

## **THE ROLE ENTOMOPHAGY IN MEETING THE FOOD REQUIREMENTS OF THE RISING POPULATION**

**Dr. Shivaprasad G<sup>1</sup>, Gayathri.R<sup>2</sup>, Dr. Srividya Shivakumar<sup>3</sup>**

<sup>1,2,3</sup> Department of Agriculture, JAIN (Deemed-to-be University), Bengaluru, India

Email Id- <sup>1</sup>dr.shivaprasad@cms.ac.in, <sup>2</sup>dr.gayathri\_r@cms.ac.in

### **Abstract**

This paper examines the inclusion of insects as well as their consumption as human food which is termed as Entomophagy. Insects are very beneficial not only considering an ecosystem point of view, but also as providing a protein-rich nutrient for human consumption. Some of the species which can be consumed are the drugstore beetle, the silkworm, the termite and the hawkmoth. The various plants existing in the ecosystem such as sweet potato, rice, soybean and green vegetables and their combination fails to provide a diet that is lacking some essential nutrients required by humans. On most of the occasions these essential nutrients are provided by foods derived from animals; for instance, fish, eggs, poultry, meat, dairy products, etc. Nevertheless, the most convenient way to obtain these essential nutrients is to extract from insects which is easier to produce as compared to the others techniques. Further, insects can also satisfy other useful biological roles. At the end this paper suggests some resolutions to earthly problems such as delivering precarious amino acids required by the individuals who suffer from a scarcity of additional conventional proteins resulting from the animals..

**Key words:** Entomophagy, Human, Insects, Interplanetary Agriculture, Species.

### **Introduction**

Entomophagy is the practical term given to the process of consuming insects in order to meet the nutritional requirement. Human being have harvested the larvae, pupae, eggs, and grown-up insect from certain species from suitable habitats or forests to eat for many years. These practices are quiet common in various tropical countries which are suitable for the definite insect species and favors them grow-up to bigger sizes, moreover they are plentiful and comparatively easy to produce on a yearly basis. Insects when consumed as a food are a tremendous source of vitamins, fats, proteins as well as essential minerals[1].

There is a robust evidence in favor of bulk rearing of insects for its consumption as food by humans as this method of protein production is contributing less damage to the environment as compared to the other forms of protein synthesis. For instance, harvesting cattle for meat as well as clearing tropical rain forests is highly destructive. When comparing cattle with the insects it was found that cattle are five times additional capable in converting the food-items into eatable flesh. Further when both the quick developmental times and high reproductive rates were considered together, the efficiency of food conversion among the insects were found to be 20 times more than that of cattle[2].

Nevertheless, a major limitation of mass harvesting insect species in order to meet the food requirement is the short of basic knowledge concerning the insects farming in a sustainable way, moreover deciding the type of species that could be appropriate for harvesting as well as commercially feasible because of the pre-existing markets. In Thailand, regardless of these issues there exist some insect farms in which the farming of red palm weevil and the large larvae are vended as food[3].

The consequent development as well as encouraging to consume insects as food as it contributes to a profitable market can be considered as a better way to augment the preservation worth of natural regions where insects can be reaped either in a sustainable way or mass harvesting can be done artificially by controlling the environment in a nonthreatening manner. Nevertheless, Entomophagy is highly predicted to become quite common in advanced western cultures, due to the absence of strong cultural or food history linked with the consumption of the insect. In the several countries subarctic areas there exist the scarcity of abundant and large insects obtainable for regular reaping and eating therefore the development was not observed in this region[4].

On the other hand, several people living in western areas inadvertently eat insects or their parts every day deprived of any idea regarding the consequences of consuming it. **It has been assessed that within a year average American eats nearly 2 pounds of deceased insects and their parts.** These microbes are present in vegetables, beer, pasta, rice, spinach and broccoli. The Food and Drug Administration of America has permitted the parts of insect per definite food types. For instance, beer made up of hops, can comprise aphids not more than 2,500 per ten grams of hops[5]. In tropical areas lying in the Asian region, people produce insects for consuming it as a food not because of the reason that they are environmentally-friendly, cheap or is best suitable way of meeting the protein requirements, rather because of the good taste insects are consumed at a large scale, prepared or either raw according to customary recipes[6].

