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Entomophagy: A Step towards Food Security

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SUMMARY

Entomophagy is practised in at least 113 countries with over 2000 documented edible insect species. Due to the increasing cost of animal proteins, food and feed insecurity, population growth, and increasing need for protein-rich food in the developed and less developed countries, alternative sources of protein-rich food are highly needed. Edible insects are a very rich source of high quality protein, amino acids, fat, CHO, vitamins, trace elements and minerals. Edible insects contribute to the diet of a part of the world population such as those living in Africa, Asia and Latin America. So, the edible insects can contribute to the complete diet of people across the globe. Hence, insect consumption might help revolutionaries' food and feed insecurity and thus replace the conventional animal source. It is widely accepted that by 2050 the world will host approximately 9 billion people. To accommodate them, current food production shall be increase to double. Land is scarce and so expansion of farming is rarely a sustainable option. To meet the food and nutrition challenges, what to eat and how to produce it needs to be re-evaluated and it is an urgent need of innovative solutions. To combat the raised situation, entomophagy can be a better option.

INTRODUCTION

Entomophagy, the consumption of insects, is rooted in human evolutionary history (Fontaneto *et al.* 2011). Insects have played an important part in the history of human nutrition in various parts of the world. Over 1900 species of insects are known worldwide to be part of human diets; some important groups include grasshoppers, caterpillars, beetle grubs, wringed termites, bees, worms, ant brood, cicadas, and a variety of aquatic insects (Bodenheimer, 1951). It is interesting to know that more than two billion people consume insects on a regular basis, and insect eating provides a significant proportion of the animal proteins consumed in some regions (Van Huis, 2013). Because entomophagy is widely practiced, and because it compares favourably with nutrient and environmental aspects of conventional livestock rearing, it has the potential to contribute substantially to reducing undernutrition among an expanding global population (Van Huis, 2013). Globally, the most commonly consumed insects are beetles (Coleoptera) (31 percent), caterpillars (Lepidoptera) (18 percent), bees, wasps and ants (Hymenoptera) (14 percent), grasshoppers, locusts and crickets (Orthoptera) (13 percent), cicadas, leafhoppers, planthoppers, scale insects and true bugs (Hemiptera) (10 percent), termites (Isoptera) (3 percent), dragonflies (Odonata) (3 percent), flies (Diptera) (2 percent) and other orders (5 percent).

What is entomo-phagy

The word "Entomophagy" is derived from the Latin word " entomon" meaning "insect" and "phagein" that means "to eat." Combining these two terms, it means, "insect eating". It is the practice of eating insects including arachnids and Myriapods (centipedes).

Why we eat insects?

Hunger and malnutrition is a serious problem in the ever-expanding human population. With the high rate at which the world population is growing, the world food supply should grow at the same rate, if not faster. Therefore, the search for new food sources including the identification and development of localized ethnic ones continues (Van Huis, 2013). In most part of the world, food resources are becoming increasingly scarce and the importing of foods is becoming more expensive. It is thus imperative to identify and develop indigenous food resources. To effectively respond not just to rapid population growth but also to other pressing challenges, researchers have turned their attention to insects not only because of their abundance, enormous biomass, and high quality protein but also because of the time-honoured practice among many culturally diverse peoples (Conconi, 1974; Wang et al. 2004). The choice of insects as food is further strengthened by the fact that they also constituted rich sources of fat, vitamins, and minerals, especially iron and zinc.

Edible insects as food for humans and feed for animals

Insects are the most abundant and most diverse multicellular organisms on planet earth and are thought to account for about 80% of all species. Numerous crops rely on them for pollination, and their importance extends into their other agricultural and human health benefit. Although, insects were mainly recognized as pests affecting humans, plants, and animal health, insects play an essential role in minimizing food insecurity in addition to provide ecosystem services (such as pollination, waste degradation, and biological control). Insects also represent an important food source for a wide variety of animal species. Some of the edible insects consumed around the world are as belows,




Cultural value of insects

Entomophagy is heavily influenced by cultural and religious practices, and insects are commonly consumed as a food source in many regions of the world. In most Western countries, however, people view entomophagy with disgust and associate eating insects with primitive behaviour. This attitude has resulted in the neglect of insects in agricultural research. Despite historical references to the use of insects for food, the topic of entomophagy has only very recently started to capture public attention worldwide.

Medicinal value of edible insects

Insects are used as medicine to treat various diseases in human beings and animals such as common fever, scabies, epilepsy, violent headaches, bronchitis, haemorrhage, and dog bite. Insects are also used to treat wound, to prevent gangrene, and to increase milk flow in lactating women. Chemicals produced by edible insects against self defense have also been exploited for the production of antibacterial and anticancer drugs. For instance, pierisin, a protein purified from pupa of cabbage butterfly, exhibits cytotoxic effects against human gastric cancer. Cercopin has also been reported to be cytotoxic against mammalian lymphoma and leukemia cells.

Market value of edible insects

Eating insects provides a valuable source of protein, minerals, and vitamins as well as a tasty snack and therefore must be in high demand. Crickets, grasshoppers, and locusts, for example, are a seasonal delicacy, while the giant water beetles are used in salads. These insects are mostly gathered from bushes and farmland by women and children, processed, and eaten or sold in school premises a local and urban markets. Some of these insects

are also processed and exported to shops and restaurants in cities in and out of the country. The commercialization of edible insects therefore provides significant income to many households.

