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A comprehensive overview of edible crickets: nutritional composition, health benefits, and safety considerations

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Abstract

Edible crickets (Orthoptera) are recognized as a sustainable and nutrient-dense food source, which can be used to address food security and environmental challenges. These insects comprise high-quality protein, essential amino acids, unsaturated fatty acids, dietary fiber, B vitamins, and essential minerals. The cricket protein has a biological value, net protein ratio, a protein efficiency ratio, and protein digestibility-corrected amino acid score of approximately 93.02%, 3.04, 1.78%, and 73%, respectively. Apart from their nutritional composition, these insects offer various health benefits, such as reducing the risk of metabolic disorders, improving gut health, and supporting the immune system. Currently, studies have shown that edible insects can be utilized in the food industry and hospitality sector in various applications, including protein powders, baked goods, snacks, and meat analogues. However, several challenges exist to the widespread adoption of crickets, including sensory attributes, cultural perceptions, allergenicity, microbial safety, and regulatory concerns. This review summarizes the nutritional composition, functional health benefits, and food applications of edible crickets, while highlighting associated risks and safety considerations.

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Introduction

Globally, protein consumption and preference patterns are changing, primarily driven by demographic shifts, urbanization, and socio-economic advancements, particularly in low- and middle-income countries[1]. The per capita meat consumption has increased by approximately 3% per year since the mid-1990s, particularly in developing and emerging economies[2]. It is predicted that there will be a sustained increase in meat consumption[3]. However, the meat industry faces several challenges, including resource depletion, labor shortages, public health consequences, rising operational costs, diseases and biosecurity risks, climatic vulnerabilities, changing consumer demand for healthier and more sustainable products, and environmental concerns such as deforestation and greenhouse gas emissions[4]. This leads to a shift toward alternative protein sources that have low environmental footprints, while also offering health and economic co-benefits.

Edible insects are commonly consumed in various parts of Africa, Asia, and Latin America, and are emerging as a globally promising solution to fulfill the protein demand. They can offer dietary diversification and nutritional fortification, particularly in regions suffering from hidden hunger[5]. A study has identified that 2,205 species of insects are consumed across 128 nations[6]. Insects are rich sources of high-quality proteins, lipids, dietary fibers, and essential micronutrients. Insects offer enhanced feed conversion ratios, shortened life cycles, and higher edible biomass yields, producing significantly lower greenhouse gas emissions. They require minimal inputs of land, water, energy, and feedstocks compared to conventional animal husbandry[7]. Additionally, insects offer several benefits, including enhanced food security, alternative feed sources, and nutrient-enriched fertilizers that improve agricultural productivity and resilience[8]. The insect value chain can provide employment opportunities, particularly for marginalized demographics[9]. Due to these attributes, and increasing consumer demand for eco-friendly proteins, the edible insect sector is expected to experience exponential growth.

It is observed that Africa, China, India, and Thailand consume around 500, 324, 255, and 164 species of edible insects, respectively. These insects belong to the orders Coleoptera (beetles), Lepidoptera (moths and butterflies), Hymenoptera (ants, bees, and wasps), Orthoptera (grasshoppers, locusts, and crickets), and Hemiptera (true bugs). This demonstrates that a broad taxonomic spectrum is used for culinary applications[10]. Among these, Orthopterans, particularly crickets, have emerged as the most widely consumed insects due to their accessibility, palatability, and nutritional density[11]. *Brachytrupes membranaceus* (African field cricket), *Gryllus similis* (Jamaican field cricket), *Gryllus bimaculatus* (two-spotted cricket), *Gryllotalpa orientalis* (oriental mole cricket), and *Acheta domesticus* (house cricket) are consumed across multiple continents for their dietary roles[10]. In Africa, crickets are used to complement nutrient-poor staples, and address seasonal food shortages[12]. Similarly, cricket consumption is increasing in Europe, North America, and Australia due to its contributions to nutritional security and sustainability[13].

Crickets are rich in high-quality proteins, essential amino acids, lipids, particularly monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA), as well as mineral elements (e.g., iron, zinc, calcium), carbohydrates, and caloric energy[7]. The cricket has a biological value of 93.02%, a net protein ratio of 3.04, a protein efficiency ratio of 1.78%, and an amino acid score of 0.91[14]. Crickets can thrive on agro-byproducts and weeds, promoting waste valorization and environmental remediation[15].

Despite these advantages, several challenges exist in utilizing crickets as a food source, including variability in nutritional value, sensory perceptions, and the scalability of farming, as well as potential health risks such as allergens or contaminants. Traditional societies use whole crickets, whereas Western consumers prefer processed forms, such as powders or flours, to mitigate visual and textural barriers[16,17]. The consumer acceptance of edible insects varies and is influenced by cultural norms, neophobia, and familiarity with the product. Thus, this review primarily focuses on the nutritional composition and potential health benefits of edible crickets. Additionally, the manuscript also addresses the safety considerations, consumer acceptance, and regulatory perspectives regarding cricket entomophagy.

Methodology

A comprehensive literature search was conducted to identify studies related to nutritional, health, and safety prospects of consuming edible crickets. Databases, including Web of Science, Scopus, PubMed, Google Scholar, EBSCO, and Medline, were searched up to July 2025. The search strategy used a combination of relevant keywords and Boolean operators. The keywords used were: 'entomophagy', 'edible insects', 'insect protein', 'crickets', '*Brachytrupes membranaceus*', '*Gryllus similis*', '*Gryllus bimaculatus*', '*Gryllotalpa orientalis*', '*Acheta domesticus*', 'nutrition', 'amino acid', 'micronutrients', 'digestibility', 'bioavailability', 'health benefits', 'functional food', 'cardiovascular health', 'metabolic health', 'gut microbiota', 'oxidative stress', 'allergenicity', 'safety', 'consumer acceptance', and 'regulatory aspects'. Boolean operators (AND, OR, NOT) were used to combine terms and refine the search for higher precision. In addition to database searches, the reference lists of all included articles and relevant reviews were manually screened to identify additional studies. Only peer-reviewed articles published in English were included. Eligible studies included *in vitro* and *in vivo* studies regarding the nutritional composition and bioactive components. Additionally, human clinical studies evaluating physiological effects or health outcomes associated with the consumption of edible crickets were included in the manuscript. Studies focusing exclusively on animal feed, insect farming technologies, or non-nutritional applications were excluded. From the selected studies, relevant information was extracted and presented in a narrative review, while studies related to clinical trials were summarized in Table 1. However, the narrative review may have limitations, including the lack of formal inclusion-exclusion criteria, the absence of meta-analysis, restriction to English-language publications, study quality, and risk of bias.