The major concerns in engineering space habitation is providing food for human inhabitants remains. Obviously, for long standing astronaut in a space vehicle or on the planet it is necessary to drive a farming system to produce foodstuff as well as decay and recycle leftover products. Traditionally, various kinds of animals are consumed by humans, and when they reach space and live there this will help them to cope-up with the situation. Hence, diverse, interesting, and superior quality food might be an essential factor in forming a convenient environment. Insects have numerous advantages as compared to the various animal groups which can be chosen as modules of a interplanetary agricultural system, particularly within limited systems. Humans have historically eaten insects, as shown by the study of fossilized feces. As a result, this paper suggests that Entomophagy can be considered in conjunction with interplanetary agriculture in order to support human life in a variety of space habitats [7].

In interplanetary agriculture, the systemic role of insects is to improve inedible or inferior bio-mass for people or animal fodders into high quality foodstuffs. In general, insect culture should not be used for astronomical or other capitals that are made up of plant culture. As a result, insects must consume plants or portions of plants that are not suitable for human consumption. Mulberry leaves, for example, are eaten by silkworm larvae and are thus unfit for human consumption. Insects are, however, talented to destroy the indigestible bits of vegetables. It is appropriate if products are degraded in a spatially demanding farming environment by insects. Wooden products, for example, insects are isolated by the aid of partial digestion and mechanical intervention in the course of decay by various soil and fungal species. This makes insects able to provide a key contribution for terminating the materials progressions. The other farm creatures for example cattle, chickens, fish, etc. can also consume Larvae, insect's pupae. The feces of creatures raised in large extent for instance, silkworm can furthermore have utilized either via culturing plankton or providing as a feed to fish in a raw form[8].

Generally, by picking and integrating suitable insect species, the existence of materials loops in an interplanetary agriculture system can be terminated and the consumption productivity of the received energy can be enriched.

#### ➤ **The health benefits of eating insects:**

According to United Nations report by the Food and Agriculture Organization (FAO) in 2013 almost two billion peoples around the globe consume insects as fraction of their traditional diet; and this particular method of eating insects is termed as Entomophagy. The most common insects which are consumed more often are beetles followed by bees, wasps, caterpillars, locusts, ants, grasshoppers, and crickets. Over all, there exists above 1,900 insects species which are considered to be suitable for eating. Entomophagy is considered as general practice in various regions of the globe, including China, Asia, Africa, New Zealand, Australia, and few developing constituencies of Central as well as South America. In some regions of the Western countries; conversely, it looks as if bugs have failed to delight the taste buds. According to a research paper focused on insects as food shows that 72 percent of the individuals residing in America are unwilling to consume insects as a foodstuff. According to the report published in FAO, people regard Entomophagy as very disgusting and often link the consumption insects with nascent behavior in the major regions of Western countries. The people existing in this category should learn the promising health benefits of eating insect which may change their mind[9].

#### ➤ **How the consumption of insects helps to deal with obesity?**

The consumption of insects provides highly nutritional value to the meal as majority of insects are rich in healthy fats, protein, iron, and calcium on the other hand low in carbohydrates. In reality, the FAO report author's claim that the consumption of insects provides more nutrients than frequently consumed meats, for instance beef. For illustration, 100 grams of cricket contains more calories, protein, fat, and carbohydrates as compared to the same quantity of beef. **The researchers involved in the FAO report of consuming insects as a foodstuff finds out the low fat content among beetles which further suggests that Entomophagy can be considered as an efficient way to deal with the obesity and the diseases related to it. According to Daily Mail report on a man living in U.S. who moved from a usual Western food to a diet filled with bugs due to mistakenly receiving a bowl of crunchy crickets instead of peanuts later find out that the consumption of insects in a meal assisted him to lose weight [10].**

➤ **How Entomophagy can help in meeting the food requirements of an increasing population?**

The FAO suggests that Entomophagy could aid a solution to the shortage food that is anticipated to take place with the scenario of increasing population. According to the report published by The World Bank, the worldwide population is estimated to grow nearly nine billion by the end of year 2050, which suggests there is a requirement to produce about fifty percent extra food with the purpose of feeding an additional two billion individuals. The climate changes are anticipated to occur which might reduce the yields of crop production above twenty-five percent, so there is a critical necessity to recognize unconventional ways in order to meet the additional food requirement [11].

The report published in FAO suggests that their existing programs for the sustainability of food contemplate Entomophagy as a viable option. Further it reminds that the fundamental objective is to advance food as well as nutritional security and deliver more environment friendly food recommendations to policymakers and consumers, which also clarifies the meaning of ecologically sustainable food arrangement. The consumption of insects as food falls properly in the category of environment friendly food scenario and in addition, it must be considered as a main candidate as both supplements and food staples as well as for their vital role commonly in sustainable diets.

