Processing and Functional Properties of Edible Insects: Risk and Benefits Associate with Its Consumption

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1 Introduction

Entomophagy is an act of eating insects and it is becoming popular globally since insects are expected to be the future food. As the earth's population is set to reach 9 billion by 2050 experts are worried about the production of edible protein to feed all of us (Gahukar 2016). Globally, sustainability is becoming more and more important (Jantzen da Silva Lucas et al. 2020). Therefore there is a need for alternative food sources to replace traditional and less sustainable ingredients. Evidence suggests that more farming and consumption of limited natural resources will not be enough, so could edible insects help? According to nutritional value, cricket provides good quality of protein which are high in essential amino acids. Crickets are rich in protein than chicken, pork beef, and the like's edamame beans. Livestock rearing especially beef gives of large volumes of greenhouse gases such as methane whereas nearly 3000 times fewer greenhouse gases are emitted from insect protein production. Around 2 billion of the world's population is already consuming insects as a part of their diet. The use of proteins, lipids, and fibres from edible insects can be a possible alternative (Jantzen da Silva Lucas et al. 2020).

Insects have been used as food for humans for millions of years (Baiano 2020). 30,000 to 9000 years ago, during the Old Stone Age to Middle Stone Age. There are more than 2,000 edible insect species in the globe. The nutritional makeup of different

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insects varies. When compared to animal production, the industrial production of insects offers more benefits for the environment because it produces fewer greenhouse gases, uses less dry land, and has a higher feed conversion efficiency (Mishyna et al. 2021). The ability to grow insects on food waste makes small-scale insect agriculture more advantageous for the environment and economically sound (Mishyna et al. 2021). Despite this, there is still little practice in the large-scale production of insects. It might be because of the insufficient understanding of industrial insect production, processing, and rearing (Mishyna et al. 2021). Because gathering in tropical zones is more easier than in temperature zones, eating insects is currently a prevalent habit in tropical nations (Huis 2017). Beetles (31%), caterpillars (17%), wasps, bees, and ants (15%), crickets, grasshoppers, and locusts (14%), and real bugs (11%), are the insects that are most commonly consumed. Termites, dragonflies, flies, and other insects are consumed to a lesser amount (Huis 2017).

Insect proteins are more advantageous because they may be more ecologically friendly because they support an atmosphere that is more eco-friendly because there is less emission of greenhouse gases and ammonia. Lao People's Democratic Republic and Nigeria are two examples of tropical nations where eating insects is most popular (Huis 2017). Insects are becoming more accepted as viable sources of protein for food and feed, however because of their look, there is a danger that they won't be accepted by contemporary civilization (Liceaga 2021). Commercial processing techniques that extract food-grade protein while preserving the food's safety, nutritional value, and sensory quality are necessary for the improvement of the insect production sector (Liceaga 2021).

Even though insects have a lot of positive qualities, their usefulness is currently being assessed. With a rise in global population, there will be a severe problem with food security in both undeveloped and emerging nations. Two main food issues that affect people's health and are related to industrialized nations are food safety and the environmental sustainability of food and production (Petkova 2019). The potential of insect protein as a highly valuable functional ingredient in food formulation is the main topic of this review. It also discusses the many difficulties and chances in the study of edible insect proteins.

2 Nutritional Value

Insects are primarily consumed by humans due to their high protein content. The nutritional value of food products can be increased by include edible insects. Insects are abundant in high-value protein sources with high-quality food composition and components that are good for your health. Because there are so many different types of edible insects, their nutritional value is quite varied. Depending on an insect's stage of metamorphosis, where it came from, and what it eats, nutritional values within a group of insects might vary substantially. Numerous variables, including gender, stage of growth, and food, affect nutritional value. Numerous environmental aspects, like the temperature, length of the day, humidity, light intensity, and spectral makeup, can also be taken into account. Insects are typically regarded as a high source of protein (35–61% of total protein), fat (13–33% of total fat), vitamins, and a sizable quantity of "animal" fiber in the form of insoluble chitins. The species has a significant impact on the protein content. Raw insects have protein contents per 100 g of fresh weight that range from 7 to 48 g. For example, edible species of the order Coleoptera have an average protein content of 40.69%, and the species within this order have protein contents ranging from 8.85% to 71.10% (Alrifai and Marcone 2019). Many insect species from a wide range of orders have been examined for their protein content.

