CURRENT SCIENCE

Volume 123 Number 5 10 September 2022

GUEST EDITORIAL

Insects for food, feed, pharmaceuticals and therapy: need for development

Insects have been used by humans for a long time as food, feed, and a source of pharmaceutical chemicals and therapy. Ethnic people traditionally consume them as unconventional food items to supplement their dietary requirements and to prevent the development of a wide range of diseases associated with malnutrition. It is a fact that roughly two billion ethnic people consume insects, arachnids, or invertebrates in about one hundred and twenty countries of Asia, Africa, Australia, and Latin America. They use approximately one thousand and nine hundred species of insects for food and many for medicine. Nowadays, entomophagy (use of insects as food/feed) is accepted for several reasons, as insects are healthy and nutritious alternatives to mainstream staples such as chicken, pork, beef, and fish because many insects contain high protein, are low in fat compared to traditional meats, have high calcium, iron and zinc.

With advancements in knowledge during the past several decades, ethnobiological data have become a pathfinder in modern medical science. Insect chemical biodiversity plays a vital role in drug discovery, a field designated as pharmaceutical entomology. With modern techniques, we know that insects produce thousands of compounds with different properties relevant to various diseases. They are proteins, terpenoids (triterpenoids, steroids, carotenoids, iridoids, tropolones), sugars, polyols, mucilage, saponins, polyphenolic glycosides, quinones, anthraquinones, glycosides, cyanogenic glycosides, and alkaloids, which have neurotoxic, immunological, analgesic, antibacterial, diuretic, anaesthetic, and antirheumatic properties. Despite this knowledge, it is a fact that insects still are not fully explored and exploited as resources of drugs for modern medicines. Although some of the chemicals from insects have been identified as medicines for human beings, many more need to be identified for future use.

Chitosan, a compound derived from chitin, is a potent anticoagulant that lowers cholesterol levels, repairs tissues and is also used to fabricate contact lenses. Generally, antimicrobial peptides (AMPs) exert a broad spectrum of inhibition against pathogenic bacteria, fungi, yeast, parasites, protozoa and viruses. Insect-derived peptides represent a vast and relatively unexplored resource for drug discovery. In the 1980s, the discovery of AMPs in insects gained attention as promising alternative sources of today's antibiotics – Cecropin A and B (from *Hyalophora cecropia*), Sarcotoxin IA, IB, IC and Sapecin (*Sarcophaga peregrine*), Defensin and Diptericin (*Drosophila melanogaster*), Attacin, Moricin and Drosocin (*Bombyx mori*). The novel peptide neurotoxins, pompilid toxins (PMTXs), have been identified in the venom of the spider wasps *Anoplius samariensis* and *Pseudagenia* (*Batozonellus*) *maculifrons* in Japan. Promising anticancer drugs, such as isoxanthopterin and dichostatin, have been isolated from the wings of Asian sulfur butterflies (*Catopsilia crocale*) and the legs of Taiwanese stag beetles (*Allomyrina dichotomus*). In January 2004, the U.S. Food and Drug Administration (FDA) granted permission to produce and market maggots for use in humans or animals as a prescription for debriding non-healing necrotic skin and soft tissue wounds, including pressure ulcers, venous stasis ulcers, neuropathic foot ulcers, and non-healing traumatic or post-surgical wounds.

In some regions of Africa, malnutrition in children is fought by eating dried caterpillar flour, as in this insect species, the required nutritive elements are very well represented. Likewise, people in Papua New Guinea eat tubers that are poor in lysine and leucine; they compensate nutritional gap by eating palm weevil larvae. The weaver ant, *Polyrhachis vicina* is used in China and in Tibet as a tonic to relieve bone and joint pain, promote longevity, vitality and sexual function, help regulate the immune systems, and it is also noted for its anti-ageing effects. Red ants are rich in bone-building calcium. Based on the phytate composition, insects could be consumed without much fear of harm to humans because, unlike seeds used as food, they do not cause phytic acid toxicity. Oxalate can bind to calcium present in the food, thereby rendering calcium unavailable for a normal physiological and biochemical role such as the maintenance of strong bone, teeth, nerve impulse transmission and cofactors in enzymatic reactions as well as clotting of blood. Saturated fatty acids extracted from the larvae of Locust Bean Tree Emperor Moth (*Bunaea alcinoe*) have potential use in diet management of suffering from certain coronary heart diseases. Termites are exceptionally high sources of iron for those who are weak and anaemic. The Raji tribals of mid-western Nepal are known as the Bee People. They use bee pollen as a tonic for older people and mothers. They also

claim that the whole-body extracts of many bees, wasps, flies, butterflies, moths, cockroaches, beetles, etc., have anti-cancer and anti-bacterial properties. Here it is necessary to mention that many insects are used by the tribals of the different states of India, including those in the northeastern region.

