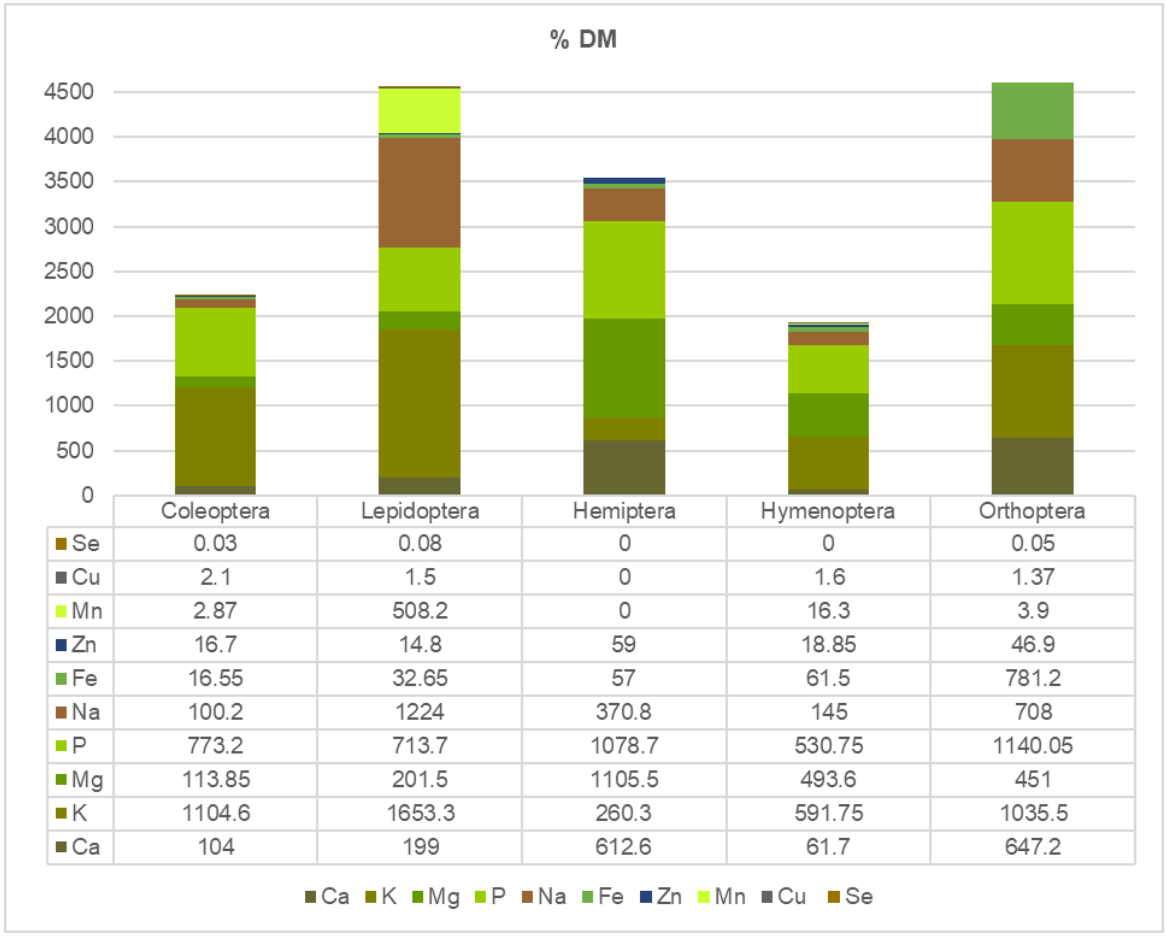
