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Would edible insects become part of our gastronomic quest?

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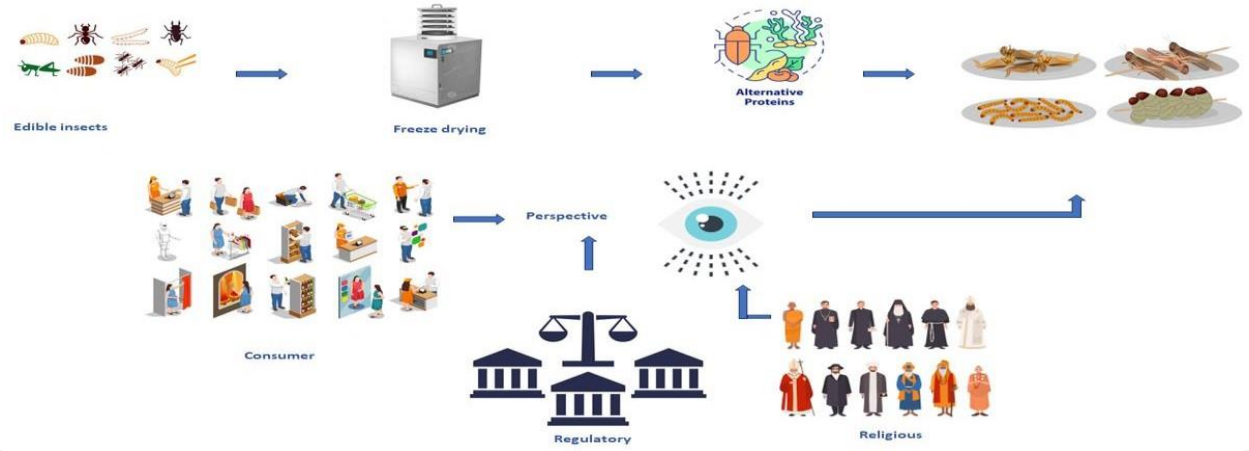
Abstract:



Global food security status has been contested in recent times with claims of efficient food production by the proponents and severe to moderate food insecurity by the opponents. The current population growth prediction of 9.7 billion by 2050 requires additional food production due to the impact of climate change leading to diminished yield rates. Novel food sources such as cellular agriculture utilizing modern biotechnology are at various trial and commercialization stages. Old traditions of insects as a reliable food (entomophagy) source are gaining momentum in recent times. This article explores various aspects of entomophagy. The ecological footprint of entomophagy on its animal counterparts is presented. Since religious factors have a major impact on eating habits that privileges certain elements, perspectives from major religions on entomophagy have been discussed. The regulatory standpoint of Anglo-Saxon, Western and Eastern societies are given. Consumer knowledge and commercialization challenges are also discussed with concluding remarks.

Keywords: *Alternative protein, Entomophagy, Food security, Religion, Sustainable.*

1. Introduction

Global food security status has been contested in recent times with claims of efficient food production by the proponents while the opponents say moderate to severe food insecurity. The factors contributing to food security include production, availability, accessibility, and affordability. Due to its multi-dimensional challenges,a conceptual framework to assess the status at the country level has been developed to monitor the progress of food security annually in the name of the Global food security index (GFSI) since 2012 [1]. The current population growth prediction of 9.7 billion by 2050 requires additional food production with existing ordiminished yield rates due to climate change-related issues.

Thus, ever-growing demands need to be met leading to the exploration of alternative and novel

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food resources. While novel food sources such as cellular agriculture utilizing modern biotechnology to produce proteins are at various trial and commercialization stages, old traditions of insects as a reliable food (entomophagy) source are gaining momentum in recent times [2]. Entomophagy is familiar in tropical and subtropical regions where it has been a dietary constituent for several years. The history of entomophagy by hominids starts before the existence of Homo sapiens [3]. Nonetheless, the stigma surrounding entomophagy does exist even today. Yet, around 140 countries across the globe [4] consume it as part of their diet having beetles as most favorites followed by bees and ants. Historically, it has been a gathered resource harvested from the wild, while contemporary diets explore waysto satisfy their appetite in a healthy way. The food and agriculture organization (FAO) explored the utilization of insects as food and feed to alleviate food insecurity [5].