Researchers have reported that insects can be a resource of satisfactory amounts of energy and protein, amino acids, monounsaturated/polyunsaturated fatty acids, and micronutrients, copper, iron, magnesium, manganese, phosphorus, selenium and zinc, as well as riboflavin, pantothenic acid, biotin and in some cases, folic acid. Hence, globally, innumerable enterprises have developed innovative foods by integrating insects into human food products. Among the enterprises, Ronzo, C-Fu, Bugs World Solution Food, Q-Biofábrica, Hakkuna Nutrinsecta, Nordic Food Lab, Entomo Farms, All Things Bugs, Bugzz, Jungle Bar, Steak Tzar Tzar, Earth & Me, Tastebugs, Gryö Bars or Edible Bug, InnovaFeed, EnviroFlight, Ynsect, Hexafly, Protix, Aspire Food Group, Chapul, Nutrition Technologies, Entomo Farms and Goterra are the world leaders. For human consumption, industries mainly concentrate on mealworms (larvae from the beetle family Tenebrionidae), crickets and grasshoppers. For animal feed, the black soldier fly – *Hermetia illucens* (Diptera: Stratiomyidae), the housefly *Musca domestica* (Diptera: Muscidae) and mealworms are being used. Currently, in India, INSECTIFii aims to scale up its production of high-value insect protein produced from black soldier fly larvae to cover South and South-East Asia.

Based on application, the edible insect market is trifurcated into animal feed, food, pharmaceuticals, cosmetics and beverages in South America, Europe, North America, the Middle East, Africa, and the Asia Pacific. According to Barclays, a corporate and investment bank in the UK, edible insect business is now a more than $20 million industry, and the insect protein market could be worth $8 bn by 2030 with over 27 per cent compound annual growth rate. Nowadays, fortified functional food is common in the western world. Mixed bags of grasshoppers, crickets, silkworms, and sago worms are marketed as energy snacks like granola bars. Cricket powder is sold and recommended to be mixed with the flour for baking purposes. Chocolate-coated roasted crickets/mealworms and insect lollipops are some of the innovative products being marketed. Renowned chefs serve insect-laced recipes like cricket-sprinkled salads, mealworm lettuce wraps, cricket fried rice, mescal worm tacos, fried dragonflies, ant egg tostada, mealworm-peppered noodles, silkworm powder-flavoured broth, etc. Recently at the Nutraceuticals Europe Summit & Expo (15–16 June 2022), Spain, presented in the 'Premium Substances' zone, a new line of functional ingredients made from insect protein – baobab pulp and hop extract – for use in making baked goods or high-performance sports nutrition products.

Today, the most prominent application of farming insects is producing food and feed for livestock, including poultry and pet feed. Insect protein is already being consumed by humans on a significant scale in Africa, Asia and South America. Despite such breakthrough in insect industries in different parts of the world, insect farming, which involves breeding, rearing and harvesting various types of insects, is less known and less talked about in India. Within the insect farming space, Black Soldier Fly larvae (BSFL), grasshoppers and cockroaches are now well-accepted candidates. It should, however, also be kept in mind that insects in the mass rearing facilities are prone to viral diseases, which requires adequate knowledge to avert the problem.

India is a mega-diverse nation with rich insect biodiversity due to its varied eco-climatic conditions. About 100 insects have been used to treat various diseases by the tribals in India. In Ayurveda – the authentic knowledge bank of the Indian medicinal system – honey, a natural product of honeybee, is recommended as an oral carrier for all medicines, and it is found that honey is a general health restorative, treats head colds, cough, throat infections, laryngitis, tuberculosis, and lung diseases. It can be applied to the skin to treat excessive scar tissue, rashes and burns. It can be used to prevent cancer as it contains phenols (quercetin, hesperidin, caffeic acid, apigenin, etc.) with anti-cancer properties. Ancient Egyptians also appreciated the medicinal properties of honey (www.beehexagon.net/files/honey/history.pdf).

In India, so far, insects have been relatively neglected as sources of food/feed, although they have significantly contributed to economy in several other Asian countries like Cambodia, Malaysia and Thailand. It may be mentioned that many of them, for example, grasshopper are halal foods. Therefore, it should be acceptable to all sections of society, from tribals to the advanced different religions. It is an opportune time to start paying attention to neglected/undervalued creatures – the insects. The government would do well to promote research and development, leading to better utilization of insects for the development of food, feed, nutraceuticals and pharmaceuticals in the country. Thrust must be given to the development of technology focusing on automatism, cost-effectiveness, energy-efficiency, safe microbial rearing, harvesting and postharvest processing, as well as sanitation procedures to ensure food and feed safety of insect products at a reasonable price on an industrial scale. Organizations like CSIR, ICAR, CDRI and other agencies, including private nutraceutical and pharmaceutical industries, should develop thrust area research programmes under entomophagy and entomo-therapy and contribute to food sustainability and health of the people.

S. K. Shrivastava

Former Professor, Entomology,
Indira Gandhi Krishi Viswavidyalaya,
Raipur 492 012, India
e-mail: shrisurya52@gmail.com