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Insect: Food for Future

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Abstract
Entomophagy – the practice of eating insects has gather increasing global interest as sustainable and nutrient-dense alternative to conventional animal protein sources. Among the continents, Asia has the highest number of edible insects (932 species), followed by North America (mainly Mexico) and Africa. The countries with the highest consumption of insects are Mexico (450 species), Thailand (272 species), China (235 species), India (262 species), Brazil (140 species), Japan (123 species). Long existed within several Indian traditional and tribal food cultures, especially across North-East India, parts of South India, studies reported over 250 insect species being consumed across different states in India and rural regions where insects like termites, grasshopper, ants and stink bugs form part of dietary customs. Among this edible species of insect consumption of coleopteran species was highest constituting about 34%; followed by Orthoptera (24%); Hemiptera (17%); Hymenoptera (10%); Odonata (8%); Lepidoptera (4%); Isoptera (2%) Renewed interest from researchers, agricultural exhibition and food innovators has brought edible insects into public discourse as nutritious, high – protein and ecologically sustainable food sources.

Keywords: Entomophagy, edible insects, protein source, food security.

Introduction
Insects have been part of human diets for thousands of years across traditional food systems, particularly in tropical region of Africa, Asia and Latin America (According to Bodenheimer) due to the warm and moist climate. The global population is rising exponentially, and so is the required to meet the nutritional needs approximately 2,000 species of insects are consumed globally, including beetles, caterpillar, ants, grasshopper, crickets and termites (Tang *et al*.,2019). Historically, these are served as important protein and micronutrient sources among indigenous and rural population. Over the past decades, edible insects have gained popularity as healthy and environmentally friendly substitute for traditional meat and dairy products like chicken, pork and fish in economically under undeveloped countries since insects are rich in protein content, easily available in nature and require very less maintenance, individuals can consume insect-based protein foods (Raheem *et al*.,2019). The global edible insect industry will be worth over 300 crores by 2030. Edible insects can solve many environmental and health issues, including climatic change, hunger and environmental degradation caused by agro-industrial production.

Table 1: List of some common worldwide available edible insect

Common name	Scientific name	Family	Order	Edible Stage
Rhinoceros beetle	*Allomyrinia dichotoma*	Scarabaeidae	Coleoptera	Larvae

Grasshopper	*Sphenarium histrio*	Acrididae	Orthoptera	Adult
Locust	*Schistocerca gregaria*	Acrididae	Orthoptera	Adult
Silkworm pupa	*Bombyx mori*	Bombycidae	Lepidoptera	Pupa
Stink bug	*Euschistus egglestoni*	Pentatomidae	Hemiptera	Adult
Termite	*Macrotermes nigeriensis*	Termitidae	Isoptera	Winged adult
Honey bee	*Apis mellifera*	Apidae	Hymenoptera	Larvae and pupa
Cricket	*Gryllodes sigillatus*	Gryllidae	Orthoptera	Adult
Soldier bug	*Hermetia illucens*	Stratiomyidae	Hemiptera	Larvae
Meal worm	*Tenebrio molitor*	Tenebrionidae	Coleoptera	Larvae
Asian weaver ant	*Oecophylla smaragdina*	Formicidae	Hymenoptera	Egg and larvae
Mexican katydid	*Pterophylla beltrani*	Tettigoniidae	Orthoptera	Adult
Melon bug	*Aspongubus viduatus*	Chrysomelidae	Hemiptera	Adult

(Milesh *et al.*,2024)

Method of Consumption

1. Rhinoceros Bettle-**Edible stage**- Larvae (grubs); **Eating methods**- Roasted over fire, fried in oil with salt and spices, boiled and added to curries, smoked for preservation; **Taste**- creamy, nutty, high in fat and protein
2. Grasshopper-**Edible stage**- adult; **Eating method**: dry roasted, deep fried with spices, sun-dried and powdered, used in chutney or mixed with rice; **Taste**- Crunchy, similar to shrimp
3. Locust- **Edible stage**- Adult; **Eating method**: roasted during locust swarms, fried or boiled, ground into flour for protein fortification; **Taste**: Slightly nutty, crispy
4. Silkworm Pupa- **Edible stage**: Pupa; **Eating method**: boiled and salted, stir-fried, added to soups, used as snacks food; **Taste**: Soft, rich, slightly nutty
5. Stink bug-**Edible stage**: Adult; **Eating method**: lightly roasted, crushed into paste for flavoring, used in chutney; **Taste**: Strong aroma, herbal flavor
6. Termite-**Edible stage**: Winged adults; **Eating method**: dry roasted, fried, mixed with maize/rice, ground to paste; **Taste**: Nutty, slightly sweet
7. Honey bee- **Edible stage**: Larvae and pupae; **Eating method**: eaten raw, fried lightly, mixed with honey, added to salads; **Taste**: Sweet and Creamy
8. Cricket- **Edible stage**: Adult; **Eating stag**e: roasted whole, cricket flour in bakery products, protein bars and snacks, stir-fried; **Taste:** Mild, nutty
9. Soldier Bug- **Edible stage**: Larvae; **Eating methods**: dried and powdered, used in protein fortification, fried or roasted (limited human use: more common as animal feed)
10. Mealworm- **Edible stage**: Larvae; **Eating method**: roasted as snacks, added to cookies and bread, powdered into protein flour, fried; **Taste**: Nutty, similar to peanuts
11. Asian Weaver Ant- **Edible stage**: Eggs, larvae, adults; **Eating methods**: used in chutney, added to salad, mixed with spices, used in curries**; Taste**: Sour due to formic acid
12. Mexican Katydid- **Edible stage**: Adult; **Eating method**: Roasted, fried with chili and salt, dried and powdered; **Taste**: Crunchy, earthy
13. Melon Bug- **Edible stage**: Adult; **Eating method**: light roasting, fried with spices, occasionally used in traditional dishes