The ecological footprint of entomophagy seems promising to its animal counterparts in many ways. For instance, the conversion efficiency of ingested feed to the biomass of insect species is significantly higher when compared to other farm animals. In the case of land utilization, insect rearing can be stacked inboxes resulting in a substantial reduction in land use, a more effective approach than Borlaug's hypothesis to increase yield and prevent cropland expansion. On acomparative note of a gram of protein production from livestock, entomophagy requires 56 times less water than beef, 28.5 times less than pork, and 17 times less than chicken [6]. Similarly, it generates low greenhouse gas emissions on a per-kilogram basis when compared with other livestock. In a recent study, it has been stated that eating edible insects does not seem to represent a higher chemical risk than the one potentially offered by consuming protein of macro livestock origin [7]. In addition, the nutritive value in terms of protein, macro- minerals, and bioactive substances appears enormous in most insects making it a preferred alternative to feed the world. According to a report, the global insect protein market is projected to grow approximately 5 times from its current value of $189 million by 2029 with a Compound annual growth rate (CAGR) of 24%. With this background, this article explores various aspects of entomophagy. Since religious factors possess a major impact on eating habits that privileges certain elements, perspectives from major religions on entomophagy have been discussed. The regulatory standpoint of Anglo-Saxon, Western and Eastern societies are presented. Consumer knowledge and commercialization challengeshave also been discussed with concluding remarks.

1.1. Religious Views and Historical Practice

Theology plays a very crucial role in shaping the culture and habits of society at large. A direct interplay does exist between religion and consumerism [8]. Therefore, any technological development of new products is initially subjected toreligious scrutiny as the prescription and proscription of food are predominantly determined by the doctrines of religious practices. In Judaism, based on the commandments revealed to Moses and recorded in the Torah, the kashrut detailsthe kind of food one can eat and describe it as kosher if it falls within the Jewish dietary regulations. Based on specific characteristics indicated by rabbinic literature, eight types of insects are considered kosher. It has been documented that the consumption of locusts was very widespread during the period of the Mishnah and the Talmud. However, the lack of clarity on insects-winged, swarmingcreatures led to a considerable decline and the tradition was preserved only amongJews of Yemen and in parts of northern Africa [9]. The insects-winged, swarming creatures that creep on four legs, and all creatures that crawl on the earth are not kosher [10].

As far as the Christian biblical canon is concerned, in the book of Genesis, God expressed, "I have given you every plant yielding seed that is upon the face of all the earth, and every tree with seed in its fruit; you shall have them for food. And toevery beast of the earth, and to every bird of the air, and to everything that creepson the earth, everything that has the breath of life, I have given every green plant for food" [11]. While there has long been a debate over whether meat should be eaten, disparities amongst the different sects of religion, cultural influences, and the level of orthodoxy play a vital role in determining food habits. For instance, theadaption of a plant-based diet as divine advice by the Adventist school differentiates it from the rest of the Christian schools [12]. Nevertheless, insects

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have historically occupied a very minor position within Christian thought and practice. According to the Old Testament food laws, locusts, katydids, cricket, or grasshopper are permitted (Leviticus 11:20-23) and in the book of Matthew (3:4), it is stated that John the Baptist lived on locusts and wild honey. It has been mentioned in the zoological lectures of Carl Linnaeus that products of bees, bumblebees, and ants were used as food [13]. Likewise, a detailed description of insect food such as ants, Cicadidae, larvae of beetles, locusts, and termites was evident in the book published by Bengt Bergius in 1797 [14]. In Europe, the edibleness of insects has been sporadic and found that ancient Greeks and Romans consumed grasshoppers and beetle larvae as a delicacy [15].

The religious guidelines for Muslims have been well documented in Quran and Sunnah describing what to eat and what not. The dietary practice is related to divine duty and strict adherence is believed to be rewarded by Allah (s.w.t). Quranis the ultimate authority and is believed to be dictated directly to Muhammed (PBUH), the last prophet. Accordingly, food provides nutrients to maintain physical well-being that facilitates worship and not just satisfy whims. Therefore, anypermissible (halal) sustenance is allowed, unless it is forbidden. Generally, blood, dead animals, Porcine, alcohol, predatory animals, and birds are considered haraam (forbidden) and mentioned explicitly in Quran and hadith.