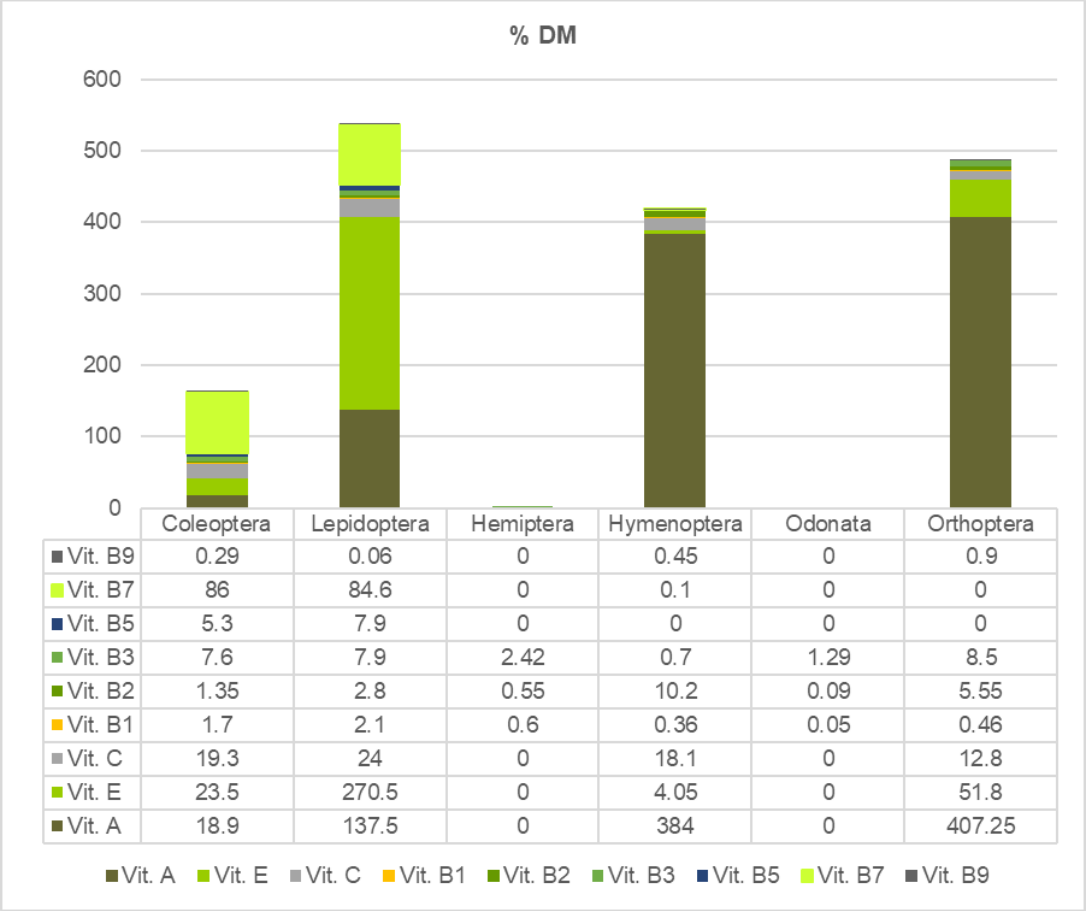