➤ **The resources derived from animals to meet nutritional necessities:**

An interplanetary agreement for agriculture must be aimed at determining the requirements to recycle vital life-saving materials, to extract additives which can damage life and supply food. Therefore, oxygen needs to be added whereas carbon dioxide needs to be removed from the gaseous phase, and then after all these steps the production of food can be initiated. Furthermore, water condensed by plants in liquid shape must also be condensed. The species selected for the scheme shall be selected on the basis of nutritional importance. As the volume and area for producing agricultural products are insufficient, it is necessary to contemplate the production by unit volume or area over a specified period of time in order to produce food and oxygen at a satisfactory rate [12].

For inter-planetary agriculture, soybean, corn, green vegetables and sweet potatoes, for the availability of dietary fibers, metabolic energies, vitamins, proteins and trace elements including iron and calcium are chosen for the inhabitants. The nutritional value of these four was measured to be the finest mixture of 100 g soybean, 300 g green vegetables 300 g rice per person per day, and 200 g of sweet potato.

The standards used for selecting the above mixture were:

1. Total energy consumption.
2. Sufficiency of quantity of each nutrient.
3. Amino acid score.
4. The energy ratio amid proteins, lipids, and carbohydrates.

Despite all this plant product mix, it does not completely fulfill all individual nutrient requirements. The sodium and lipids are also very limited, and the presence of amino acid does not seem to be balanced either. This is a

reciprocal characteristic of herbal diets. Sodium should also be given in mineral form in order to solve these scarcities by supplying insect-shaped animal protein with several other difficulties.

➤ **Species of Insect for Space Agriculture:**

Roughly 70-75% of all animal species that live on earth are insects and play an active part in the recycling of components in the biosphere of land-dwelling. For example, a large variety of insects, similar to the normal environment, are satisfactory to eat. In nature, insects are equivalent to the commonly consumed lobster, shrimp, and crab, and the taste and flavour of insect-based meat is similar.

In its co-evolution, plants and other inter-species relations between plants and insects are readily recognized by the large assortment of insects. Therefore, in some instances, only a single species of insect can adapt and regulate the protection of the plant, eats the leaves of a specific plant. In order to yield floral nectar, a particular flower is thus dependent on a specific insect for cross-pollination. Because of these environmental characteristics, the interplanetary agricultural system strategy would rely on the natural partnerships between constituent to promote the efficiency of the food associations and the completion of recycling processes.

Therefore, we must have a better knowledge regarding interaction amongst the organisms for the engineering of ecological unit. For interplanetary agriculture purposes, the several species of insect are examined such as the hawkmoth, the silkworm, the termite and the drugstore beetle. In the middle of various advantages, considering the food resources these insects can't compete with human, on the other hand it transforms waste or inedible biomass into eatable food for the consumptions of humans.

### **Literature Review**

"Thiamin Is Decomposed Due to Anophe spp. Entomophagy in Seasonal Ataxia Patients in Nigeria" research paper by Takahiro Nishimune et al. presents a study identifying the thiaminase insect. Their findings suggest the need for extensive heat treatment for African silkworm detoxification, rendering the worm a healthy source of high-quality protein[13]. "Entomophagy: an evolving terminology in need of review" research paper by J. Evans et al explains how the origins and uses of the word 'entomophagy' have developed over time. It highlights some of the issues of the term that require its review; and offers guidelines for potential studies and other practices to use the term. As defined by some Western cultural sources, this paper provides a brief historical analysis of insect feeding, discusses some of the taxonomic ambiguities and difficulties surrounding the category 'insects' and eventually argues for more specific and contextual terminology in this area that is both richly conventional and rapidly evolving[14].

Sigfredo Fuentes explored the sensory and biometric reactions of customers to insect-based food snacks and machine learning models. The results showed greater love and emotional responses for samples which contain insects as ingredients (not visible) and without insects. Insect samples were associated with a lower level of liking and negative emotional reactions. Artificial neural network models demonstrated high accuracy for different cultures to determine liking based on biometric responses. A general model with an accuracy of 89 percent for all cultures was also achieved[15].