Insects have nutritional value, and according to the WHO and FAO, they are an acceptable source of protein for people who are starving. The second-largest part of an insect's nutritional makeup is fat. For instance, Orthoptera, which includes grasshoppers, locusts, and crickets, has an average fat level of 13.41%, Lepidoptera, which includes caterpillars, has a fat content of 27.66%, and Isoptera, which includes termites, has a fat content of 32.74% (Ojha et al. 2021). In insects, there are primarily two types of carbohydrates: chitin and glycogen (Ojha et al. 2021). According to Ojha et al. 2021, the average amount of carbohydrates in edible insects ranges from 6.71% (stink bug) to 15.98% (cicada). Some insects, such crickets, grasshoppers, mealworms, and termites, are also high in iron, zinc, calcium, copper, phosphorus, magnesium, and manganese in addition to the macronutrients. Although the iron content of most edible insects is comparable to that of meat, nothing is known about how readily insects absorb minerals.

3 Farming of Edible Insects

In nature, there are many different species of edible insects that are rich in nutrients and other components that support life. All around the world, people have historically eaten these delectable insects. Approximately 92% of the various species of edible insects, according to Yen (2015a, b), are collected from wild forests, aquatic ecosystems, and agricultural fields; however, these edible insects are not always present in the wild due to various environmental conditions (Baiano 2020). It is impossible to ensure the caliber and safety of insects that are taken from the wild. Taking insects out of the wild could lead to the extinction of certain species as red agave worm (*Comadia redtembacheri* or *Xyleutes redtembacheri*) used in mezcal, the Navajo reservation ant (*Liometopum apiculatum*), and the agave weevil (*Scyphophoru sacupunctures*) (Yen 2015a, b). Hence, continuous farming of edible insects became necessary. There are many insects species that are more often seasonally available. They appear after the first rain of the dry season. For example, insects such as termites and ants often the reproductives (winged ones) are eaten and some of them like caterpillars are depended upon host plants. Some of the insects like the giant water bug*, Lethocerus indicus* (Hemiptera: Belostomatidae) are the kind of aquatic species present in south-east Asia (Huis and Dunkel 2017).

For various edible insect species, different agricultural methods are employed (Huis 2017). Not all types of distinct species of insects can be raised exclusively in laboratory settings. By manually removing pests of edible insects that threaten crops from agricultural crops, we can reduce the need for insecticides and other chemicals while also protecting crops from these pests. For use as food and as animal feed, edible insects are raised and then bred. For farming, two methods are typically used. First, an insect can be completely domesticated and raised in captivity using a straightforward procedure. As an alternative, an insect can be partially raised in captivity by enhancing its habitat and providing it with sustainable circumstances so that it can increase its production without being separated from its wild population (Baiano 2020). As a result, the first method was used to raise mealworms, cockroaches, and a few beetles, whereas the second method was used to raise wasps, bamboo caterpillars, palm weevil larvae, and dragonflies. Each insect species is harvested differently based on three key variables: the stage of development (eggs, caterpillars, larvae, or adults), the season (rainy or dry), and the location (desert or agricultural field). Prior to this strategy, adults who are skilled at harvesting a range of edible insects would gather all edible insects (Huis 2017).

4 Processing of Edible Insects

As is well known, edible insects include a variety of nutrients necessary for a long and healthy existence. We need to process edible insects, such as roasting, frying, and boiling them, in order to get their nutrients and benefits. Traditionally, edible insects were eaten whole right away after harvesting until processing methods were developed. However, after processing methods were developed, people now prefer to eat processed insects. For instance, to enhance the flavor and palatability of edible insects, waste material and non-edible sections are peeled off and then changed into various forms. Their shelf life is also increased by processing (Santiago et al. 2020). Additionally, whole edible insects are ingested after being killed using processing methods like freezing, drying, boiling, and sun-drying. The most popular way among all of these is roasting, which is followed by boiling and then frying. Sun and oven drying are used to create the normally dried product. For the floor and powder of insects, however, freeze-drying and oven drying are more common (Baiano 2020). New techniques like extrusion, marination, supercritical fluid hydrolysis, and fermentation are being used to maintain the quality parameters.