Edible insects in India

Entomophagy is a culture of tribal people found in Phek, Dimapur and Kohima district of Nagaland eat grasshopper, cricket, red ant and larvae of mulberry silkworms. They eat green color larvae infested on gulmohar tree in the month of March and April (Srivastava et al.,2009). Some tribal people in Midnapur district of West Bengal eat ant eggs, larvae (and also uses them as fish bait. Tribal people of Kandhamal, Koraput, Sundergarh, Keonjhar and

Mayurbhanj district of Odisha eat red ant and termite. Termites were collected at the time of swarming, while red ants collected from the nest formed on the plant (Srivastava *et al*.,2009). In Arunachal Pradesh, the Nyishi and Galo tribes consume at least 81 species of local insects, belonging to 26 families and 5 order of insects (Chakravorty *et al*.,2011). Some people use termite insects as source of protein and carbohydrate in Meghalaya and also mineral content of termites used greater than conventional vegetarian food, salmon fish and broiler chicken (Paul and Dey.,2011)

Nutritional Attributes of edible insects

Edible insect is varying in nutritional content depending upon their species type, habitat, metamorphic stage and diet (Meyer-Rochow *et al*.,2021). Insect contain high level of protein along with fats, carbohydrate, vitamin, and mineral. Few insects have been identified slightly higher level of proteins, fats and minerals as comparison with meat and fish (Shah et al.,2022). The protein content of these insects was extremely like egg protein (95%) or bee (98%) and was also found to be more than plant proteins (Kuntadi *et al.*,2018). Based on their fatty acid profile, they generally have more unsaturated fatty acid than saturated fatty acid (Castro *et al*.,2018). Among the main minerals, iron(Fe), zinc(Zn), potassium(K), sodium(Na), calcium(Ca), phosphorus(P), magnesium(Mg), manganese(Mn), copper(Cu) has been described(Van Huis *et al*.,2013). Edible insects could also be considered a dietary source of nutritionally important vitamins (B1, B2, B6, C, D, E and K) and antioxidant provitamins with functional properties (i.e., carotenoids) (de Castro *et al*.,2018)

Table 2: General composition of nutrient and mineral of edible insects

S.No.	Nutrient	Percent %
1.	**Protein**	10.3%- 70.7%
2.	**Essential amino acid**	46.0%-96.0%
3.	**Fatty acid**	10.5%-69.8%
4.	**Fiber**	2.0%-25.1%
5.	**Vitamins**	
	Folic acid	0.5-0.9
	Niacin	0.9-12.6
	Riboflavin	1.4-11.1
	Thiamin	0.1-3.4
	Vitamin C	0.1-36.1
6.	**Minerals (mm/100g)**	
	Calcium	24.5-210.0
	Iron	5.5-229.7
	Magnesium	33.1-1094.4
	Phosphorus	352.0-957.8
	Potassium	259.7-2206.0
	Sodium	44.8-435.1

(Milesh *et al.*,2024)

Discussion

Urban population often view insect consumption as primitive. Misconceptions and myth about cleanliness and safety hinder mainstream adoption (Das,2021)Overexploitation and Habitat loss- increasing demand may threaten local biodiversity. Habitat destruction reduces insect population and traditional access. Integrating insect farming into rural development schemes could promotes nutrition and income. Research and Innovation-Developed improved rearing systems.

Conclusion

Insects as food offer a sustainable and practical approach to addressing global issues such as food security, malnutrition and environmental degradation. Around the world, particularly in parts of Asia, Africa, and Latin America, entomophagy has been a long-standing cultural practices and recent regulatory developments along with commercial innovation have further strengthened its acceptance as an alternative protein sources. Research conducted between 2010 and 2025 consistently demonstrates that edible insects are rich in nutrients, requires fewer resources for production, and generates significantly lower greenhouse gas emissions compared traditional livestock. In India, although insect consumption has deep roots within tribal and indigenous communities, broader societal acceptance remains limited due to cultural attitudes and concerns regarding hygiene and safety. Nevertheless, growing scientific research, awareness initiatives, and agricultural exhibitions are gradually promoting insects as sustainable dietary option. With proper regulation, safety assurance, and public education, edible insects could play a meaningful role in strengthening both national and global food systems.

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