Figure 1 Chemical composition of macronutrients of insect species
(processed average data according to Xiaoming et al, 2010; no data found for CP for *Isoptera* and *Diptera* or Fat and Fiber for *Homoptera*)



	Coleoptera	Lepidoptera	Hemiptera	Hymenoptera	Orthoptera
Se	0.03	0.08	0	0	0.05
Cu	2.1	1.5	0	1.6	1.37
Mn	2.87	508.2	0	16.3	3.9
Zn	16.7	14.8	59	18.85	46.9
Fe	16.55	32.65	57	61.5	781.2
Na	100.2	1224	370.8	145	708
P	773.2	713.7	1078.7	530.75	1140.05
Mg	113.85	201.5	1105.5	493.6	451
K	1104.6	1653.3	260.3	591.75	1035.5
Ca	104	199	612.6	61.7	647.2

Figure 2 Mineral composition of edible insects
(processed average data according to Rumpold & Schluter, 2013)



	Coleoptera	Lepidoptera	Hemiptera	Hymenoptera	Odonata	Orthoptera
Vit. B9	0.29	0.06	0	0.45	0	0.9
Vit. B7	86	84.6	0	0.1	0	0
Vit. B5	5.3	7.9	0	0	0	0
Vit. B3	7.6	7.9	2.42	0.7	1.29	8.5
Vit. B2	1.35	2.8	0.55	10.2	0.09	5.55
Vit. B1	1.7	2.1	0.6	0.36	0.05	0.46
Vit. C	19.3	24	0	18.1	0	12.8
Vit. E	23.5	270.5	0	4.05	0	51.8
Vit. A	18.9	137.5	0	384	0	407.25

Figure 3 Vitamin composition of edible insects
(processed average data according to Rumpold & Schluter, 2013)

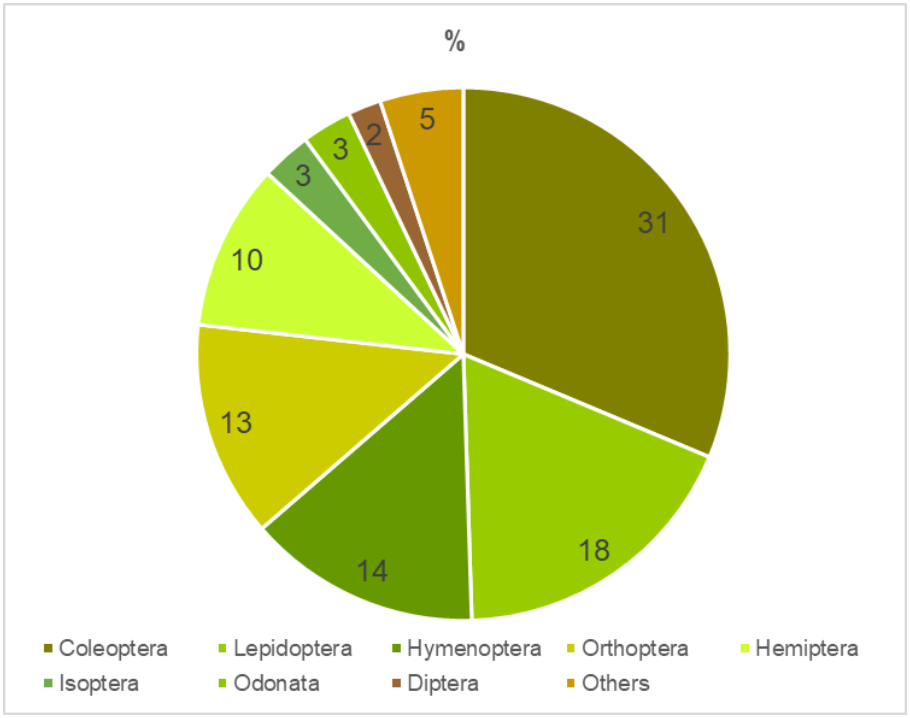


Figure 4 Percentage of insects often eaten globally
(processed data according to Cerritos, 2009)

The consumption of lepidopters is predominantly in the form of omelets, and for hymenopters, the intake is higher, especially in their larval or pupal stages. Both the adult and the larvae of the *Coleoptera* order are eaten, while the *Orthoptera*, *Homoptera*, and *Isoptera* orders are mainly eaten at the maturity stage (Cerritos, 2009).

Potential benefits and challenges of Potential benefits and challenges of integrating new food resources into the diet. Populations around the world are facing serious nutrition and health problems. It is estimated that more than 150 million preschool children suffer from chronic malnutrition, caused by inadequate diets and poor living conditions. Every year, more than 3 million young children die due to malnutrition, either due to a lack of adequate nutrition or a lack of essential micronutrients in the diet. These alarming figures underline the importance of paying attention and having adequate resources to combat these global public health and food security issues (FAO, 2013).