It has been seen that some customers avoid consuming edible insects directly. This is likely owing to the associated unpleasantness. For those who advocate for the eating of edible insects, this is a serious matter. The consumption of edible insects can be increased by processing them into a paste or powder. Paste or powder that has been prepared can be added to other food items, such as bread, spaghetti, crunchy foods, or similar items, to enhance their flavor. In order to maximize their benefits, edible insects are typically turned into powder. The content of protein, fat, and fiber in edible insects was affected by standard techniques such thermal treatment such as boiling, drying, roasting, toasting, and smoking as well as microwave-assisted, microwave, vacuum, and conventional hot drying on rotating rack.. It is also responsible for decreasing energy value, water-soluble vitamins, nutrient content and bioactive compounds of edible insects (Santiago et al. 2020).

5 Functional Properties of Edible Insect

5.1 Solubility

An intriguing replacement for traditional proteins is insects. Protein solubility is the percentage of proteins that are in a soluble state under particular circumstances. As the functional features like forming, gelling, and emulsions depend on it, it is one of the most crucial characteristics in food systems (Gravel and Doyen 2020). It is one of the most desired properties both for protein applications and for digestion (Mishyna et al. 2021). Protein that is soluble depends on a number of variables, including intrinsic and extrinsic ones (Table 1). Insect protein solubility is pH-dependent (Mishyna et al., 2021). The kind of processing treatment used and how intense it is has a significant impact on how soluble insect proteins are. As an illustration, the protein solubility of yellow mealworms dried in a fluidized bed, microwave, and rack oven decreased from 12.65 to 19.25%.It is 40.65% compared to freeze-drying, 49.70 compared to vacuum-drying, and 53.24% compared to fresh mealworms. According to Mishyna et al. (2021), mealworms and crickets both have relatively lower solubility's when roasted and pulverized, 28.2 and 23.2%, respectively. Protein denaturation unfolding and exposition of internal hydrophobic groups are the main cause of a decrease in insect protein solubility. Solubilization of grasshopper proteins at alkaline pH and precipitation at the isoelectric point without thermal treatment caused to increase in protein suitability (Mishyna et al. 2021). After protein extraction and defatting of yellow mealworm in comparison with full-fat flour, the increase in solubility was observed whereas solubility was not changed by defatting of mealworm larvae and silkworm pupae. It has been shown that blanching and fermentation of mealworms with meat starter cultures led to a significant decrease in protein solubility and also shifted the isoelectric point from pH 4 to pH 6. If the given study is perused, it is seen that African cricket (*Gryllida*e) also shows low solubility at pH 3 and 4. The insect proteins, however in both pH values were not enzymatically hydrolyzed. Hence, the study suggests that the isoelectric point of cricket (*Grillades sigillatus*) protein is at or near pH 3.0 (Jantzen da Silva Lucas et al. 2020). Protein solubility depends on intrinsic factors such as amino acid composition and structure, protein size, and three-dimensional structure, as well as extrinsic factors such as ionic length, pH and temperature. The presence of negatively charged and polar amino acids at a protein surface increases solubility while non-polar amino acids decrease solubility (Gravel and Doyen 2020). Extrinsic factors such as temperature can also change the value of protein solubility. Generally, temperature improves protein solubility up to the point where the protein is denatured. Now if we consider ionic length, at lower ionic length ions act as a shield protecting proteins from each other attractive forces and promoting solubility and at high ionic length. The fierce competition between salt and protein for water molecules makes the proteins less soluble (Gravel and Doyen 2020). Protein solubility could be an important concern in improving the functional and rheological properties of edible proteins.

Table 1 Outcomes of functional properties of edible insects with their parameters

Functional Properties	Edible insect		Processing conditions	Outcome	References
Solubility	Scientific name	Common name			
	Tenebrio. M Olitor	Yellow mealworm	Drying [using a microwave and rack oven]	Protein solubility depressed to 12.65–19.25%	Kroncke et al. (2018)
	Gryllus bim aculatus, and B. mori	Two-spotted cricket, and silkworm	Enzymatic hydrolysis [using commercial enzymes like Flavourzyme and Alcalase]	Solubility of protein increases	Sungwon Yoon, Nathan A. K. Wong (2019)
Emulsifying property	Chondracris Roscapbrunner	Large grasshopper	Flour, concentration	Demonstrated greater cmulsifying property	Chatsuwan et al. (2018)
Foaming property	Protactia. br evitarsisseulensis	White-spotted flower chafer beetle	Pressur-treatment, concentration	The foaming capacity of pressure-treated P. breviaries selenosis is high	Kim (2020)
Gelling property	Acheta domesticus	House cricket	Heating, defatted concentration	Gel formation takes place at pH 7	Mishyna et al. (2021)
Oil holding capacity	Acanthoplus discoidalis	Armored bush cricket	Oven drying, flour	Oven-dried sample have higher oil holding capacity compared to sundried samples	Mugova A. and R2 (2021)
Water holding capacity	Tenebrio. M olitor	Yellow Mealworms	Roasting, grinding, and Fermentation	The water holding capacity increased	Mishyna et al. (2021)