Nutritional value of edible crickets

Edible crickets are a rich source of macronutrients and micronutrients; however, their nutritional profile is not uniform and can vary depending on various factors, including species, developmental stage, habitat, climate, sex, diet, and processing methods. The nutritional compositions of various species of crickets are presented in Table 2. The protein content of house cricket ranges from 15.1% to 75.34%; this wide difference is due to the varied processing conditions. The present study demonstrates that frozen house crickets contain less protein content than dried and defatted ones. Additionally, the crude protein content of dried and partially defatted cricket products was determined using the Kjeldahl method, with a conversion factor of 6.25; however, literature recommends using 5.57 and 5.33, respectively, to account for chitin-derived non-protein nitrogen. This also contributes to the high protein content in these two products[18]. This highlights that the protein content of crickets is higher than that of roasted goat, broiler chicken, and pork; therefore, it is a potential option for individuals with protein deficiencies[10]. The protein digestibility of *A. Domesticus* (adult) ranges from 80.36% to 85.28%[19,20], which is lower than that of eggs and beef but higher than many plant sources, such as sorghum, wheat, rice, and maize[7]. However, the oven-drying method results in a reduction in protein digestibility. *In vitro* DIAAS for blanched *A. domesticus* was 92, which is lower than that of chicken and balanced *Tenebrio molitor* larvae. However, there is a significant impact of processing conditions on DIAAS, for example, a reduction in chitin in *A. domesticus*, resulting in a substantial decrease in DIAAS. This indicates that the protein quality of *A. domesticus* is excellent, allowing it to be incorporated into the diet of 6-month-old children[21]. The protein digestibility-corrected amino acid score (PDCAAS) of cricket powder was reported as 73%, with threonine identified as the first limiting amino acid and a true protein digestibility of 81% in young male weanling albino rats[14]. *A. domesticus* and G. *bimaculatus* are good sources of essential amino acids (EAAs), including valine (3.50–4.50 g/100 g protein), leucine (3.80–3.88 g/100 g), and lysine (2.89–3.22 g/100 g). Crickets can provide lysine (2.89–3.22 g/100 g), threonine (1.65–1.69 g/100 g), and tryptophan (0.27–0.43 g/100 g)[22], which are deficient in cereal- and tuber-based diets. This demonstrates that crickets can be used to mitigate malnutrition when incorporated into local meals.

The amino acid digestibility demonstrated that during the intestinal phase of *in vitro* digestion, it clearly indicates that both the nutrient composition and bioavailability differ substantially between cricket protein and whey protein. At the onset of the intestinal phase (0 min), the digestibility of most amino acids in cricket protein ranged between 40%–59%, whereas whey protein exhibited comparatively higher values (approximately 61%–65%), reflecting its inherently higher solubility and susceptibility to enzymatic hydrolysis. Over the digestion period, a progressive increase in digestibility was observed in both samples. However, the rate and extent of digestion was significantly higher for whey protein. After 120 min, the total amino acid digestibility of cricket protein reached 79.64% ± 2.16%, while whey protein achieved near-complete hydrolysis (98.38% ± 2.19%). Essential amino acids digestibility remained lower in cricket protein (78%–82%), compared to whey protein (97%–99%). This may be due to higher content of chitin and complex protein–polysaccharide matrices in insect-derived proteins, which may limit enzymatic accessibility, and thus reduce amino acid bioavailability[23].

The lipids are composed of triglycerides for energy storage, and phospholipids for cellular functions. The lipid content of crickets ranges from 6–34 g/100 g dry weight, with higher levels observed in nymphs of *G. assimilis* and lower levels in *Acheta Testacea*[10]. The fatty acid composition emphasizes health-promoting unsaturated fats; for example, the range of polyunsaturated fatty acids is 4.33–

Table 1. Impact of cricket consumption on various health outcomes.

Intervention	Dosage	Duration	Subject	Outcome	Ref.
Pumpkin spice muffin and dry mix chocolate malt shake containing dried, roasted cricket powder	Total daily intake of 25 g (shake containing 10 g of cricket powder and muffins containing 15 g of cricket powder)	Randomized, double-blind, crossover trial, with two 14-d intervention periods, and a 14-d washout period	Twenty healthy adults aged between 20 to 48	Acetate level in the stool was reduced to 2.31 uM/g, and propionate levels were reduced to 0.58 uM/g. No significant changes observed in excreted bile acids or fecal triglycerides. *Bifidobacterium animalis* level increased by a log fold of 5.7. *Lactobacillus reuteri* and two other lactic acid-producing bacteria (LAB) levels decreased by 3 to 4. Reduced plasma TNF-α	[34]
Porridge containing maize, millet, and 5% cricket powder	250 ml of porridge	A single-blind, randomized, controlled dietary intervention for 6 months, every 5 d of the week	One hundred and thirty-eight children aged between 3–4.5 years	Hemoglobin levels increased from 11.93 g/dl to 13.10.05 g/dl to 13.59 g/dl ($p = 0.02$)	[35]
Intrinsically [^{57}Fe]-labeled and control house crickets (*Acheta domesticus*) powder consumed with refined (low-phytate, noninhibiting) or nonrefined (high-phytate, inhibiting) meals	Two portions of 400–450 g each	Two-time blocks of 3 consecutive days, separated by 2 weeks	Twenty iron-depleted Dutch females with serum ferritin levels under 25 µg/L, aged 18–30 years old	The fractional iron absorption (FIA) from meals containing ^{57}Fe-labeled crickets was 3.06% (95% CI: 1.75–4.37). Meals with unlabeled crickets combined with $^{54}FeSO_4$ showed a higher absorption of 4.92% (95% CI: 3.59–6.25). The reference meal fortified with $^{58}FeSO_4$ demonstrated the highest absorption, at 14.2% (95% CI: 12.9–15.5)	[36]
Maize-based meals with intrinsically 67Zn-labeled house crickets (*Acheta domesticus*) (2.61 mg Zn); meals containing 68Zn (low-enriched: 0.90 mg Zn; high-enriched: 3.24 mg Zn, or with intrinsically 67Zn-labeled low-chitin cricket flour (2.51 mg)	Twenty grams of cricket flour	Single-center, single-blind, randomized crossover trial with a one-month washout period between test meals	Twenty-five pre-school Kenyan children aged between 24 and 36 months	Whole cricket meal: 0.36 mg (geometric mean; 95% CI: 0.30–0.43 mg). Low-enriched maize meal: 0.14 mg (95% CI: 0.11–0.16 mg). The cricket meal resulted in 2.6 times higher absorbed zinc compared to the low-enriched meal ($p < 0.001$). Low-chitin cricket meal exhibited similar available zinc to the whole-cricket meal. Both cricket-enriched meals outperformed the high-enriched $ZnSO_4$ meal in performance	[37]
Beverages containing 25 g of cricket protein	Twenty-five grams of insect protein	Two occasions separated by a minimum interval of 1 week	Twenty healthy, active young men	The adjusted mean postprandial incremental area under the curve (iAUC) was higher for cricket-derived protein in relation to plasma leucine, branched-chain amino acids, and essential amino acids concentrations (all $p < 0.0001$). The adjusted mean postprandial iAUC for hunger was lower for cricket-derived protein (−1197 (SE: 525), $p = 0.02$). The adjusted mean *ad libitum* energy intake was recorded as 4,408 (SE: 316) kJ for cricket-derived protein ($p = 0.30$)	[38]
Drinks enriched with cricket protein after one-legged resistance exercise	0.25 g protein per kilogram of fat-free mass	A randomized, single-blind, parallel trial consisting of one experimental day	Fifty healthy young men, aged 18–30, with a BMI ranging from 18.5 to 30	Cricket protein resulted in lower circulating levels of amino acids. Cricket protein elevates plasma amino acids above baseline. No significant differences were observed in mTORC1 activation among whey, cricket, or pea protein. Cricket proteins stimulate mTORC1 signaling	[40]
Pancakes with an addition of 20% and 30% *A. domesticus* flour	One 240-kcal serving of pancakes	One-meal test session. Assessment of satiety and hunger levels using a Visual Analogue Scale (VAS) at multiple intervals throughout 3 h after eating	Seventy-one healthy volunteers ($n = 39$ women, $n = 32$ men)	*A. domesticus* flour (20% and 30% Cr) suppressed the feeling of hunger quickly and for an extended period. Pancakes with 20% cricket and 30% cricket are the most satisfying	[39]