Prior to the origination of Islam, Locusts used to be a favorite dish for Arabs due to the belief that they can be consumed as both food and medicine. The tradition had become lawful when the Holy Prophet Muhammad (peace upon him) was reported to have said: "There are two dead (animals) that are permitted to us (to consume without slaughter); the fish and the locusts [8]. Nevertheless, differencesamong Islamic schools exist. The Sunni schools of Jurisprudence represent about85% of the Muslim population across the world. Within the Sunni schools, the Hanafi Schools consider all types of Arthropoda (hasharaat) including insects are forbidden [16] while the Malikis school deemed them permissible. Shafi and Hanbali scholars prohibited the consumption of certain insects and permitted the consumption of others. The controversies surrounding Cochineal insects-based red dye (E-120) is a classic example. It is considered non-halal according to the Standards and Metrology Institute for Islamic Countries (SMIIC) while it is free to use in Turkish standards [17]. It is not uncommon that these differences exist in other religions also due to interpretational variations among religious scholars.

As far as the Hindu mythological significance is concerned, all living creatures aremanifestations of God and deserve respect and compassion irrespective of whether they are human or non-human forms adopting the principle of "live and letlive". Life and death are due to the action and reaction of the past deed (karma). Human life is considered precious as it comes after many lives of existence in the lower life forms. Thus, by not harming any living being and following the path of karma, one becomes fit for salvation. According to Bhagavad Gita, our eating habit plays an important role in the process of purifying ourselves, and food is classified into three types [18] namely Satvik (quality of goodness), Rajashik (quality of passion), and Tamasic (quality of ignorance). Nevertheless, the prevalence of animal sacrifice did exist even during the Vedic period. With regards to insects, according to Forbes [19], termites were consumed by certain tribes of Southern provinces in India. In Northeastern India insects have been used for both edible and medicinal purposes [20]. Hymenopteran insects are consumed by more than 85% of the tribal population. In Buddhism, according to the teachings of Buddha, the first moral injunction accepted and shared by all schools and lineages is the precept to refrain from destroying living creatures. Thus, killing insect creatures has karmic consequences and should be abstained.

1.2. Regulatory standpoint

While regulation dates to the ancient Egyptian, Indian, Greek, and Roman civilizations, the economic motivation of food adulteration as early as the fourth century BCE resulted in Roman law with punishment for fraudulent activities [21]. In England, the enactment of wholesome food was codified in 1822 with a view toprohibiting the sale of food that is not wholesome. In the contemporary world, the Food and Agricultural Organization (FAO) of the United Nations (UN) plays a pivotal role

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in promoting and strengthening international regulatory cooperation (IRC). The vision is to achieve a hunger-free world thereby improving the living standards of all in a sustainable manner. With this objective, FAO has been working on alternative avenues to mitigate food insecurity. It was the forestry department of FAO in the year 2003 that unfolded the contribution of edible insects to diets in Central Africa. Later, a collaborative effort with Wageningen University and Research Centre to promote entomophagy was instigated. The official expert consultation of FAO to assess the potential of insects as food and feed began in 2012 [22]. During the 17th meeting of the FAO/WHO Codex Alimentarius Coordinating Committee for Asia, a regional Codex food standard was proposed for edible crickets and products made from crickets. Accordingly, the proposal compared edible insects under foods of animal origin and hence the applicable standards *viz*, General principles of Food Hygiene CAC/RCP 1-1969, Code of Hygienic Practice for Meat CAC/RCP 58-2005, and Code of Practice on Good Animal Feeding CAC/RCP 54-2004 deemed fit for this purpose partially or fully. Nevertheless, insect-specific standards with more precise information on farming-related guidelines, insect species that are recognized as safe, labeling, etc. are still lacking. Although the standards of Codex are considered voluntary by the Member Countries, it is used as a benchmark while developing national legislation and helps in resolving trade disputes among the members.

On the other hand, in the European Union (EU), edible insects are classified under 'novel foods' requiring pre-market authorization as per Regulation (EU) 2015/2283. In addition, imports from third countries are also regulated by Article 20 of Regulation (EU) 2019/626. The European food safety authority (EFSA) has carried out a risk assessment on yellow mealworms with positive feedback and approved whole insects and dried powder for human consumption. Currently, there are 3 approved insect species namely yellow mealworm, migratory locust, and house crickets that are considered safe under the uses submitted by the applicant company. Nevertheless, the allergenic potential requires further investigation, and labeling of existing products for possible allergens has been done on a voluntary basis [23].