5.2 *Emulsifying Property*

Emulsification is known as the homogenous mixture of two immiscible liquids, whether it be a droplet of oil in water or a droplet of water in oil. Methods for determining emulsifying property given by Wu et al. (2009). Overall, the surface action on the oil–water interface is determined by the amphiphilic character of the protein, similar to the air–water interface, but scattering interactions often accelerate protein absorption in the oil–water interface. The amphiphilic properties of proteins allow them to form and stabilize food emulsions by reducing surface tension at the oil–water interface (Mishyna et al. 2021). The emulsifying activity of proteins is affected by their molecular weight, hydrophobicity, conformation stability, surface charge, and their physicochemical properties, such as pH, ionic strength, and temperature (Zhao et al. 2012). Emulsification is also influenced by intrinsic and extrinsic factors. In particular, protein shapes affect emulsion formation and stability (Gravel and Doyen 2020). Smaller proteins are conducive to diffusion and generally show better emulsion capacity, but lower emulsion stability. Whereas, larger proteins have lower diffusion rates, which increases emulsion stability after the formation of a layer around the oil–water interface.

Unlike solubility, which is crucial for oil absorption, the presence of hydrophobic amino acids on the surface of proteins enhances emulsification capabilities. External elements that affect emulsion, like extremely low ionic strengths, severe pH values, and partial hydrolysis, also enhance the ability of proteins to emulsify (Lam et al. 2018). Due to their emulsifying qualities, traditional proteins including milk, eggs, and soy are frequently employed as additions. There are various studies on the emulsifying abilities of insects in the literature that can be used as a benchmark. High emulsifying activity index (EAI) values indicate a small number of oil droplets dispersed in the oil–water interface and high absorption capacity of proteins (Pacheco-Aguilar, Mazorra-Manzano, and Ramírez-Suárez 2008). Hall et al. (2018) verified that the treatments that showed the highest emulsion capacity (27–32 m^2/g) were Tests 1 and 2 (0.5% E/S for 30 and 60 min, respectively) and Test 8 (3% E/S, 60 min.). Tests, 5–7 and 9 (1.5% E/S, 30–90 min and 3% E/S, 90 min, respectively), showed lower EAI compared to other treatments, and unhydrolyzed protein values were significantly different ($p < 0.05$) in emulsions stabilized by crickets (*Grillods singultus*)—CPH hydrolysates. The highest functional properties became apparent when hexane was used as a solvent, followed by ethanol. Overall, the emulsifying properties are affected by protein processing as well as foaming properties (Mishyna et al. 2021).This emulsion property has many useful applications, for example in baked goods, mayonnaise, salad dressing, frozen desserts, and comminute meats (Kinsella 1976).

5.3 Foaming Property

Different insect species that are treated with the same methods typically have different foaming qualities. A continuous aqueous phase and a dispersed gas phase combine to form foams, which constitute a two-phase colloidal system. The movement, penetration, and rearrangement of molecules control foam formation at the air–water interface. Mealworm powder that has been roasted and crushed is renowned for its lack of foaming. In comparison to fava beans (62%) and yellow peas (49%) cricket powder has superior foaming stability (86%) (Mishyna et al. 2021). In order to form like other functional features that depend on many aspects like protein structure, foams are formed by air bubbles caught in the liquid and stabilized by proteins in the air–liquid interface. Foam formation means protein unfolding to ensure better absorption in the air–water interface. Globular and compact proteins are usually less effective at forming foam than their more fibrous and elastic counterparts. Rapid air bubble formation does not always imply foam stability. Strongly related and closely packed globular proteins from a more resistant film, which makes them better at foaming and forming a deformation-resistant foam than elastic proteins (Kinsella 1981).