### **Discussion**

➤ **The type of Insects which can be consumed:**

In a situation of survival, one couldn't make it probably on bugs alone, regardless of the fact that what few sites would have you believe. But insects are considered undoubtedly a significant part of nature which keeps us alive. The high nutrient content is present in Bugs comprising lots of vitamins and proteins as well as uncertain amounts of fat. The few things should be known before consuming insects. Avoid the glowingly colored insects,

particularly ones that are yellow, red and orange for example, ladybugs. Insects with bright colors appearances are considered as the nature's way of presenting that these particular kind of insects are highly dangerous to consume. Therefore, instead of the bright colored insects chose the difficult-to-view ones such as green, black, and brown. They're imperceptible for a purpose. It's due to the fact that they're the desired foods of humans as well as other critters. Likewise, stay away from insect that release unpleasant odors that generally indicates the presence of toxins within the bugs.

Ironically an exception is stink bugs that are habitually eaten raw in some parts of Mexico as well as some other regions. It is observed to be taste strongly like anise, which later at the end taste like cinnamon. The basic rule about consuming bugs is to cook them when you catch them. Insects are used to protect foul parasites, bacteria, and several other ruthless things. Most of these parasites and bacteria are neutralized by cooking at an optimum temperature. Moreover, cooking helps people to avoid the fact that they're consuming bugs in their regular food.

Following are some of the insect which can be consumed.

### **1. Grasshoppers and Crickets:**

Grasshoppers as well as crickets are insects which are very extensively consumed all over the world. They are present in plentiful quantity at the same time easy to catch also it tastes crunchy when consumed. These insect can be caught with bare hands, even though it's a reasonable amount of work. The easiest way is to catch crickets at night and grasshoppers during day-light. The capturing of grasshoppers in early morning is considered to be good as the cold slows them down. The legs, head, and antennae are removed and then it is roasted in a frying-pan over a fire. The fried grasshoppers are consumed widely and it doesn't taste bad. Figure 1 shows the appearance of a grasshopper.



Figure 1: The physical appearance of a Grasshopper. Grasshopper present in plentiful quantity and are easy to catch also it tastes crunchy when consumed.

### **2. Ants:**

Ants are present in abundant quantity, which sounds beneficial because there is a requirement of whole share of them to overcome the hunger issues among the population. The best suitable method utilized to catch ants are by finding ant hole or an anthill and push a stick inside the hole which enforces the bunch of ants present inside the anthill to crawl up, and once they are out take out the stick and collect ants and put them inside cooking water and boil it. Boiling of ants in a hot water neutralizes the acid present inside the ants which is used to pacify their prey, despite of the fact that it won't human. The consumption of ant with boiling feels like sour taste previously being cooked. Correspondingly, when it is consumed uncooked, it is vital to make sure that they are already

dead so they can't bite when going down the abdomen. If not, boil them to make sure they are dead. Figure 2 shows the appearance of ant.



Figure 2: The physical appearance of an Ant. The consumption of ant with boiling feels like sour taste.

### **3. Termites:**

Around the world Termites are extensively consumed, particularly in regions having the presence of termite mounds moreover they are very tranquil to catch. Termites are very much free of toxins as they eat wood items. The mature adult termites can fly as they possess wings. It is easier to catch them in their early stage as at this moment their wings have not been developed yet which forbids them to fly. In fewethos, the queen termites are considered as a taste of delicacy. Corresponding to ants, the roasted, raw, baked, boiled forms of termites can be consumed by humans. Figure 3 shows the appearance of termites.



Figure 3: The physical appearance of Termites. Termites are very much free of toxins as they eat wood items.

### **4. Grubs:**

The Grubs appears to be gross and slimy when considering their survival scenario. The ideal method of roasting the tiny suckers and preparing Grubs is by picking rotting logs away from each other and looking via a leaf litter. The grubs are more often spongy in appearance and taste better when consumed. Figure 4 shows the appearance of the Grubs.



Figure 4: The physical appearance of the Grubs. The Grubs appears to be gross and slimy when considering their survival scenario.

## **5. Earthworms:**

Earthworms are surely edible and it is more often considered about their nutritious benefits, but on the other hand earthworms taste very dirt, surprise, moreover they totally harbor the various parasites. It seems to be a hectic task to catch them in large quantity. However, during rainy days it is found that bunch of earthworms are coming out from the soil. Not any proper method has been found yet to cook them in such a way that it tastes better. The approach used to consume earthworms are by boiling them numerous times and squash to eliminate the undesirable contents present inside their stomachs. The other way is to roast them followed by pounding them inside a powder, and further adding the obtained powder to additional foods. Figure 5 shows the appearance of Earthworm.



Figure 5: The physical appearance of an Earthworm. Earthworms are surely edible and it is more often considered about their nutritious benefits.