58.37 g/100 g dry matter[24,25]. The present study found that the PUFA/SFA ratio of *Gryllus testaceus* was 3.49, which demonstrates that cricket consumption may reduce low-density lipoprotein cholesterol[26]. It has been observed that *Brachytrupes spp* comprises approximately 13.29 ± 1.61 g/100 g dry weight of fiber[27]. The significant component of edible cricket fiber is insoluble chitin, which is present in the exoskeleton of the edible crickets[7,28]. Crickets provide 18.10–537.50 kcal/100 g of calories based on dry weight[10], varying from species to species, such as 18.10 kcal/100 g found in *Gryllus testaceus*, while other species have a high energy value[10]. These energy- and protein-rich foods are particularly beneficial for populations suffering from protein-energy malnutrition.

Crickets are a good source of minerals, for example *G. bimaculatus* had high levels of phosphorus (1,169.6 mg/100 g DM), potassium (1,079.9 mg/100 g DM), sodium (452.99 mg/100 g DM), calcium (240.17 mg/100 g DM), and magnesium (143.65 mg/100 g DM), with zinc (22.43 mg/100 g DM) and manganese (10.36 mg/100 g DM). Similarly, *Teleogryllus ema* and *A. domesticus* exhibited relatively good quantities of phosphorus, potassium, calcium, and magnesium, with significant iron (8.75–10.75 mg/100 g DM) and zinc contents (18.47–20.22 mg/100 g DM). Whereas, the iron content of *Tarbinskiellus portentosus* is 122.5 mg/100 g dry matter. This suggests that it can be used as a dietary intervention for combating iron deficiency[10]. Cricket adults and nymphs have less than 1,000 IU/kg of vitamin A[31]. The Recommended Dietary Allowance (RDA) of vitamin A for men and women is 3,000 and 2,333 IU/day, respectively[32]. Studies have shown that the thiamine and riboflavin content of cricket (adult) is 0.4 mg per 100 g, and 3.41 mg per 100 g of dry weight[31]. Vitamin B12 is essential for neurological function and the production of red blood cells. Cricket adults and nymphs can provide a significant amount of vitamin B12 (5.37–8.72 µg per 100 g)[31]. The RDA of vitamin B12 is 2.4 to 2.8 µg for adults, and 0.4 to 2.8 µg for infants, children, and adolescents[33]. This indicates that a 100 g serving of crickets can provide a significantly higher amount

Table 2. Nutritional composition of edible crickets and their comparison with animal foods (data is adapted from the following studies[10,18,22,29,30]).