Generally higher foaming capacity was noted in the protein preparation. The foam stability ranged from 19.33% to 34.67% for the whole insect and from 6.17% to 99% for the protein preparation. The highest value of 92.0% and 34.67% protein preparation and foam capacity is found in whole pest's *G. singultus*, respectively. The lowest value of foam capacity and protein preparation was reported in *S. gregoria* i.e. 6.17% and 19.33%, respectively. These results are not consistent with most hydrophobic amino acid content in the proteins of species studied, but in the case of *G. sigiltus*, they may depend on the location of the hydrophobic amino acid residue on the surface of the protein.

5.4 Gelling Property

Disulfide bonds and hydrophobic interactions are the key factors in gel formation, which is measured by a protein's gel-forming capability (Villaseor et al. 2021). The most important functional characteristic of animal proteins in emulsion products is their ability to gel. Gel-forming ability is influenced by protein content, pH, ionic strength, processing, and protein denaturation. Gelation is dependent on a number of internal elements, such as electrostatic interaction, and external factors, such as temperature, which is the most important factor, much like every other functional feature we have previously explored. According to Kim et al. (2020), the gel can be understood as a structured protein network capable of holding huge amounts of water without exhibiting laminar flow in a fixed area. Animal products' heat stability and animal proteins' gel stability are crucial in various procedures. Heat supply is crucial for gel formation because it speeds up protein production and breakdown, which leads to gradual rearrangement and accumulation and the development of the ideal gel during the cooling phase (Kim et al. 2020). Due to the protein pH being close by, acid circumstances were unsuitable for gel formation. In these circumstances, weak electrostatic interactions between proteins cause aggregates to develop during denaturation changes. On the other hand, low protein concentrations make it simple to produce gases in an alkaline pH. The gel in *Locusta. migratoria* contains between 4 and 20% protein concentrate when the pH is 7.2 (Villase-Or et al. 2021).

5.5 Water Holding Capacity

The ability of proteins to hold or bind water molecules and thus prevent their release is called water holding capacity (Mishyna et al. 2021). Water-holding capacity (WHC), water-binding capacity (WBC), and water absorption capacity (WAC) are all terms associated with the ability of protein matrix to retain as much water as possible per gram of sample material, against gravity whether it can be bound or physically entrapped water (Gravel and Doyen 2020).Water holding capacity is highly correlated with gelation properties. It is associated with improved texture and moisture, which is of great importance in food formulation (Mishyna et al. 2021). Cricket powder of 66% of protein (dry weight) and approx 16% lipids showed a water holding capacity of 1.76 g/g. These types of commercial powders were obtained by roasting the whole insects at 107 °C and then grinding them into powder. Whole yellow mealworm powder obtained through freeze-drying and grinding showed a water holding capacity of 1.29 g/g (Mishyna et al. 2021).

5.6 Oil Holding Capacity

Oil holding capacity, oil absorption capacity, and oil holding capacity are all terms used to describe a protein's ability to absorb and keep onto fat (Mishyna 2021). All refer to how many lipids a specific volume of protein powder may absorb (Gravel and Doyen 2020). This characteristic and emulsifying properties are connected. Taste and texture are connected to oil absorption potential. For cricket powder with 66% protein (dry weight) and 16% lipids, the measured value range is between 1 and 4 g/g OHC, with an OHC of 1.42 g/g. The complete insects were roasted at 107 °C and then ground into powder to create these commercial powders.

6 Food Safety and Environmental Effect

Cooking, drying, and acidification by lactic fermentation are a few methods that can be used to prevent entero-bacterial and bacterial spore-related contamination of insects. Edible insects should be regarded as regular food, and food safety procedures should be followed, to ensure food safety. A popular technique for preventing physical–chemical and biological contamination throughout the food production processes is the HACCP (hazard analysis and critical control points) system (Huis 2017).

