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Status and prospects of edible insect production

Shreya Bohini[1], Pramod Kumar M[1]., Hariharan S.[2]

Introduction:

It is anticipated that the current 7.2 billion people on Earth would grow by 1 billion within the next 12 years, reaching 9.6 billion by 2050. The amount of food produced currently will need to nearly double in order to feed this enormous population. The amount of land used for farming is declining; variations in the climate and pollution in the environment may have a significant impact on food production. We must develop new methods of food production if we are to address the current issues with food and nutrition. Evolution has developed a wide diversity of arthropod species during the last 400 million years, assisting many of them in adapting to new settings. Of the 1.4 million known animal species on Earth, about 1 million are insects, and millions more are thought to exist. Of the 1 million known bug species, only 5000 are thought to be dangerous to humans, animals, or crops (Van Lenteren, 2006).

There are several ecological services that insects provide that are essential to human life. One such function is their participation in plant reproduction; of the estimated 100,000 species of pollinators known to science, 98% are insects. The practice of eating insects is known as entomophagy. Edible insects in many cultures have been eaten as staple or as a delicacy. However, in some societies there is a degree of distaste for their consumption.

According to MacEvilly (2000), there are approximately 1500 types of insects that humans from over 300 ethnic groups in 113 countries have been reported to eat, and at least 2 billion people are thought to habitually

Shreya Bohini[1], Pramod Kumar M[1]., Hariharan S.[2]

[1]M.Sc. Entomology, College of Agriculture Rajendranagar, PJTSAU
[2]Ph.D. Scholar, Division of Entomology, IARI Hyderabad Hub

eat insects globally. Globally, the most commonly eaten insects are beetles (Coleoptera) (31 percent) because of their large no of population almost 40 percent of all known insect species; followed by caterpillars, bees, wasps, ants, grasshoppers, locusts, crickets, cicadas, leaf and planthoppers, scale insects and true bugs, termites, dragonflies and flies. The consumption of caterpillars (Lepidoptera), especially popular in sub-Saharan Africa, is estimated at 18 percent.

Coleoptera. Notably, they also represent the most significant group of edible insects globally, with over 500 species consumed.

- There are more than 107 species of edible grasshoppers consumed across Africa. The most frequently consumed grasshopper species in Africa include *Ruspolia differens* and *Schistocerca gregaria* whose availability is limited by swarming patterns.

Table 1: Legal framework for marketing edible insects of different countries

Country	Legislation	Remark
Australia	Food Standard Australia and New Zealand (FSANZ) Advisory Committee on Novel Food (ACNF)	Non-traditional but not Novel food Zophobas morio, *Tenebrio molitor, Achaeta domestica*
Korea	Insect industry law, Food safety regulation	6 species listed as food materials
Canada	Food and Drug Act (Canada), Farm Producers Act (Québec city)	-
Belgium	Federal Agency for the Safety of the Food Chain (FASCA)	Ten species listing as edible insects *
Thailand	Food and Drug Administration Thailand 2014 BE2522 (1979)	
Uganda	Uganda Wildlife Act	
Mexico	ACUERDO	Rearing of organic insects
United States of America	Federal Food and Drug Administration (FDA)	Edible insects as food additives

**Acheta domesticus, Locusta migratoria migratorioides, Zophobus atratus morio, Tenebrio molitor, Alphitobius diaperinus, Galleria mellonella, Schistocerca americana gregaria, Gryllodes sigillatus, Achoria grisella, Bombyx mori*

Status of entomophagy scenario

- Beetles constitute the most numerous orders in the living world, with 25% of all eukaryotic species belonging to

- Rising interest in backyard farming has boosted attention given to insect production. Part of the reason involved the Covid-19 pandemic, which

disrupted food supply chains, and increased domestical food production across the globe.

- At present time only the black soldier fly is permitted as ingredient in animal feed in North America.
- There are at least 11 cricket companies in the US offering an assortment of products.
- In 2020, at least 28 companies were producing insects in Canada (Cohen & Duchemin 2020).