As far as the Anglo-Saxon countries are concerned, in the USA, regulatory governance of products related to food is under Food and Drug Administration (FDA). There is no specific set of standards for edible insects in the USA. However, any substance that becomes a component of food is an additive and requires premarket approval through a food additive petition (FAP) unless the substance is generally recognized as safe (GRAS) or meets one of the other exclusions from the food additive definition of the Federal Food, Drug, and Cosmetic Act [24]. According to Health Canada which governs the Canadian Food Agency, edible insects shall meet the same requirements as any other foods marketed for human consumption. However, if an insect lacks a history of safe consumption, it is considered in the novel food category. Insect species having historical backgrounds are not classified under the novel food category. The Food Safety Authority (FSA) of the United Kingdom (UK) has carried out a risk assessment on allergens, microbial, and heavy metal contamination from seven edible insect products from the UK market and reported a low risk to the public from edible insects. It has been proposed to classify edible insects under the novel food category and the amendment is expected in Great Britain before 2023. In Australia, entomophagy has been a culinary tradition of indigenous people. The Food Standards Australia New Zealand (FSANZ) categorized insects into three categories namely, traditional, non-traditional, non-novel, and authorized novel food [25].

In Asian countries like China, South Korea, and Thailand, insects are traditional culinary components having informal value chains. Therefore, regulations related to safety are contextual. For instance, Thailand happens to be the world's largest breeder of crickets having formal guidelines for farming (GAP — Good Agricultural Practice) since 2017. With an exception, silkworm pupae in the list of foods allowed by the Ministry of Health in 2014, there is no food law for insects in China. The Korean Food and Drug Administration classified crickets and mealworms as normal foods without restrictions in 2016. African countries namely Kenya, Uganda, Tanzania, and Malawi have developed specific requirements for edible insects and insect products to be used as food and feed while the remaining countries are in the transition to modernize food systems [26].

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1.3. Consumers Perspectives

One of the key determinants of product success is consumer acceptance. Hence, it is imperative to consider consumer attitudes to new products. The contemporary stigma that insects are the food of uncivilized people poses a major challenge in many societies. While eating habits are embedded in the culture and tradition at large, food neophobia and disgust seem to contribute considerably and exist even among the Chinese having historical inheritance of entomophagy [27]. As far as Westerners are concerned, the generalized notion is that insects are harmful as they sting and spread diseases even though not all insect species possess these characteristics. Also, the affinity of certain insects to stool and decaying matter has a psychological impact to consider it disgusting [28]. Consumer attitude and acceptance were studied in detail [29] using the articles published from 2013-2020. Almost 70% of the articles assessed were from the western world having a negative response to edible insects. The main reason for the negativity seems to be associated with food neophobia and disgust. Similarly, in a survey from USA and India, disgust emerges as the predominant factor [30]. In the case of Turkish respondents, food neophobia, health, and religious concerns were found to be the factors contributing to consumer acceptance [31]. On the contrary, Australians carry a neutral or positive attitude towards edible insects [32]. As far as Africa is concerned, a wide range of insects thrives abundantly, and their diets consist of a vast variety of wild foods including edible insects [33]. A comprehensive global survey from 13 different countries involving 7800 respondents concluded that most of the participants (8/13 countries) would not attempt to consume edible insects due to religious prohibition, and adverse reactions such as allergies [34]. The survey also produced the percentage of consumers willing to try edible insects across the globe. It is evident from the figure that countries having cultural or historical backgrounds tend to exhibit a higher percentage of acceptance than those without.

While neophobia and disgust factors are the most challenging barrier to edible insect acceptance, it is also worth considering product presentation, preparation methods, taste, awareness, and interest that could contribute to positivity. For instance, to reduce the impact of neophobia burger patties of insect origin were presented without names in a study. It was observed that the level of acceptance

has improved, placing them between meat and vegetable burger. The results indicate that blending insect-based products with familiar foods can reduce neophobia [35]. To avoid disgust, product presentation through invisible means in the form of powder or processed ingredients has better consumer acceptance comparatively. Partial substitution and reformulation of whole insects or dried powder on various food products are being studied. In this context, a 10% yellow mealworm substitution with 40% pork meat in a frankfurter formulation maintained the quality characteristics [36]. In another study, the addition of 5% mealworm flour in the bread recipe enriched protein of comparable quality to traditional wheat bread [37]. Awareness and interest creation have also been recognized as possible solutions to curb disgust. Product-related benefits through educational interventions regarding entomophagy including live tasting sessions found to provide positive impacts [38]. Since taste is associated with a feeling of pleasure and increases the frequency of consumption, such measures will trigger a positive attitude of acceptance. Pricing is also a contributing factor and needs to be considered. Generally, the cost-benefit of new products will have a better market reach when compared to premium functional food.