The prevalence of micronutrient deficiency, also known as "hidden hunger," affects a significant number of over 2 billion people, according to a IFPRI report. According to research by Black et al. (2013), this problem is acute in low-income countries, where a lack of iron and zinc is a major concern, contributing to the emergence of conditions such as anemia and growth delay. Similarly, Saini et al. (2016) highlighted that iron and zinc deficiencies are often associated with the predominance of herbal diets, in which not only are levels of iron and zinc reduced, but the bioavailability of these minerals may also be reduced due to the presence of phytic acid, which binds these minerals. Given that iron and zinc are more bioavailable in foods of animal origin, exploring alternative options, such as edible insects, could play a significant role in improving the quality of diets and combating micronutrient deficiencies (Aguilar-Toala et al, 2022).

Edible insects have been identified as a source of bioactive compounds that have the potential to reduce health risks and strengthen the immune system. Studies have demonstrated the presence of these compounds in insects, and their bioactive characteristics could bring significant health benefits. However, it is important to stress that health benefits must be sufficiently documented to be properly supported (Finke et al, 2015; Roos & van Huis, 2017).

Similar to bioactive compounds identified in other foods, it is necessary that the effects of these compounds in insects on health be studied rigorously (Belluco et al, 2023). Direct studies conducted on human subjects are usually a prerequisite for validating the health benefits of these compounds. Therefore, more research is needed to fully understand the impact of potentially bioactive compounds identified in insects on human health.

This additional research will help strengthen our knowledge of the health benefits of eating insects and provide essential information for promoting their use in human food in a sustainable and responsible way.

According to the literature, edible insects contain bioactive compounds that can present a wide spectrum of bioactivities beneficial to human health. These bioactivities include anti-hypertensive, antioxidant, antimicrobial, anti-inflammatory, and immunomodulatory effects. Studies have shown that different species of edible insects have been tested in this regard using in vitro tests and in vivo models, both with whole insect extracts and with isolated compounds. These findings suggest that eating edible insects could have significant benefits for human health due to their content of bioactive compounds.

In most studies, antioxidant activity is the most commonly evaluated biological activity of bioactive compounds in edible insects.

However, it is important to continue research to better understand how insects and their bioactive compounds can be used effectively in the prevention and management of these diseases. It is also essential to consider other aspects, such as the proper processing and preparation of insects for consumption, as well as possible allergies or adverse reactions associated with their use (Stull, 2021).

Although studies mostly show positive and neutral results, it is important to recognize that there are potential risks associated with insect consumption. Allergies are among the most significant risks, as some people may be sensitive to insect proteins and may develop allergic reactions (Stull et al, 2018). There are also food safety concerns, including microbiological or chemical contamination of insects, as well as the presence of antinutrients that could affect the absorption of nutrients.

Like other products of animal origin, the consumption of insects can pose health risks, and proper processing is essential to minimize these risks. Thermal treatments are recommended to reduce the microbial risks associated with insect consumption.

Microbial contamination can be a particular concern in the processing, storage, and transport stages of edible insects. The natural microflora of insects can promote the growth of dangerous microorganisms, such as *Enterobacteriaceae*, known to cause food-borne diseases.

However, it is important to stress that risks can be managed by proper processing and handling of insects for consumption. Thus, compliance with strict hygiene and food safety rules is crucial for reducing the risks associated with the consumption of insects. It is also necessary to continue research to properly identify and assess all potential risks and to develop appropriate practices and regulations with regard to insect consumption (EFSA, 2015).

Generally, provided they are processed and handled properly, insects known to be edible are considered safe for consumption. However, it is important for consumers to be aware of the potential risks and to follow food safety recommendations when eating insects.

In this regard, it should be noted that most research has focused on two species of edible insects: the yellow flour worm (Tenebrio molitor) and the homemade grey (Achetadomesticus). These two species are considered among the most promising for industrial applications and large-scale production and are already approved for human consumption in Europe.