The reasons for the current and future human consumption of insects

Insects are regarded as one of the essential components of future human nutrition for a number of reasons, aside from their customary use in feeding certain people. First and foremost, the nutritional worth of insects must be taken into account, particularly in areas where a sufficient supply of nutrient-dense foods is scarce. The nutritional composition of insects is influenced by various factors, including species, developmental stage, feeding, and processing (Oonincx & Dierenfeld, 2012). Generally, insects show interesting amounts of high quality proteins since all the essential amino acids are present in the recommended ratios. However, as their nutritional makeup varies depending on a number of circumstances, including species, stage of development, method of insect death, and preparation, it must be taken into account. Insects belonging to the Gryllidae taxonomic family, for instance, have low calorie counts (153 Kcal) and high protein contents (~20 g), but they also have high sodium contents (152 mg) per 100 g of edible portion, which is not wanted.

In contrast, Curculionidae insects have high calorie contents (~480 Kcal) and low protein, salt, and contents (~10 g and 11 mg, respectively). In China, for 174 of the 324 species of insects that are either edible or associated with entomophagy, the nutritional values are available and, although the data vary among species, all the insects examined contain protein, fat, vitamins and minerals at levels that meet human nutritional requirements (Feng *et al*., 2018). According to Oonincx and de Boer (2012), to produce 1 kg of edible protein, mealworms required only 10% of the land needed for beef production. Additionally, Mwangi *et al*. (2018) study on 11 edible insect species raised in large quantities and 6 species collected from the wild revealed that: the insect's levels of zinc and iron are equal to or higher than those of other animal-based food sources; high protein levels in edible insect species are linked to high levels of zinc and iron.

Economic impact of edible insects

The global edible insect market is dominated by human consumption, followed

by animal nutrition, cosmetics, and pharmaceutical. An important economic implication of insect gathering and farming is that they can offer revenue opportunities, either at household level or at industrial-scale. This is mainly true in the developing countries, where there is a concrete demand for edible insects. Insects can fetch prices at markets that are up to 15% above those of the crops from which they were harvested, and occasionally even higher than those of traditional fish and meat. An overview of the costs associated with selling insects in different nations was provided by the findings of Munke and Owino's investigations (Van Huis *et al*., 2013). One kilogram of termites cost €10 in Kenya. 50 g each of the smaller and yellow mealworms cost € 4.85 in the Netherlands. 35 migratory locusts were available for purchase online in the Netherlands for about €10. Grasshoppers in the Lao People's Democratic Republic were sold for € 8–10 per kilogram. In southern Cameroon, the selling of insects allowed for daily earnings ranging from USD 2-3 for honeybees, USD 5-10 for termites, and USD 16-20 for cockchafers, according to Tamesse *et al*. (2018). In the lake Victoria basin, a kilogram of R. differens was sold at about US$ 3.00, vs. US$ 3.50 for beef, and US$ 1.95 for fish. According to van Huis et al. (2013), the demand for edible insects in western countries is mostly driven by the emergence of niche markets for exotic cuisines and by migrating communities from Africa and Asia.

Prospects for insect production

Acceptability of insects as feed for livestock and other animals is another important consideration in the development of the insect rearing industry. Circular economy could be one of the biological benefits of edible insects that can effectively convert lowvalue food waste into high-quality proteins, amino acids, and vitamins that can help to increase the productivity of alternative protein production, which will further improve the sustainability of the food system. Global trade of edible insects has become increasingly popular in recent years due to their high nutritional value and low environmental impact. Mass production is the method used in the majority of insect farms. The production and processing of edible insects must be expanded in order to meet the demand. The use of contemporary technology is necessary for the raising and processing of edible insects for the mass population. To increase the profitability and competitiveness of insect mass production, it is imperative to automate the processes of insect rearing, harvesting, and processing.

Conclusion

Many ethnic communities around the world still harvest and eat insects, mostly in

tropical regions where they are readily available all year round. In the last fifteen years, insects have come to be recognized as a viable source of food for both people and animals in the Western world. The edible insect industry is relatively new-it has only been around for ten years-and in order to successfully advance agricultural research and education, industry and government cooperation will be needed on both a national and international scale. This kind of cooperation fosters creativity, draws in talent (human capital), and helps create answers for today's problems.

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