1.4. Safety Consideration and Commercialization

Food safety refers to the procedures and practices adhered to while handling food at various stages to minimize the risk of foodborne illnesses. It is considered paramount as more than half a billion cases of foodborne diseases are caused due to unsafe food across the world [39]. Any living organism is prone to microbial and chemical exposure and insects are not exceptional. Unlike animal counterparts,

insects are used fully and as far as farming and processing activities are concerned, it is relatively new. There are about 2111 edible insect species recorded across the world and it is a challenge to generalize microbiological criteria for all edible insects. Since the disease vulnerability of an insect is dependent on

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invading microbes and hence its relevance in causing illnesses in humans and animals need to be studied in detail. According to available data, the most commonmicrobes isolated from reared and wild insects include Gram-positive organisms such as *Staphylococcus*, *Streptococcus*, *Bacillus*, *Micrococcus*, *Lactobacillus*, *Clostridium*, Gram-negative *Enterobacteriaceae*, and *Erwinia* to name a few. The microbiological data from insects were compiled by Vandeweyer and colleagues [40] for almost 2 decades (2000-2019) from different geographical origins. A greater threat has been identified from Bacillus cereus followed by *Staphylococcus* and *Clostridium* while other foodborne pathogens like *Salmonella*, *Campylobacter*, and *Listeria* are of less prominence. In the case of fungus, *Penicillium* and *Aspergillus* were predominant. It has been reported that the transmission of foodborne viruses to humans through edible insects is of less significance [41]. With regards to parasites, *Cryptosporidium*, *Isospora*, *Balantidium*, *and Entamoeba* have been reported to occur frequently [42].

The chemical hazard is associated with the accumulation of contaminants from the substrate and varies across insect species. Investigation into the levels of organiccontaminants such as PCBs, dioxins, pesticides, and heavy metals from the commercial farm was carried out. The organic chemical mass fractions appeared to be low when compared to other animal products. Heavy metal contaminations

were low or comparable to those present in meat or fish [43]. Since available data is fragmented over a wide range of insects, further studies may unravel the significance of chemical hazards. It is noteworthy to mention the impact of food- induced allergies given the fact that food anaphylaxis incidences are mounting in recent times [44]. In general, food allergies are caused when the body's defense mechanism fails to recognize certain food substances and treats them as threats. Since the protein found in many insects is structurally like those found in Crustaceans [45], it is important to address the issue by cautioning the consumer through labeling legislation.

For any new product, the final stage of the development process is commercialization. The broader act of commercialization entails infrastructure andresources, including buildings, equipment for scale-up, personnel, and other key functions critical to achieving mass production. It has been a decade since conceptualization and throughout the value chain, more companies and researchers are exploring robust ecosystems for insect farming. Currently, more than 1.2 trillion insects are raised on farms annually for food and animal feed and industry is growing rapidly in many parts of the world. In the insect value chain, strategies to overcome existing scaling challenges are extensively studied by

SUSINCHAIN, a European Union-funded project with the objectives of developingbusiness models for commercialization, fostering large-scale commercial rearing of insects with continuous improvement, and validating research to guarantee optimal animal performance and product quality among others [46].

2. Conclusion

Globally, there is a great concern for sustainable food production given the fact that our resources are getting depleted with a steady rise in population. While technological advancement leads to novel food categories such as GM food, cultured food, and proteins from algal resources, there exist some differences. Notably, edible insects (wild) have been part of the human diet across the globe for thousands of years. The concern is the legitimate exploration of an existing practice through mass cultivation to meet the growing global demand in a sustainable way. Secondly, entomophagy is a revival attempt by the FAO to meetthe objective of a hunger-free world and has been at the forefront of supporting countries by encouraging insect farming. To this end, there is an increasedawareness on the significance of conscious eating for a healthy lifestyle among consumers. Thus, functional foods are gaining prominence to an extent that the consumer is willing to pay a premium price. As far as edible insects are concerned, studies have shown that it is an excellent source of nutrients packed with essential amino acids, fibers, vitamins, and omega-3 fatty acids. Recently, a comparative nutrient profiling study was conducted for edible insects and meat using profiling models, a method to assess the health claims of foods [47]. The study showed a more profound variation in the nutritional contents than meat and a direct species- to-species comparison is suggested while considering them as meat alternatives.