Nutrients	*A. domesticus*	*G. bimaculatus*	*Gryllodes sigillatus*	Pork	Chicken	Lamb
Proximate (g/100 g DW)						
Energy (kcal/100g)	147.0–455.50	120.00	452.00	233.00	143.00	282.00
Crude protein	15.40–76.19	58.30–60.70	56–71.15	48.97	64.80	40.99
Lipid/fat	3.30–43.90	11.88–23.40	14.92–18.23	48.26	30.22	57.78
Carbohydrates	1.60–11.80	0.1	0.10–4.83	0.00	0.15	0.00
Fiber	3.90–10.20	9.53–10.00	3.65–7.10	–	–	–
Chitin	5.40–8.34	9.77	3.4	–	–	–
Ash	3.00–11.50	2.8	4.35–18.10	2.56	4.37	2.14
Essential amino acids (g/100 g of protein)						
Valine	0.05–4.50	3.20	5.20	5.00	4.50	2.32
Isoleucine	0.04–4.45	2.16	2.66–3.70	4.90	4.20	2.38
Leucine	0.07–6.50	3.97	5.78–6.90	7.50	6.90	3.86
Lysine	0.05–5.40	2.42	3.84–5.30	7.90	7.80	3.84
Threonine	0.74–3.60	2	3.50–3.68	5.10	3.70	2.52
Phenylalanine	0.03–3.00	1.83	2.20–3.10	4.10	2.50	2.40
Methionine	0.01–1.40	0.27	1.59–1.60	2.50	2.10	1.63
Histidine	0.02–2.25	2.5	1.72–2.20	3.20	4.40	1.87
Tryptophan	0.13–0.68	–	0.9	–	–	–
Unsaturated fatty acids (g/100 g DM)						
Myristoleic acid (C14:1)	0.019–0.44	0.007	–	0.000	–	–
Palmitoleic acid (C16:1)	0.09–0.70	0.17-1.22	3.780	2.1-2.8	0.270	1.679
cis Oleic acid (C18:1n-9)	3.90–20.18	2.91–23.32	–	32.8–43.7	–	–
cis Linoleic acid (C18:2n-6)	1.17–41.39	34.52	–	10.7–14.2	–	–
Linolenic acid (C18:3n-3)	0.01–1.59	1.78	2.130	1.0–1.1	0.670	–
Eicosapentaenoic (C20:5n-3)	0.01–0.06	0.070	–	0.2–0.4	–	0.00
Erucic acid (C22:1n-9)	0.014–0.52	0.01–0.02	–	0.00	–	0.00
MUFA	4.14–29.99	9.85–4.33	34.33	3.26–43.04	46.670	23.704
PUFA	1.45–36.48	1.80–7.46	31.910	0.62–16.00	20.00	4.568
Saturated fatty acid (g/100 g DM)						
Lauric acid (C12:0)	< 0.02–0.10	0.04–0.44	0.100	0.210	–	–
Myristic acid (C14:0)	0.04–0.55	0.05–0.271	1.650	1.3–1.4	1.330	2.296
Pentadecanoic acid (C15:0)	0.01–0.11	0.01–0.036	–	4.1–4.7	–	–
Palmitic acid (C16:0)	1.56–24.92	2.16–23.92	23.500	23.2–27.3	22.670	12.667
Heptadecanoic acid (C17:0)	0.02–0.12	0.03–0.101	0.320	0.2–0.3	–	–
Stearic acid (C18:0)	0.58–8.97	0.76–8.34	7.350	12.2–16.1	8.00	7.951
Minerals (mg/100 g of DM)						
Calcium	27.50–3,105.04	240.17	117.30–130.00	6.00	6.00	16.00
Copper	0.51–5.08	4.55	4.79–4.90	0.07	0.04	0.10
Iron	1.93–11.23	8.75	4.23–4.70	0.79	0.59	1.55
Magnesium	22.60–136.58	143.65	42.70–101.00	19.00	20.50	21.00
Manganese	0.89–4.40	–	2.90	< 0.0125	0.01	0.02
Phosphorus	32.37–1,806.00	1,169.60	782.10	173.00–320.00	166.00–407.00	157.00
Potassium	347.00–1,280.00	1,079.90	870.00–1,190.00	318.00–400.00	248.00–302.00	222.00
Selenium	0.02–0.60	–	0.09	–	–	18.80
Sodium	95.05–863.34	452.99	298.00–330.00	45.00–87.00	63.00	59.00
Zinc	2.18–24.40	22.43	13.90–16.80	2.23	1.18	3.41
Vitamins (mg/100 g DM)						
Retinol	24.33	–	–	–	0.006–0.020	–
Thiamine (B1)	0.02-1.66	0.42	–	0.49	0.08–0.09	0.11
Riboflavin (B2)	3.84	0.89	–	0.23	0.15–0.25	0.21
Niacin (B3)	3.84	1.09	–	4.86	3.06–12.44	5.96
Pantothenic acid (B5)	2.30	–	–	–	–	0.65
Pyridoxine (B6)	0.13-0.23	5.28	–	0.25	0.33–0.55	0.13
Biotin (B7)	0.02	–	–	–	–	–
Folate (B9)	0.15–0.49	0.51	–	–	–	–
Vitamin B12	0.01	–	–	0.57	0.40	0.00
Vitamin C	3.00	–	–	0.00	–	–
Vitamin E (α-tocopherol)	1.32	–	–	0.33	0.30	0.20
Choline	151.90	–	–	–	–	69.30

Variations in the reported nutrient contents may arise due to differences in species, developmental stage, diet composition, analytical methodologies, and processing conditions. These details are excluded from the table to maintain clarity and readability.

of vitamin B12. Thus, the excessive intake of crickets should be monitored to avoid potential adverse effects. Although vitamin B12 has a low risk of toxicity due to its water-soluble nature, it is still advisable to limit intake to prevent potential adverse effects.

Cricket-based interventions

There are limited clinical studies that have demonstrated the physiological impacts of cricket consumption (shown in Table 1). In a randomized crossover study, adults consuming 25 g of cricket powder daily (comprising approximately 14.78 g of protein, and 2.21 g of dietary fiber, provided through muffins and shakes) demonstrated significant alterations in gut microbial composition. Levels of *Bifidobacterium animalis* increased markedly, while certain lactic acid bacteria, including *Lactobacillus reuteri*, declined. Parallel biochemical analyses indicated reductions in stool short-chain fatty acids such as acetate and propionate, alongside a decrease in circulating tumor necrosis factor-alpha, suggesting potential anti-inflammatory and gut-modulating effects of cricket intake[34]. Nutritional benefits have also been observed in vulnerable populations. A six-month dietary intervention among preschool-aged children showed that porridge enriched with 5% cricket powder significantly improved hemoglobin concentrations, indicating a positive influence on iron status[35]. This is particularly relevant in regions with a high burden of anemia, where cricket-based foods may provide a sustainable dietary strategy to enhance micronutrient intake. The bioavailability of key minerals from cricket powder has been further validated through isotope-labeled feeding studies. In iron-depleted women, fractional iron absorption from cricket-based meals was modest yet comparable to conventional dietary sources[36], while zinc absorption in young Kenyan children consuming cricket-enriched maize meals exceeded that of standard fortified meals[37]. These results highlight the potential of cricket protein to serve as a vehicle for improving micronutrient nutrition, particularly in populations vulnerable to micronutrient deficiencies. Cricket protein has also been investigated in relation to postprandial amino acid kinetics and satiety regulation. Acute feeding trials in healthy men demonstrated that beverages containing 25 g of cricket protein produced robust increases in circulating leucine, branched-chain amino acids, and essential amino acids, while concurrently reducing hunger ratings[38]. Similarly, cricket-enriched pancakes, containing 20%–30% flour substitution, were effective in suppressing hunger over a three-hour postprandial window, supporting their use in satiety management[39]. From a performance nutrition perspective, resistance exercise trials revealed that cricket protein stimulated mTORC1 signaling to a similar degree as whey and pea protein, affirming its capacity to promote anabolic responses essential for muscle recovery and adaptation[40]. These studies highlight that cricket-based ingredients offer a multifaceted contribution to human diets. Cricket consumption not only increases protein and micronutrient intake but also offers several health benefits, including gut modulation, reduced inflammation, and appetite regulation.