CONCLUSIONS

The consumption of insects as an alternative source of protein presents both benefits and risks, both in the long and short term.

These benefits include aspects such as sustainability, helping to reduce environmental impact; nutritional aspects, providing a nutritious and affordable alternative to other sources of protein; and efficiency, which can help reduce the costs and greenhouse gas emissions associated with food production.

However, there are also risks associated with the consumption of insects, such as allergies and risks related to food safety and microbiological contamination. As for the psychological and cultural aspects, in many societies, there is still a strong aversion to the consumption of insects, which can prevent their adoption as the main source of food.

In general, eating insects can be a promising option to address issues related to food safety, sustainability, and food security, but it is important to continue research to fully understand their impact on human health and the environment.

This development opens up opportunities to associate conventional knowledge with modern science, both in developed and developing countries. A balanced perspective addressing both benefits and risks is essential to ensuring that insect consumption is an informed and sustainable choice for consumers.

REFERENCES

Adamkova, A., Kourimska, L., Borkovcova, M., Kulma, M. & Mlcek, J., 2016. Nutritional values of edible coleoptera (Tenebrio molitor, Zophobas morio and Alphitobius diaperinus) reared in the Czech Republic. Potravinarstvo, 10(1), 663-671.

Aguilar-Toala, J.E., Cruz-Monterrosa, R.G. & Liceaga, A.M., 2022. Beyond Human Nutrition of Edible Insects: Health Benefits and Safety Aspects. Insects, 13 (11), 1007.

Alves, A.V., Sanjinez-Argandona, E.J., Linzmeier, A.M., Cardoso, C.A. & Macedo, M.L., 2016. Food Value of Mealworm Grown on Acrocomia aculeata Pulp Flour. PLoS ONE, 11(3), e0151275.

Belluco, S., Bertola, M., Montarsi, F., Di Martino, G., Granato, A., Stella, R., Martinello, M., Bordin, F. & Mutinelli, F., 2023. Insects and Public Health: An Overview. Insects, 14 (3), 240.

Berg, J., Wendin, K., Langton, M., Josell, A. & Davidsson, F.K., 2017. State of the Art Report Insects as Food and Feed. Ann Exp Biol, 5(2), 1-9.

Bernard, T. & Womeni H.M., 2017. Entomophagy: Insects as Food, InTechOpen, Insect Physiology and Ecology. Agric Biol Sci, 232-253.

Cerritos, R. 2009. Insects as food: an ecological, social and economical approach. CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources. Agr Food Sci Environ Sci, 4(27), 1–10.

Conway, A., Jaiswal, S. & Jaiswal, A.K., 2024. The Potential of Edible Insects as a Safe, Palatable, and Sustainable Food Source in the European Union. Foods, 13(3), 387.

EFSA Scientific Committee, 2015. Risk profile related to production and consumption of insects as food and feed. EFSA Journal, 13(10), 4257.

EFSA, 2021. Safety of frozen and dried formulations from whole housecrickets (Acheta domesticus) as a Novel food pursuant to Regulation (EU) 2015/2283, EFSA Journal.

FAO, 2021. Looking at edible insects from a food safety perspective. Challenges and opportunities for the sector. Food and Agriculture Organization of the United Nations, 1-90.

FAO. 2022. Thinking about the future of food safety – A foresight report. Food and Agriculture Organization, 1 – 158.

Finke, M.D., Rojo, S., Roos, N., van Huis A. & Yen, A.L., 2015. The European Food Safety Authority scientific opinion on a risk profile related to production and consumption of insects as food and feed. J Insects Food Feed, 1(4), 245-247.

Ghosh, S., Meyer-Rochow, V.B. & Jung, C., 2023. Embracing Tradition: The Vital Role of Traditional Foods in Achieving Nutrition Security. Foods, 12(23), 4220.