The first factor contributing to global warming is greenhouse gas (GHG) emissions from human activity. Studies show that the average global temperature has risen by 1.4°F over the past century, and it is expected to keep rising, which will have serious adverse effects. Climate change will have a significant impact on crop productivity, which is already declining, rainfall, and ambient temperature. Because of intensive farming practices using synthetic fertilizers and pesticides, soil fertility is fast declining and the environment is being severely harmed. To protect food and feed crops from damage, chemical pesticides are employed against pests, weeds, and plant diseases (Gahukar 2016). According to FAO (2014), the production of meat contributes significantly to the present 15–24% global warming emissions. The settings under which insects or animals are raised have an impact on the rate of emission of these gases. Given the rising demand for meat, it is expected that by 2050, emissions would rise by 39% and biomass use will rise by 21%. In contrast to conventional livestock (pigs and beef cattle), insects emit substantially less GHG per kilogram of meat (Gahukar 2016). There is a very visible accompanying drop in the amount of land resources available to produce this amount of food as a result of the ongoing increase in human population, which in turn leads to a large demand for food. Currently, global warming poses a risk to utilizing all of the accessible land area (Premalatha et al. 2011). Insect farming is far more advantageous from an environmental standpoint than conventional cattle farming since it produces fewer greenhouse gas emissions, uses less water and land, costs much less money, and has a higher feed conversion rate. For instance, 1 kg of insect protein may be produced from various kinds of crickets and mealworms using just 40 L of water. Insects are also observed to have a rapid rate of reproduction and a broad geographic range. However, if the research of the UN and FAO are examined, it is thought that insects offer a potential answer to any potential food insecurity.

From the viewpoint of environmentally clean farming, insects are more suitable as compared to the livestock for the following reasons:

- ***Their farming on organic side streams is possible;***
- ***They emit less GHGs and little ammonia;***
- ***High feed conversion efficiency is possible;***
- ***Compared to mammals and birds, insects pose less risk of transmitting zoonoticm infections to humans, livestock, and wildlife; and***
- ***An increase in animal production will require additional cropland and feed and it may also trigger deforestation of land used for grazing.***

It can be understood better with this example, forest land in the Amazon basin would be reduced in the future nearly by 70% when used for pasture or feed crops (Gahukar 2016). In addition to the above advantages, the largest advantage of edible insects in comparison to conventional livestock is that several species can successfully be grown on organic side-streams, converting low-value organic by-products into high-value proteins. This particular conversion is extremely significant considering that one-third of all our agricultural produce and food is wasted, which is, globally1.3 billion tons each year annually (FAO 2011) costing US$750 billion (Economist 2014). Ramos-Elorduy et al. (2002) demonstrated the usefulness of edible insects in waste management by using waste fruits and vegetables for mealworms (Huis and Dunkel 2017). If developed and poor countries are compared globally, developed countries consume more protein per person per day (approximately 96 g), but a significantly higher percentage (65%) of this comes from meat. According to Alan (2009), protein consumption in underdeveloped nations is significantly lower (approximately 56 g/person/day), and only 15% of that is made up of animal protein. Livestock raising, In addition, it should be remembered that among the 6 billion people that inhabit the planet, one in every six die from starvation and malnutrition (Premalatha et al. 2011). Given the aforementioned situation, it is crucial to stop ignoring the potential of insects as human food, especially to offer the much required protein for the world's growing population. While insects farming is economical as well as beneficial in many aspects, insect consumption can be risky as well as beneficial. Hence, it is necessary to pursue the same.

7 Risk and Benefits of Consuming Insects

7.1 Benefits

Insects are consumed globally as it has nutritional values. With over 1900 species of edible insects, nutritional values are highly variable, and would be rather difficult to generalize their nutritional composition. However, it must be noted that Nutritional values of edible insects can vary depending on their metamorphic stage, an environment they are in, their diet, preparation, method of processing (i.e., baking, frying, boiling), and storage before consumption (Gravel and Doyen 2020). Though these variations can be significant, Rumpold and Schlüter (2013) compiled data on nutrient compositions of 236 edible insects (based on the dry matter) found in the literature which shows promise of edible insects providing satisfactory amounts of energy and protein for humans, both MUFAs and PUFAs, including essential linoleic and a-linolenic and several vitamins and minerals (calcium, iron, zinc) (Alrifai and Marcone 2019). Some of the major application and benefits of edible insects are shown in given Fig. 1.