Edible crickets: food applications and consumer acceptability

Several studies have investigated the effect of incorporating cricket powder on the sensory properties of various food products. Early consumer-based studies tested snack formulations such as puffed rice fortified with 33% cricket powder, and chili paste containing 25% cricket powder. In both cases, young adult participants reported high acceptance scores, particularly for attributes such as color and aroma. While taste responses reflected modest improvements in perceived sweetness, and relatively lower effects on saltiness and spiciness. These findings suggest that even at moderate inclusion levels, cricket-fortified foods can achieve favorable sensory acceptance without compromising palatability[41]. Consumer perception trials have additionally demonstrated the role of cricket-based products in shaping attitudes toward insect consumption. When exposed to chocolate beverages containing 30% cricket powder, participants not only rated the products favorably but also reported a measurable decline in feelings of disgust and misconceptions about insects as disease vectors. Importantly, participants became more likely to recommend, purchase, and integrate such products into their diets, reflecting the power of direct exposure in shifting cultural attitudes toward entomophagy[42].

Traditional cooking methods such as toasting, boiling, frying, steaming, and smoking can be used to prepare cuisines from crickets. Frying is the most common cooking method to improve the sensory attributes of edible insects. Additionally, cooking can inactivate enzymes, kill microorganisms, increase palatability, improve digestibility, and enhance the biological activity of the insect's protein. However, before cooking, it is necessary to remove the intestines, wings, legs, and heads, followed by washing. After washing, the crickets must be processed according to local eating habits[43]. For example, in India, crickets (*Tarbinskiellus orientalis*, *Tarbinskiellus portentosus*, and *Teleogryllus occipitalis*) are consumed in various forms, including cooked (with bamboo shoots and local spices), deep-fried, and boiled. In contrast, the Naga tribes use a traditional way of preparing crickets. They mixed the salt, dry bamboo shoots, and crickets, then stuffed them into bamboo pipes and enclosed them in a banana leaf. Afterwards, they were cooked over a fire for 20–30 min[44].

In a study, *Henicus whellani* were cooked using various techniques, including boiling, roasting, or a combination of boiling and roasting. These cooking methods are commonly used in Zimbabwe. The study found that boiling crickets resulted in the loss of protein, a reduction in protein digestibility, and a loss of minerals; therefore, it was concluded that roasting is a more suitable method of cooking[45]. In Thailand, live insects were cleaned and toasted for 5 min in a hot, non-frying pan with regular stirring. Similarly, smoking is another method of cooking used to cook, dry, and provide a smoky flavor. Additionally, this method preserves the insects by reducing the pH and preventing the growth of microorganisms. Crickets are fried in vegetable oil or animal fat at a temperature of 170–210 °C for cooking[46–48].

Crickets such as *A. domesticus* and *G. bimaculatus* have emerged as promising edible insects for improving the nutritional, functional, and sensory properties of various baked products. In sourdough bread (SDB) production, fermentation of *A. domesticus* powder with *Lactiplantibacillus plantarum* ATCC 8014 has been shown to increase the organic acid levels (e.g., acetic, lactic, and oxalic acids) while reducing citric acid content. Fermentation for 24 h resulted in increased mineral bioavailability, amino acid content, and the production of aromatic volatile compounds[49]. Spontaneous fermentation of cricket powder (CRIP) facilitates the isolation of lactic acid bacteria (LAB) strains, including *Enterococcus durans*, *Lactococcus garvieae*, *Latilactobacillus curvatus*, *L. plantarum*, *L. sakei*, and *Weissella confusa*. Incorporation of 20% CRIP into wheat flour doughs using these strains increases the lipid content (from 0.7 to 6 g/100 g), and protein content (up to 94%) in the bread, highlighting spontaneous fermentation as a potential method for developing nutritionally improved bread[50]. SDB developed with CRIP hydrolysate fermented by *Yarrowia lipolytica* RO25 exhibits increased levels of free fatty acids and proteins, which are attributed to the yeast's lipolytic and proteolytic activities, as well as a reduced biogenic amine index. The developed SDB demonstrated an acceptable level of sensory attributes[51]. Optimized fermentation of CRIP with *L. plantarum* No. 122 achieves high LAB counts (8.24 log CFU/g) and a pH of 4.26, reducing total biogenic amines by 13.1%, while wheat bread enriched with 10%–30% fermented CRIP exhibits superior specific volume, sensory acceptability, and lower acrylamide levels at 10% inclusion. However, higher concentrations may increase acrylamide content[52]. Whole wheat breads fortified with CRIP (up to 20%) have shown an increased level of ash (2.09%–2.33%), protein (18.97%–25.94%), and fat (10.91%–15.07%), as well as darker crumb, firmer texture, and high consumer acceptance[53].

In fermented probiotic beverages, the incorporation of cricket protein hydrolysates (CPH) has been demonstrated to improve both the physicochemical and nutritional properties. For example, enrichment with CPH significantly increases viscosity, reduces pH, and increases titratable acidity, while maintaining viable probiotic counts above 8.45 log CFU/mL over 5 months of refrigerated storage at 4 °C. This stability is attributed to the antimicrobial effects of organic acids produced during fermentation, which inhibit the growth of spoilage microorganisms. Furthermore, fermented CPH-enriched beverages exhibit an increase in low molecular weight (LMW) peptides (< 260 Da), reaching 74.7% after storage, compared to 59.9% in the non-enriched product, indicating continuous proteolysis that enhances bioavailability. *In vitro* gastrointestinal simulations found high probiotic survival rates (up to 83%) in CPH-enriched formulations, highlighting their potential as functional foods for gut health[54]. A Colombian traditional beverage (chucula) is fortified with 4.6% cricket flour (CR), which results in altered granulometry, increased particle size at 150 µm, elevated water activity (a_w), and reduced solubility. Sensory evaluations indicate a 74% liking for CR-enriched chucula, characterized by a milky brown appearance, a cocoa aroma, and a sweet-nutty flavor, with emotions evoked including adventurousness and enthusiasm. However, neophobia scores are higher among consumers over 45 years old, although overall values below 2.5 suggest opportunities for integrating familiar products[55].

Potential hazards associated with crickets

In recent years, the consumption pattern of edible insects has increased. However, in many countries, there is no regulation governing the use and rearing of edible insects, which raises special concerns about food safety issues. There are three different types of hazards commonly associated with edible insects, including chemical, biological, and allergenic hazards[56]. During the rearing of insects, there is a high risk of contamination, which can be influenced by various factors, including the insect species, developmental stage, substrate used, and production method[57]. A significant component of crickets is protein, which means there is a chance of an allergic reaction in some people. The field cricket contains Hexamerin B1, an allergenic protein[58]. Arginine kinase is considered an allergen, and exposure to it may cause skin reactions, respiratory issues, and systemic symptoms in some individuals. It was observed that thermal processing (frying) may reduce the arginine kinase in Bombay locust[59]. It can be assumed that similar changes may occur in crickets with thermal processing; however, further studies are necessary.