Nutritional value of edible insects

Insects are highly nutritious and healthy food source with high content of nutrients such as fats, proteins, amino acids, carbohydrates, vitamins, fibres, and minerals required by humans and animals. However, the nutritional compositions of edible insects between and within species are highly variable depending upon the metamorphic stage, habitat, and diet of the insect as well as the preparation and processing methods applied before consumption.

Dietary energy content of edible insects

Location	Common name	Scientific name	content kcal/100 weight
Australia	Australia plague locust, raw	*Chortoicetes terminifera*	499
Australia	Green (weaver) ant, raw	*Oecophylla smaragdina*	1272
Canada, Quebec	ed-legged grasshopper, whole, raw	*Melanoplus femurrubrum*	160
The USA, Illinois	Yellow mealworm, larva, raw	*Tenebrio molitor*	206
The USA, Illinois	Yellow mealworm, adult, raw	*Tenebrio molitor*	138
Ivory Coast	Termite, adult, winged, dried, flour	*Macrotermes subhyalinus*	535
xico Veracruz St	Leaf-cutter ant, adult, raw	*Atta mexicana*	404
exico Hidalgo Sta	Honey ant, adult, raw	*Myrmecocystus melliger*	116
Thailand	Field cricket, raw	*Gryllus bimaculatus*	120
Thailand	Giant water bug, raw	*Lethocerus indicus*	165
Thailand	Rice grasshopper, raw	*Oxya japonica*	149
Thailand	Grasshopper, raw	*Cyrtacanthacris tatarica*	89
Thailand	ailand Domestic silkworm, pupa, r	*Bombyx mori*	94
The Netherlands	Migratory locust, adult, raw	*Locusta migratoria*	179

Edible insects as an engine for improving/replacing livestock rearing

Land, water, and energy resources are declining, so these resources need to be conserved and managed to produce more food. Also, animal husbandry competes for these vital resources, as the land is occupied by the production of feed and cannot be used to produce more food for humans. It is very expensive to carry out livestock farming. This is because they consume large amounts of energy than they produce. For example, livestock consume 77 million tons of protein in feedstuff that is potential for human nutrition to produce 58 million tons of protein. Insect culture, on the other hand, requires little areas. Also, many of the edible insect species do not compete with human beings for food resources. Equally, insect farming requires little water, which is significant because water shortages already exist throughout the world and are likely to increase. Hence, insects are nick named “minilivestock”

Environmental (ecological) opportunities of insect rearing

Insects deliver a host of ecological services fundamental to the survival of humankind. Utilization of insects as a protein source could benefit insect conservation through habitat protection. Insects are essential agents feeding on organic matter in nature, and they efficiently exploit all organic sources. Insects also recycle organic waste and provide nutrients for farm animals. Many insect species are absolutely necessary to improve soil fertility. This is because insects play an important role in breaking down waste products until it is fit to be consumed by fungi and bacteria, thus releasing minerals and nutrients which become readily available in the soil for plant uptake, hence improving soil fertility. Animal carcasses, for example, are consumed by fly maggots and beetle larvae. Dung beetles of which there are about 400 known species also play a significant role in decomposing manure. Hence, insects could be used as efficient bio-transformers to convert abundant, low-cost organic wastes into animal biomass rich in proteins and suitable for use in animal nutrition.

Role of Insects in Climate Change

The planet Earth is under the appalling shadow of climate change. The rise of temperature due to emission of Green House Gases (GHGs') has become a universal phenomenon throughout the world. In this context it is important to reduce the emission of GHGs. Insects play a vital role in this process through the following ways,

a) Carbon sequestered in the green vegetation is not returned back to the nature by decomposition rather they are consumed and subsequently converted to body mass of the insects.

b) Insects produce less ammonia to the atmosphere as compared to livestocks.

Beneficial roles of insects for humans

Besides serving as sources of food, edible insects provide humans with a variety of other valuable products. A huge variety of insect species are known to have remarkable commercial and pharmaceutical values. For example, bees and silkworm have been shown to produce massive tons of honey and silk, respectively. These products can be sold in the local as well as in the international markets, while silkworms produce more than 90,000 tons of silk. Also carmine, a red dye produced by scale insects of the order Hemiptera, is used to colour foods, textiles, and pharmaceuticals. Resilin, a rubberlike protein that enables insects to jump, has been used in medicine to repair arteries because of its elastic properties. In addition to this, other products produced by edible insects such as honey, propolis, royal jelly, and venom have been used in treating traumatic and infected wounds and burns. Furthermore, insect products have also been used in engineering methods in the production of biomaterials.

CONCLUSION

Sustainably meeting global food demands is one of humanity's greatest challenges and has attracted considerable attention in the past few years. There is general consensus on agriculture's positive contribution to food security through its role in increasing availability of affordable food and the incomes of the poor. Within the context of sustainable diet, the use of insects as food and feed has a significant role to play in assuring food security and improving livelihood of the African people. Insects contribute to food security by providing sufficient nutrition *viz*., amino acids, vitamins, minerals, protein, CHO, trace elements and fat to people across the globe. In comparison to livestock, rearing insects seems to be more environmentally friendly with regards to greenhouse gas production, water consumption and land requirement. Food derived from insect rearing and insect cell culture represents the most feasible solution to feeding humans traveling in spacecraft or living in domed structures on other planets. The insects (grasshopper, crickets, termites, silkworm, locusts, fruit flies *etc*.) are tasty and delicious and can be utilized for a successful acceptance of entomophagy which have a potential to profound a positive impact on food industry. These edible insects should therefore be taken into consideration for a world in which human nutrition has been a huge problem.

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