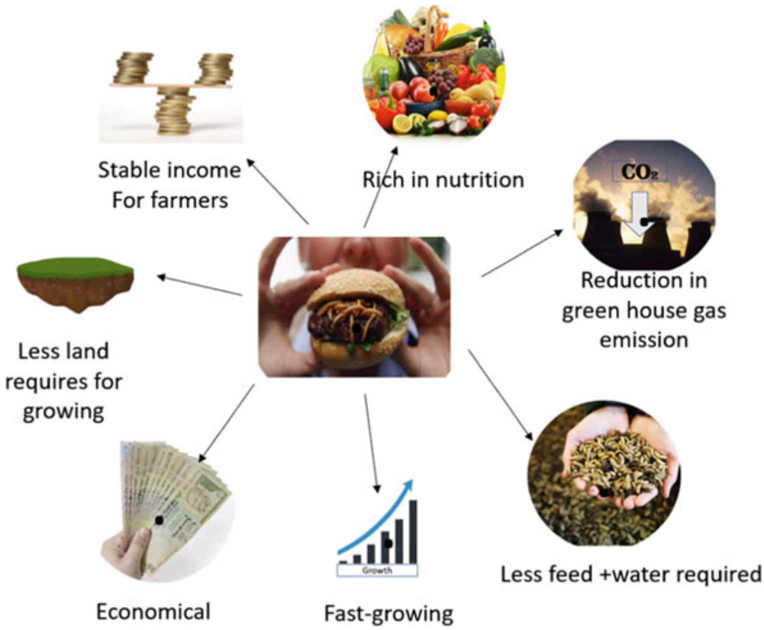

Fig. 1 Major Application and benefits of edible insects

- On a fresh weight basis, the protein and calorie contents of insects are generally comparable to those of beef, fish, and chicken, while they include more PUFAs and minerals like iron and zinc.
- In addition, Onore (1997) contends that insects are a healthy meal. For instance, 100 g of dried termites have considerable levels of phosphorus, salt, iron, and potassium as well as about 53% protein, 15% fat, and 3.5% carbs (Alrifai and Marcone 2019).
- Consuming insects, such as termites and crickets, can also help strengthen our immune systems and stimulate metabolic processes because they contain vital vitamins.

7.2 Risk

There may be dangers associated with eating insects that need to be considered. The EFSA recently issued a risk profile connected to insect ingestion (Kouimská and Adámková 2016).

- Eating an insect at the wrong stage of development poses the greatest risk when eating edible insects. In addition, improper handling and preparation of food might increase the danger of ingesting insects. According to a study (Kouimská and Adámková 2016), eating grasshoppers and locusts without first removing their feet can result in intestinal blockage, which may be fatal.

- Some insects have a chitin-based, stiff outer shell for their bodies that makes it challenging for humans to ingest and digest. Additionally, ingesting insects has been linked to allergies.
- It is also important to mention that some insect species that have come into touch with the incest to be consumed pose a serious risk of transmitting infectious diseases. Insects' gut microbiome may provide a favourable environment for the development of harmful pathogens.
- Insects have a very diverse microbiota in both their digestive system and on the outside of their bodies; these microbial communities are moulded by the insect's upbringing and living circumstances as well as by the processing involved in turning it into food (Mishyna et al. 2021).

In addition to this, insects act as carriers of pathogenic germs. It is crucial to ensure the microbiological safety of edible insects since the total microbial load of a product affects both food safety and its shelf life.

8 Conclusion

The new source of animal protein is insects that can be eaten. It is impractical to distribute food to everyone because of the increasing global population. This problem will primarily be solved by entomophagy, which is a particularly nutrient-dense source of food and feed for animals. Numerous edible insects include key amino acids that humans need and have a well-balanced nutritional profile. The creation of protein hydrolysates will be useful in preventing various illnesses, including diabetes, hypertension, and cardiac arrest. A large portion of the population is put off by eating edible insects because they are disgusting, but habits of doing so continue since they are rich in nutrients, proteins, and other components that support life. Producing and raising food insects is more environmentally friendly than raising conventional livestock. Comparatively speaking to more traditional animals (such as cattle, chickens, goats, etc.), insects needed a lot less space to flourish. Additionally, they don't need a lot of food or water. Because of this, there is an increased need for edible insects as a source of diverse proteins, minerals, and vitamins. This review article explains how various processing procedures are used on edible insects to get the varied functional qualities. This review article explains how various processing procedures are used on edible insects to get the varied functional qualities. As a result, edible insects are utilized for a variety of purposes, including food, medicine, and vitamin supplements for particular diets, such as those for athletes.

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