Additionally, α-amylase and tropomyosin are the other common allergens of edible crickets[60,61]. A study has found that 19% of people in Belgium are sensitive to grilled *A. domesticus*. This highlights that people are at high risk of developing allergic reactions upon consumption of *A. domesticus*[62]. To minimize the health risk, all food products containing crickets are labeled appropriately[60]. The label should explicitly declare the presence of cricket-derived ingredients, and include a clear allergen warning statement to inform consumers about potential allergic reactions, particularly for individuals sensitive to crustaceans, dust mites, or other related allergens. Such mandatory labeling ensures transparency, consumer safety, and regulatory compliance in the commercialization of edible insect products.

Studies have reported that entomophagy may cause microbial foodborne infections and intoxications[62]. Edible insects can be contaminated with *Citrobacter* spp., *Fusobacterium* spp., *Salmonella* spp., *Yersinia* spp., *Bacteroides* spp., and *Escherichia coli*[63−65]. Therefore, good manufacturing and hygiene practices should be used across all the unit operations (from farm to fork) to protect consumers. Additionally, controlled rearing conditions and thermal processing are crucial in minimizing the risk of pathogenic microorganisms and spoilage, thereby ensuring the microbiological safety and quality of edible cricket-based products.

In crickets, heavy metals such as cadmium and mercury can accumulate[60]. Whereas, in a study, cadmium, arsenic, chromium, lead, and tin were found in acceptable levels for human consumption[66]. According to EFSA, no toxic compounds are present in crickets[67], as they lack specific organs for producing toxic compounds[67,68]. Similarly, a study has shown that administering 5,000 mg/kg of cricket powder does not produce any adverse effects[69]. These points highlight that crickets are generally safe to consume.

Conclusions

Edible crickets are a good source of protein, essential amino acids, fiber, minerals, and vitamins; thus, they can be used as an adjunct therapy to alleviate the risk of nutrient deficiency. Apart from their nutritional composition, clinical studies have shown the potential role of crickets in enhancing zinc and iron absorption, modulating gut microbiota, reducing inflammatory markers, and improving satiety responses. Cricket protein can stimulate mTORC1 signaling and play a crucial role in muscle protein metabolism. However, to date, there are limited clinical studies. Therefore, well-designed clinical studies are needed to explore the potential of edible crickets in managing anemia and micronutrient deficiencies, modulating gut microbiota and inflammation, addressing obesity, diabetes, and inflammatory bowel disorders, enhancing satiety and weight management, and stimulating muscle protein synthesis. Additionally, cohort studies focused on the long-term impact of consuming edible insects should be conducted.

Crickets are considered safe to consume; however, it is crucial to maintain appropriate rearing practices and processing technologies. Therefore, exploring optimal processing conditions to reduce allergenicity, anti-nutritional factors, and microbial risk will be essential to increase consumer acceptance. Additionally, regulatory guidelines must be strengthened to optimize the farming practice, handling, processing, and labelling practices are required to ensure consumer safety and to build consumer trust.

Author contributions

The authors confirm their contributions to the paper as follows: conceptualization: Kumar A, Kumar S, Mehra R; writing – original draft and editing: Yadav S, Kumar A, Batta K, Joia S, Bawa Y, Mishra SS; writing – review and editing: Mehta L, Khatkar P, Rustagi S, Ruliya R; supervision: Kumar S, Mehra R; visualisation: Kumar A. All authors reviewed the results and approved the final version of the manuscript.

Data availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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Conflict of interest

The authors declare that they have no conflict of interest.