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Nevertheless, some edible insect species have a higher energy value than livestock meat [48]. From the sustainability perspective, it appears to be a promising alternative. But when it comes to the creation of a hunger-free world, affordability is an indispensable factor to be considered. To the best of our knowledge, information on the economic affordability of novel food categories is generally lacking. According to a recent report from FAO [49], about 40% of the global population cannot afford a healthy diet and this disparity is very alarming. Thus, innovative technologies should not create a competitive advantage but rather accomplish burning issues such as malnutrition. In the case of edible insects, though it has many advantages over meat production in terms of sustainability, and environment-friendly among other factors, currently, edible insects are expensive. The price elasticity is related to the law of supply/demand and is expected to reduce as the demand increases. Also, smart innovative farming techniques using robotics are being attempted to minimize labor thereby facilitating cost reduction. Nevertheless, availability and affordability are the key elements of a successful introduction of new products in the market. From a religious perspective, since insects have been a part of a regular diet in many parts of the world, religions having animal diet practices do not forbid all insects, and hence it is deemed as an opportunity. In the case of Hinduism and Buddhism where the doctrines do not support insect diets, a mixed response is anticipated as observed with animal diets. Regulation is one of the key elements to avoid trade-related barriers across borders. The guiding principle for Codex is to base its work on the best available scientific resources. Therefore, the formulation of guidelines by the Codex commission on edible insects is a need of the hour, especially on allergenicity and other safety parameters to make their way into the global market. Considering the pace at which the industry is growing, entomophagy will soon become an inevitable gastronomic reality.

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References

[1] Thomas, A.-C., D'Hombres, B., Casubolo, C., Saisana, M., and Kayitakire, F. 2017.The use of the Global Food Security Index to inform the situation in food insecure countries, EUR 28885 EN, JRC, Ispra, ISBN 978-92-79-76681-7, doi:10.2760/83356.

[2] Shah, K., Thorakkattu, P., Khanashyam, A. C., Babu, K. S., and Nirmal N P. 2022. Entomophagy: A sustainable alternative towards food security. *Adv in Nutri and Food Sci*: ANAFS-246.

[3] Sutton, M. Q. 1990. Insect resources and Plio-Pleistocene hominid evolution. Proceedings of the First International Congress of Ethnobiology,Museu Paraense Emilio Goeldi, Belém, Brazil, pp 195-207.

[4] Jongema, Y. 2017. List of Edible Insect Species of the World. Laboratory ofEntomology, Wageningen University, The Netherlands. FAO, 2021. Looking at edible insects from a food safety perspective. Challenges and opportunities for the sector. Rome.

[5] Dossey, A.T.; Tatum, J.T.; and McGill, W.L. 2016. Modern Insect-Based Food Industry: Current Status, Insect Processing Technology, and Recommendations Moving Forward. In Insects as Sustainable Food Ingredients; Dossey, A.T., Morales-Ramos, J.A., Rojas, M.G., Eds.; Academic Press: San Diego, CA, USA, pp. 113–152.

[6] Poma, G., Yin S, Tang., B, Fujii., Y, Cuykx, M., and Covaci, A. 2019. Occurrence of Selected Organic Contaminants in Edible Insects and Assessment of Their Chemical Safety. *Environ Health Perspect*: 127(12).

[7] Tajudeen, A.L. 2020. Halal certification of insect-based food: A critique. *Int. J. Islamic Bus. Ethics*, 5 [13].

[8] Amar, Z. 2003. The Eating of locusts in Jewish tradition after the Talmudic period. *The Torah u-Madda Journal*, 11: 186–202.

[9] Hewamanage, W. 2016. "A Critical Review of Dietary Laws in Judaism." *International Research Journal of Engineering, IT and Scientific Research*, 2 [3]: 58-65.

[10] Mclaughlin, R. P. 2017. A Meatless Dominion: Genesis 1 and the Ideal of Vegetarianism. *Biblical Theology Bulletin*, *47*(3), 144-154.

[11] Sanchez, Ruben, Ramon Gelabert, Yasna Badilla, and Carlos Del Valle. 2016. Feeding Holy Bodies: A Study on the Social Meanings of a VegetarianDiet to Seventh-Day Adventist Church Pioneers. *HTS Teologiese Studies/Theological Studies* 72: A3080.

[12] Lönnberg, E. 1913. Linnés föreläsningar öfver djurriket. Uppsala: Akademiska Bokhandeln.

[13] Svanberg, I., and & Berggren, A. 2021. Insects as past and future food in entomophobic Europe. *Food, Culture & Society*, 24:5, 624-638, DOI: 10.1080/15528014.2021.1882170.