Glew, R.H., Jackson, D., Sena, L., VanderJagt, D.J., Pastuszyn, A., & Millson, M. 1999. Gonimbrasia belina (Lepidoptera: Saturniidae), a nutritional food source rich in protein, fatty acids and minerals. Am Entomol 45(4), 250–253.

Kourimska L. & Adamkova, A., 2016. Nutritional and sensory quality of edible insects. NFS Journal, 4, 22-26.

Mariutti, L.R.B., Rebelo, K.S., Bisconsin-Junior, A., de Morais, J.S., Magnani, M., Maldonade, I.R., Madeira, N.R., Tiengo, A., Marostica Jr., M.R. & Cazarin, C.B.B., 2021. The use of alternative food sources to improve health and guarantee access and food intake. Food Res Int, 149, 110709, 1-22.

Nguyen, P., Kim, K.Y., Kim, A.-Y., Kim, N.-S., Kweon, H., Ji, S.-D. & Koh, Y.H., 2016. Increased healthspan and resistance to Parkinson's disease in Drosophila by boiled and freeze-dried mature silk worm larval powder. J Asia-Pacific Entom, 19(2), 551-561.

Payne, C.L.R., Scarborough, P., Rayner, M. & Nonaka, K. 2016.Are edible insects more or less 'healthy' than commonly consumed meats? A comparison using two nutrient profiling models developed to combat over- and undernutrition. Eur J Clin Nutr, 70, 285–291.

Rocillo-Aquino, Z., Cervantes-Escoto, F., Leos-Rodriguez, J.A., Cruz-Delgado, D. & Espinoza-Ortega, A., 2021. What is a traditional food? Conceptual evolution from four dimensions. J Ethn Foods, 8, 38.

Roos, N. & van Huis, A., 2017. Consuming insects: are there health benefits?. Journal of Insects as Food and Feed, 3(4), 225-229.

Rumpold, B.A., & Schluter, O.K., 2013. Nutritional composition and safety aspects of edible insects. Mol Nutr Food Res, 57, 802–823.

Schabel, H.G. 2010. Forest insects as food: a global review, In Durst, P.B, Johnson, D.V., Leslie, R.N.& Shono, K., eds. Edible Forest Insect: Humans Bite Back. Proceedings of a workshop on Asia-Pacific resources and their potential for development, Bangkok. Food and Agriculture Organization.

Stull, V.J., Finer, E., Bergmans, R.S., Febvre, H.P., Longhurst, C., Manter, D.K., Patz, J.A., & Weir, T.L., 2018. Impact of Edible Cricket Consumption on Gut Microbiota in Healthy Adults, a Double-blind, Randomized Crossover Trial. Sci Rep 8(1), 10762.

Stull, V.J., 2021. Impacts of insect consumption on human health. J Insects Food Feed, 7(5), 695-713.

Tang, C., Yang, D., Liao, H., Sun, H., Liu, C., Wei L. & Li, F., 2019. Edible insects as a food source: a review. Food Production, Processing and Nutrition, 1, 8.

van Huis, A., 2016. Edible insects are the future?. Proceedings of the Nutrition Society, 75(3), 294–305.

van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G. & Vantomme, P., 2013. Edible insects: future prospects for food and feed security. FAO Forestry Paper, 1-187.

Xiaoming, C., Ying, F., Hong, Z. & Zhiyong, C. 2010. Review of the nuritive value of edible insects, Proceedings of a Workshop on Asia-Pacific Resources and Their Potential for Ddevelopment. FAO Regional Office for Asia and the Pacific, 34-40.

Zhou, Y., Wang, D., Zhou, S., Duan, H., Guo, J. & Yan, W., 2022. Nutritional Composition, Health Benefits, and Application Value of Edible Insects: A Review. Foods, 11(24), 3961.

Zielinska, M., Deren, K., Polak-Szczybylo, E. & Stepien, A.E., 2021. The Role of Bioactive Compounds of Nigella sativa in Rheumatoid Arthritis Therapy-Current Reports. Nutr 25, 13(10), 3369.