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References

[1] Lumsden CL, Jägermeyr J, Ziska L, Fanzo J. 2024. Critical overview of the implications of a global protein transition in the face of climate change: key unknowns and research imperatives. *One Earth* 7:1187−1201
[2] USDA. 2015. *USDA Agricultural Projections to 2024*. Washington, DC: Office of the Chief Economist, World Agricultural Outlook Board, U. S. Department of Agriculture. Long-term Projections Report OCE-2015-1. 97 pp. https://ers.usda.gov/sites/default/files/_laserfiche/outlooks/37753/51683_oce151.pdf
[3] FAO. 2023. *World Agriculture: Towards 2015/2030 - An FAO perspective*, ed. Bruinsma J. London, UK: Earthscan Publications Ltd. 444 pp. www.fao.org/3/Y4252E/Y4252E.pdf
[4] Caputo V, Sun J, Staples AJ, Taylor H. 2024. Market outlook for meat alternatives: challenges, opportunities, and new developments. *Trends in Food Science & Technology* 148:104474
[5] Anyasi TA, Acharya P, Udenigwe CC. 2025. Edible insects as an alternative protein source: nutritional composition and global consumption patterns. *Future Foods* 12:100699
[6] Omuse ER, Tonnang HEZ, Yusuf AA, Machekano H, Egonyu JP, et al. 2024. The global atlas of edible insects: analysis of diversity and commonality contributing to food systems and sustainability. *Scientific Reports* 14:5045
[7] Kumar A, Goyal N, Pramanik J, Joia S, Singh S, et al. 2025. Feasting on the future: unveiling edible insects as a sustainable food with enriched health benefits. *Current Nutrition & Food Science* 21:191−201
[8] Sogari G, Amato M, Palmieri R, Hadj Saadoun J, Formici G, et al. 2023. The future is crawling: evaluating the potential of insects for food and feed security. *Current Research in Food Science* 6:100504
[9] Reid G. 2023. A value chain to improve human animal and insect health in developing countries. *Microbiome Research Reports* 3:10
[10] Magara HJO, Niassy S, Ayieko MA, Mukundamago M, Egonyu JP, et al. 2021. Edible crickets (Orthoptera) around the world: distribution, nutritional value, and other benefits—a review. *Frontiers in Nutrition* 7:537915
[11] Murugu DK, Onyango AN, Ndiritu AK, Osuga IM, Xavier C, et al. 2021. From farm to fork: crickets as alternative source of protein minerals, and vitamins. *Frontiers in Nutrition* 8:704002
[12] Matandirotya NR, Filho WL, Mahed G, Maseko B, Murandu CV. 2022. Edible insects consumption in Africa towards environmental health and sustainable food systems: a bibliometric study. *International Journal of Environmental Research and Public Health* 19:14823
[13] Larouche J, Campbell B, Hénault-Éthier L, Banks IJ, Tomberlin JK, et al. 2023. The edible insect sector in Canada and the United States. *Animal Frontiers* 13:16−25
[14] Oibiokpa FI, Akanya HO, Jigam AA, Saidu AN, Egwim EC. 2018. Protein quality of four indigenous edible insect species in Nigeria. *Food Science and Human Wellness* 7:175−183
[15] Magara HJO, Hugel S, Fisher BL. 2025. Growth performance and nutritional content of tropical house cricket (*Gryllodes sigillatus* [Walker, 1969]) reared on diets formulated from weeds and agro by-products. *Insects* 16:600
[16] Kröger T, Dupont J, Büsing L, Fiebelkorn F. 2022. Acceptance of insect-based food products in Western societies: a systematic review. *Frontiers in Nutrition* 8:759885
[17] van Huis A, Rumpold B. 2023. Strategies to convince consumers to eat insects? A review. *Food Quality and Preference* 110:104927
[18] Siddiqui SA, Zhao T, Fitriani A, Rahmadhia SN, Alirezalu K, et al. 2024. *Acheta domesticus* (house cricket) as human foods - an approval of the European Commission - a systematic review. *Food Frontiers* 5:435−473
[19] Lampová B, Kopecká A, Šmíd P, Kulma M, Kurečka M, et al. 2024. Evaluating protein quality in edible insects: a comparative analysis of house cricket. yellow mealworm, and migratory locust using DIAAS methodologies. *LWT* 213:117062
[20] Ndiritu AK, Kinyuru JN, Kenji GM, Gichuhi PN. 2017. Extraction technique influences the physico-chemical characteristics and functional properties of edible crickets (*Acheta domesticus*) protein concentrate. *Journal of Food Measurement and Characterization* 11:2013−2021
[21] Hammer L, Moretti D, Abbühl-Eng L, Kandiah P, Hilaj N, et al. 2023. Mealworm larvae (*Tenebrio molitor*) and crickets (*Acheta domesticus*) show high total protein *in vitro* digestibility and can provide good-to-excellent protein quality as determined by *in vitro* DIAAS. *Frontiers in Nutrition* 10:1150581
[22] Udomsil N, Imsoonthornruksa S, Gosalawit C, Ketudat-Cairns M. 2019. Nutritional values and functional properties of house cricket (*Acheta domesticus*) and field cricket (*Gryllus bimaculatus*). *Food Science and Technology Research* 25:597−605
[23] Lampová B, Doskočil I, Šmíd P, Kouřimská L. 2024. Comparison of cricket protein powder and whey protein digestibility. *Molecules* 29:3598
[24] Raksakantong P, Meeso N, Kubola J, Siriamornpun S. 2010. Fatty acids and proximate composition of eight Thai edible terricolous insects. *Food Research International* 43:350−355
[25] Ghosh S, Lee SM, Jung C, Meyer-Rochow VB. 2017. Nutritional composition of five commercial edible insects in South Korea. *Journal of Asia-Pacific Entomology* 20:686−694
[26] Hart T, DiMattia ZS, Tate KE, Jafari F, Damani JJ, et al. 2024. Dietary polyunsaturated to saturated fatty acid ratio as a predictor for LDL-C response in adults: a systematic review and meta-analysis of randomized controlled trials. *Current Developments in Nutrition* 8:102796
[27] Okwee-Acai J, Agea JG, Nakimbugwe D, Akullo J, Obaa BB. 2018. Nutrient composition of commonly consumed edible insects in the Lango sub-region of northern Uganda. *International Food Research Journal* 25:159−165
[28] van Huis A. 2019. Edible insects. In *Handbook of Eating and Drinking*, ed. Meiselman HL. Cham: Springer International Publishing. pp. 1−16 doi: 10.1007/978-3-319-75388-1_123-1
[29] Pilco-Romero G, Chisaguano-Tonato AM, Herrera-Fontana ME, Chimbo-Gándara LF, Sharifi-Rad M, et al. 2023. House cricket (*Acheta domesticus*): a review based on its nutritional composition, quality, and potential uses in the food industry. *Trends in Food Science & Technology* 142:104226
[30] Loypimai P, Moontree T, Pranil T, Moongngarm A. 2024. A comparative study of nutritional components of *Gryllus bimaculatus* and *Acheta domesticus* cricket powder prepared using different drying methods. *Journal of Food Measurement and Characterization* 18:3974−3983
[31] Finke MD. 2002. Complete nutrient composition of commercially raised invertebrates used as food for insectivores. *Zoo Biology* 21:269−285
[32] Institute of Medicine (US) Panel on Micronutrients. 2001. Vitamin A. In *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington, DC: National Academies Press. 800 pp. doi: 10.17226/10026
[33] NIH. 2025. *Vitamin B12*. Health Professional Fact Sheet. https://ods.od.nih.gov (Accessed on 24 August 2025)

[34] Stull VJ, Finer E, Bergmans RS, Febvre HP, Longhurst C, et al. 2018. Impact of edible cricket consumption on gut microbiota in healthy adults, a double-blind, randomized crossover trial. *Scientific Reports* 8:10762

[35] Kipkoech C. 2019. *Nutrient profile, prebiotic potential of edible cricket, and effect of cricket-based porridge on growth, haemoglobin and fatty acid levels of school children*. Thesis. Jomo Kenyatta University of Agriculture and Technology, Kenya. 203 pp. http://ir.jkuat.ac.ke/handle/123456789/5179

[36] Mwangi MN, Oonincx DGAB, Hummel M, Utami DA, Gunawan L, et al. 2022. Absorption of iron from edible house crickets: a randomized crossover stable-isotope study in humans. *The American Journal of Clinical Nutrition* 116:1146−1156

[37] Hilaj N, Boit T, Andang'o P, Zeder C, Mwangi MN, et al. 2025. Zinc absorption from maize-based meals enriched with edible house crickets: a randomized crossover stable-isotope study in Kenyan pre-school children. *Nature Communications* 16:1003

[38] Dai J, Lov J, Martin-Arrowsmith PW, Gritsas A, Churchward-Venne TA. 2022. The acute effects of insect vs. beef-derived protein on postprandial plasma aminoacidemia, appetite hormones, appetite sensations, and energy intake in healthy young men. *European Journal of Clinical Nutrition* 76:1548−1556

[39] Skotnicka M, Mazurek A, Karwowska K, Folwarski M. 2022. Satiety of edible insect-based food products as a component of body weight control. *Nutrients* 14:2147

[40] Lanng SK, Oxfeldt M, Pedersen SS, Johansen FT, Risikesan J, et al. 2023. Influence of protein source (cricket, pea, whey) on amino acid bioavailability and activation of the mTORC1 signaling pathway after resistance exercise in healthy young males. *European Journal of Nutrition* 62:1295−1308