[14] DeFoliart, G. R. 1999. Insects as food: Why the western attitude is important. *Annu Rev Entomol*, 44(80), 21–50.

[15] doi: 10.1146/annurev.ento.44.1.21 PMID:9990715

[16] Schleifer, A. 2019. The World"s 500 Most Influential Muslims. Jordan National Library, (10), 44.

[17] Altun S. K., and Aydemir, M. E. 2021. Analysis of E-coded food additives in delicatessen product labels within the status of Halal food. *J VetBio Sci Tech*, 6(1), 29-34.

[18] Yadav. A. 2021. "Traditional Methods of Food Habits and Dietary Preparations in Vedas". *Altern Integ Med*, 10:21.

[19] Forbes J. 1813. Oriental Memoirs: A narrative of seventeen years of residence in India. London: Richard Bentley I 2: 305.

[20] Loganathan, R., and Haldhar, S. 2020. Utilization of edible insects as food in Northeast India. *Indian Entomologist*, 1(2), 25-31.

[21] Hutt, P.B., Hutt P.B. II. 1984, A history of government regulation of adulteration and misrepresentation of food, *Food Drug Cosmetic Law J*., 39,pp. 2-73.

[22] Vantomme, P., Mertens, E., van Huis, A., and Klunder H. 2012. Assessing the potential of insects as food and feed in assuring food security: summary report. Rome (Italy): Food and Agricultural Organization of the United Nations, Forestry Department.

[23] EFSA NDA Panel (EFSA Panel on Nutrition, Novel Foods and Food Allergens),Turck D, Castenmiller J, De Henauw S, Hirsch-Ernst KI, KearneyJ, Maciuk A, Mangelsdorf I, McArdleHJ, Naska A, Pelaez C, Pentieva K, Siani A, Thies F, Tsabouri S, Vinceti M, Cubadda F, Frenzel T,Heinonen M, Marchelli R, Neuh€auser-Berthold M, Poulsen M, Prieto Maradona M,Schlatter JR, vanLoveren H, Ververis E and Knutsen HK, 2021. Scientific Opinion on the safety of dried yellowmealworm (Tenebrio molitorlarva) as a novel food pursuant to Regulation (EU) 2015/2283. *EFSA Journal* 2021;19(1):6343, 29 pp.

[24] USFDA. 2013. Generally recognized as safe. United States Food and Drug Administration. http://www.fda.gov/Food/IngredientsPackagingLabeling/GRAS/

[25] Sogari, G., Amato, M., Biasato, I., Chiesa, S., and Gasc,o L. 2019. The Potential Role of Insects as Feed: A Multi-Perspective Review. *Animals*. 9(4):119.

[26] Niassy, S, Omuse, E. R., Roos, N., Halloran, A., Eilenberg, J., Egonyu, J.P.,Tanga, C., Meutchieye, F., Mwangi, R., Subramanian, S., Musundire, R., Nkunika POY., Anankware, J. P., Kinyuru, J., Yusuf, A, and Ekesi, S. 2022.Safety, regulatory and environmental issues related to breeding and international trade of edible insects in Africa. *Rev Sci Tech*, 41(1):117-131.

[27] Liu, A., J, Li., J, and Gómez, M. I. 2019. Factors Influencing Consumption of Edible Insects for Chinese Consumers. *Insects*. 20;11(1):10.

[28] Looy, H., Dunkel, F.V. and Wood, J.R. 2014. How then shall we eat? Insect-eating attitudes and sustainable foodways. *Agric Hum Values* **31**, 131–141.

[29] Ngo, H. M., and Moritaka, M. 2020. Consumer attitudes and acceptance ofinsects as food and feed: A review. *J Fac Agr Kyushu Univ*. 66(2), 259– 266.

[30] Ruby, Matthew B., Paul Rozin, and C-D. Chan. 2015. "Determinants of willingness to eat insects in the USA and India." *Journal of Insects as Foodand Feed*,1(3): 215-225.

[31] Bakkaloglu, Z. 2022. Edible insect consumption and Turkish consumers' attitudes towards entomophagy. *Journal of Agriculture, Environment and Food Sciences*, 6 (1): 165-171

[32] Wilkinson, K., Muhlhausler, B., Motley, C., Crump, A., Bra,y H., Ankeny, R. 2018. Australian Consumers' Awareness and Acceptance of Insects as Food. *Insects*. 9(2):44.