## **6. Locusts:**

Locusts are extensively consumed around the globe, particularly in regions where they appear in swarms. The locust appearance is pretty similar to grasshoppers apart from the fact that they do not swarm. The best efficient way to consume locust is by roasting them after removing the wings, legs, head, as well as antennae and cooking them likewise. After performing all the steps, it seems like nothing much left, despite this locust body is considered very substantial. Figure 6 shows the physical appearance of the Locust.





Figure 6: The physical appearance of the Locust. Locust are extensively consumed around the globe, particularly in regions where they appear in swarms.

#### **7. Bees and Wasps:**

The specialists in the Entomophagy field suggest to create a trap and later pull it with something honeyed. During a survival situation the consumption of bees are something sweet, as the persons who have already consumed before prefer to eat wasps again and again. Among all the species of insect bees are considered to be taste sweeter and better. Figure 7 shows the physical appearance of the bees.



Figure 7: The physical appearance of the Bee. The specialists in the Entomophagy field suggest to create a trap and later pull it with something honeyed.

#### **8. Dragonflies:**

Dragonflies are considered very unique and quite tasty comparing to the other bugs. The citizens of Indonesia, took out their stick, smudge it in some type of sticky fluid, and later catch the flies flying in the air. There is also a different approach to catch dragonflies in which a net is created using a tee shirt along with some branches to catch the flies from the air. The best suited way to consume dragon flies is by remove their wings and later roast them or fry according to the taste of a person to person. Figure 8 shows the physical appearance of the Dragonflies.





Figure 8: The physical appearance of the Dragonflies. Dragonflies are considered very unique and quite tasty comparing to the other bugs.

## 9. Cicadas:

The researchers suggest the person must schedule their backwoods emergency to happen together with the various cycle of these species of insect. This can happen when all of them are observed. The cicadas taste better right after molting, in case of the adult cicadas are most appetizing and gentle. The cooking of cicadas is very similar to the cooking of locust or grasshopper. Figure 9 shows the physical appearance of Cicadas.



Figure 9: The physical appearance of the Cicadas. The cicadas taste better right after molting, in case of the adult cicadas are most appetizing and gentle.

## ➤ Nutritional Value of Insects and Their Prototypical Diet:

The value of nutrients content among the insects was surveyed to figure out whether or not they could provide a feasible alternative to the insect's meat. Despite of possessing comparatively high content of protein as compared to various other mulberry leaf plants, there is a significant improvement in case of protein passing within the insect. Therefore, the improvement of protein content is observed along with the enrichment of numerous precarious amino acids. The silkworm pupa contains the lipid which is eight times as compared to the mulberry leaf. Moreover, it also shows animal-like configuration[16]. This model diet contributes to the key composition such as sweet potato, barley, soya and green vegetable and adds 50 grams of silkworm or various

insects to it. The area required to produce mulberry trees is estimated to be 64 meter square per individual, with the objective of meeting the requirements for supply of this huge quantity of silkworm per day. The cultivation of the four key plant species requires 200  $m^2$  per male.[17].

Despite of the fact that insects doesn't consist full accompaniment of nutrients which can be acquired from avian egg or insect meat, a foremost share of these required nutrients can be provided with them. All the other remaining requirements of nutrients can be full-fill in various other approaches. The materials derived from the chicken are involved to address insufficiencies of B12, cholesterol and vitamin D in the main diet. The insufficiencies in the quantity of vitamin D are overcome by including the Japanese mushroom. If the food is powdered and finely reduced and then exposed to ultraviolet light, the amount may be reduced to turn the antecedent into vitamin D. Different additional nutrients may be used with the tablets or food additives [18].

#### ➤ **The various other considerations:**

For the interplanetary agricultural system the toughness of different organisms is important. The collection of fish species for interplanetary agriculture should be taken into consideration. In several countries the cultivation of fish takes place in rice paddies. In this case, loach fish are known as common species. This particular species of fish's are unaffected by the adverse weather conditions such as fractional aeration of the paddy as well as poor quality of water. It is capable of gulping air within their digestive tube and dissipate it using their anus once the oxygen is absorbed. It possesses a very high value of nutrients. Some others are found to be quite negligible and not concerned about inter planetary agriculture when inspection is carried out to measure the food's nutritional value.