[41] Toontom N, Namyotha C, Wongprachum K, Nilkamheang T, Tudpor K. 2024. Development of health-promoting edible cricket products by using sensory evaluation techniques. *Studies in Health Technology and Informatics* 314:163−167

[42] Barton A, Richardson CD, McSweeney MB. 2020. Consumer attitudes toward entomophagy before and after evaluating cricket (*Acheta domesticus*)-based protein powders. *Journal of Food Science* 85:781−788

[43] Liang Z, Zhu Y, Leonard W, Fang Z. 2024. Recent advances in edible insect processing technologies. *Food Research International* 182:114137

[44] Mozhui L, Kakati LN, Kiewhuo P, Changkija S. 2020. Traditional knowledge of the utilization of edible insects in Nagaland, north-east India. *Foods* 9:852

[45] Manditsera FA, Luning PA, Fogliano V, Lakemond CMM. 2019. Effect of domestic cooking methods on protein digestibility and mineral bioaccessibility of wild harvested adult edible insects. *Food Research International* 121:404−411

[46] Tenyang N, Tiencheu B, Mamat A, Mawamba LA, Ponka R. 2021. Effect of cooking methods on the nutritive value and lipid oxidation of two cricket species consumed in Cameroon. *European Journal of Nutrition & Food Safety* 13:11−23

[47] Durst PB, Hanboonsong Y. 2015. Small-scale production of edible insects for enhanced food security and rural livelihoods: experience from Thailand and Lao People's Democratic Republic. *Journal of Insects as Food and Feed* 1:25−31

[48] Krongdang S, Phokasem P, Venkatachalam K, Charoenphun N. 2023. Edible insects in Thailand: an overview of status, properties, processing, and utilization in the food industry. *Foods* 12:2162

[49] Vasilica BTB, Chiș MS, Alexa E, Pop C, P ăucean A, et al. 2022. The impact of insect flour on sourdough fermentation-fatty acids, amino-acids, minerals and volatile profile. *Insects* 13:576

[50] Galli V, Venturi M, Pini N, Granchi L. 2020. Technological feature assessment of lactic acid bacteria isolated from cricket powder's spontaneous fermentation as potential starters for cricket-wheat bread production. *Foods* 9:1322

[51] Rossi S, Parrotta L, Gottardi D, Glicerina VT, Del Duca S, et al. 2022. Unravelling the potential of cricket-based hydrolysed sourdough on the quality of an innovative bakery product. *Journal of Insects as Food and Feed* 8:921−935

[52] Bartkiene E, Zokaityte E, Starkute V, Zokaityte G, Kaminskaite A, et al. 2023. Crickets (*Acheta domesticus*) as wheat bread ingredient: influence on bread quality and safety characteristics. *Foods* 12:325

[53] Mafu A, Ketnawa S, Phongthai S, Schönlechner R, Rawdkuen S. 2022. Whole wheat bread enriched with cricket powder as an alternative protein. *Foods* 11:2142

[54] Dridi C, Millette M, Aguilar B, Salmieri S, Lacroix M. 2022. Storage stability of a fermented probiotic beverage enriched with cricket protein hydrolysates. *Food and Bioprocess Technology* 15:2587−2600

[55] Sotelo-Díaz LI, Ramírez B, García-Segovia P, Igual M, Martínez-Monzó J, et al. 2022. Cricket flour in a traditional beverage (chucula): emotions and perceptions of Colombian consumers. *Journal of Insects as Food and Feed* 8:659−672

[56] Murefu TR, Macheka L, Musundire R, Manditsera FA. 2019. Safety of wild harvested and reared edible insects: a review. *Food Control* 101:209−224

[57] van Huis A. 2021. Prospects of insects as food and feed. *Organic Agriculture* 11:301−308

[58] Srinroch C, Srisomsap C, Chokchaichamnankit D, Punyarit P, Phiriyangkul P. 2015. Identification of novel allergen in edible insect, *Gryllus bimaculatus* and its cross-reactivity with *Macrobrachium* spp. allergens. *Food Chemistry* 184:160−166

[59] Pener MP. 2016. Allergy to crickets: a review. *Journal of Orthoptera Research* 25:91−95

[60] Swedish University of Agricultural Sciences (SLU), Department of Biomedical Sciences and Veterinary Public Health S, Fernandez-Cassi X, Supeanu A, Jansson A, et al. 2018. Novel foods: a risk profile for the house cricket (*Acheta domesticus*). *EFSA Journal* 16:e16082

[61] Imathiu S. 2020. Benefits and food safety concerns associated with consumption of edible insects. *NFS Journal* 18:1−11

[62] Francis F, Doyen V, Debaugnies F, Mazzucchelli G, Caparros R, et al. 2019. Limited cross reactivity among arginine kinase allergens from mealworm and cricket edible insects. *Food Chemistry* 276:714−718

[63] Ulrich RG, Buthala DA, Klug MJ. 1981. Microbiota associated with the gastrointestinal tract of the common house cricket, *Acheta domestica*. *Applied and Environmental Microbiology* 41:246−254

[64] Vandeweyer D, Crauwels S, Lievens B, Van Campenhout L. 2017. Microbial counts of mealworm larvae (*Tenebrio molitor*) and crickets (*Acheta domesticus* and *Gryllodes sigillatus*) from different rearing companies and different production batches. *International Journal of Food Microbiology* 242:13−18

[65] Grabowski NT, Klein G. 2017. Microbiology of cooked and dried edible Mediterranean field crickets (*Gryllus bimaculatus*) and superworms (*Zophobas atratus*) submitted to four different heating treatments. *Food Science and Technology International* 23:17−23

[66] Poma G, Cuykx M, Amato E, Calaprice C, Focant JF, et al. 2017. Evaluation of hazardous chemicals in edible insects and insect-based food intended for human consumption. *Food and Chemical Toxicology* 100:70−79

[67] EFSA Scientific Committee. 2015. Risk profile related to production and consumption of insects as food and feed. *EFSA Journal* 13:4257

[68] Van der Spiegel M, Noordam MY, van der Fels-Klerx HJ. 2013. Safety of novel protein sources (insects, microalgae, seaweed, duckweed, and rapeseed) and legislative aspects for their application in food and feed production. *Comprehensive Reviews in Food Science and Food Safety* 12:662−678

[69] Ryu HY, Lee S, Ahn KS, Kim HJ, Lee SS, et al. 2016. Oral toxicity study and skin sensitization test of a cricket. *Toxicological Research* 32:159−173