[33] Raheem, D., Carrascosa, C., Oluwole, O. B., Nieuwland, M., Saraiva, A., Millán, R., and Raposo, A. 2019. Traditional consumption of and rearing edible insects in Africa, Asia and Europe. *Crit Rev Food Sci Nutr*. 59(14):2169-2188.

[34] Castro, M., and Chambers, I. V. E. 2019. Willingness to eat an insect-basedproduct and impact on brand equity: A global perspective. *J Sens Stud*, 34:e12486.

[35] Megido, R. C., Gierts, C., Blecker, C., Brostaux, Y., Haubruge, E., Alabi, T.,Francis, F. 2016. Consumer acceptance of insect-based alternative meat products in Western countries, *Food Quality and Preference*, 52: 237-243.

[36] Choi Y. S, Kim T. K, Choi H. D, Park J. D, Sung J. M, Jeon K. H, Paik H. D,Kim Y. B. 2017. Optimization of Replacing Pork Meat with Yellow Worm (*Tenebrio molitor* L.) for Frankfurters. *Korean J Food Sci Anim Resour*;37(5):617-625.

[37] Gantner, M.; Król, K.; Piotrowska, A.; Sionek, B.; Sadowska, A.; Kulik, K.; Wi ˛acek, M. 2022. Adding Mealworm (Tenebrio molitor L.) Powder to Wheat Bread: Effects on Physicochemical, Sensory and Microbiological Qualities of the End-Product. *Molecules*, 27, 6155.

Edelweiss Applied Science and Technology
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[38] Barsics, F.; Megido, R.C.; Brostaux, Y.; Barsics, C.; Blecker, C.; Haubruge, E.; Francis, F. Could new information influence attitudes to foods supplemented with edible insects? *Br Food J.* 2017, 119, 2027–2039
[39] World Health Organization. 2015. WHO estimates of the global burden of foodborne diseases, foodborne disease burden epidemiology reference group 2007- 2015. https:// apps.who.int/iris/handle/10665/199350
[40] Vandeweyer D, De Smet J, Van Looveren N, Van Campenhout L. 2021.Biological contaminants in insects as food and feed. *J Insects Food Feed.*7:807-22.
[41] Bertola, M., and Mutinelli, F. 2021. "A Systematic Review on Viruses in Mass-Reared Edible Insect Species" *Viruses* 13(11): 2280.
[42] Gałęcki R, and Sokół R. 2019. A parasitological evaluation of edible insects and their role in the transmission of parasitic diseases to humans and animals. *PLoS One*, 8;14(7): e0219303.
[43] Poma G, Cuykx M, Amato E, Calaprice C, Focant JF, Covaci A. 2017. Evaluation of hazardous chemicals in edible insects and insect-based foodintended for human consumption. *Food Chem Toxicol*, 100:70-79.
[44] Baseggio Conrado, A., Ierodiakonou, D., Gowland, M. H., Boyle, R. J., and Turner, P. J. 2021. Food anaphylaxis in the United Kingdom: analysis of national data, 1998-2018. *BMJ (Clinical research ed.)*, *372*, n251.
[45] Broekman H, Verhoeckx K.C, den Hartog Jager C.F, Kruizinga A.G, Pronk-Kleinjan M, Remington B.C, Bruijnzeel-Koomen C.A, Houben G.F, Knulst A.C. 2016. Majority of shrimp-allergic patients are allergic to mealworms. *J Allergy Clin Immunol.* 137(4):1261-1263.
[46] Veldkamp T, Meijer N, Alleweldt F, Deruytter D, Van Campenhout L, Gasco L, Roos N, Smetana S, Fernandes A, van der Fels-Klerx HJ. 2022. Overcoming Technical and Market Barriers to Enable Sustainable Large- Scale Production and Consumption of Insect Proteins in Europe: A SUSINCHAIN Perspective. *Insects.*12;13(3):281.
[47] Weru, J., Chege, P., Wanjoya, A. *et al.* 2022. Comparison of healthfulness of conventional meats and edible insects in Sub-Saharan Africa using threenutrient profiling models. *Bull Natl Res Cent*, 46:43.
[48] Orkusz A. 2021. Edible Insects versus Meat-Nutritional Comparison: Knowledge of Their Composition Is the Key to Good Health. *Nutrients.* 6;13(4):1207.
[49] FAO, IFAD, UNICEF, WFP and WHO. 2020. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome, FAO.

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