#### **Conclusion**

Entomophagy is observed as a promising means of meeting dietary requirements of human in different planet. In an interplanetary agriculture system insect are capable of recycling objects, process waste, moreover not only it functions as food and feed but also helps to pollinate plants. The prototypical diet which comprises sweet potato, rice, soybean, green vegetable, loach fish and silkworm pupa was found to overcome all the nutritional requirements by the human. The interplanetary agriculture system can be enhanced by integrating insects as their components as they can perform numerous functions devoid of contending with the production of plant. The design of prototype for interplanetary agriculture system must also deliver insight into enhancing the Earth's biosphere management and sanction it for durable sustainability. At the end we conclude that Entomophagy is considered as the promising initiative in mitigating the problem of food shortage across the globe.

#### **References**

1. E. J. S. Lensvelt and L. P. A. Steenbekkers, "Exploring Consumer Acceptance of Entomophagy: A Survey and Experiment in Australia and the Netherlands," *Ecol. Food Nutr.*, 2014, doi: 10.1080/03670244.2013.879865.
2. R. T. Gahukar, "Entomophagy and human food security," *International Journal of Tropical Insect Science*. 2011, doi: 10.1017/S1742758411000257.
3. R. Caparros Megido et al., "Edible insects acceptance by belgian consumers: Promising attitude for entomophagy development," *J. Sens. Stud.*, 2014, doi: 10.1111/joss.12077.
4. A. L. Yen, "Edible insects: Traditional knowledge or western phobia?," *Entomological Research*. 2009, doi: 10.1111/j.1748-5967.2009.00239.x.
5. N. Katayama et al., "Entomophagy: A key to space agriculture," *Adv. Sp. Res.*, 2008, doi: 10.1016/j.asr.2007.01.027.
6. D. Raubenheimer and J. M. Rothman, "Nutritional ecology of entomophagy in humans and other primates," *Annu. Rev. Entomol.*, 2013, doi: 10.1146/annurev-ento-120710-100713.

7. A. Müller, J. Evans, C. L. R. Payne, and R. Roberts, "Entomophagy and power," *J. Insects as Food Feed*, 2016, doi: 10.3920/JIFF2016.0010.
8. J. Ramos-Elorduy, "Anthropo-entomophagy: Cultures, evolution and sustainability," *Entomological Research*. 2009, doi: 10.1111/j.1748-5967.2009.00238.x.
9. M. Premalatha, T. Abbasi, T. Abbasi, and S. A. Abbasi, "Energy-efficient food production to reduce global warming and ecodegradation: The use of edible insects," *Renewable and Sustainable Energy Reviews*. 2011, doi: 10.1016/j.rser.2011.07.115.
10. R. Caparros Megido et al., "Consumer acceptance of insect-based alternative meat products in Western countries," *Food Qual. Prefer.*, 2016, doi: 10.1016/j.foodqual.2016.05.004.
11. L. Nadeau, I. Nadeau, F. Franklin, and F. Dunkel, "The Potential for Entomophagy to Address Undernutrition," *Ecol. Food Nutr.*, 2015, doi: 10.1080/03670244.2014.930032.
12. B. A. Rumpold and O. K. Schlüter, "Nutritional composition and safety aspects of edible insects," *Molecular Nutrition and Food Research*. 2013, doi: 10.1002/mnfr.201200735.
13. T. Nishimune, Y. Watanabe, H. Okazaki, and H. Akai, "Thiamin is decomposed due to anaphe spp. entomophagy in seasonal ataxia patients in Nigeria," *J. Nutr.*, 2000, doi: 10.1093/jn/130.6.1625.
14. J. Evans et al., "'Entomophagy': An evolving terminology in need of review," *Journal of Insects as Food and Feed*. 2015, doi: 10.3920/JIFF2015.0074.
15. S. Fuentes, Y. Y. Wong, and C. G. Viejo, "Non-invasive biometrics and machine learning modeling to obtain sensory and emotional responses from panelists during entomophagy," *Foods*, 2020, doi: 10.3390/foods9070903.
16. A. Halloran and P. Vantomme, "The contribution of insects to food security, livelihoods and the environment," *Fao*, 2012.
17. A. K. Chakravarthy, G. T. Jayasimha, R. R. Rachana, and G. Rohini, "Insects as human food," in *Economic and Ecological Significance of Arthropods in Diversified Ecosystems: Sustaining Regulatory Mechanisms*, 2016.
18. A. Halloran, P. Vantomme, Y. Hanboonsong, and S. Ekesi, "Regulating edible insects: the challenge of addressing food security, nature conservation, and the erosion of traditional food culture," *Food Secur.*, 2015, doi: 10.1007/s12571-015-0463-8.