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Black Soldier Fly for Food Sufficiency and Agricultural Waste Management

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Introduction

The amount of food consumed is increasing at an exponential rate as living standards rise and the human population grows. As a result, the amount of food waste is rapidly increasing, creating a wide range of socioeconomic issues. Food waste is described by the Food and Agriculture Organization (FAO) as food that is discarded, usually in the retail and consumption stages.

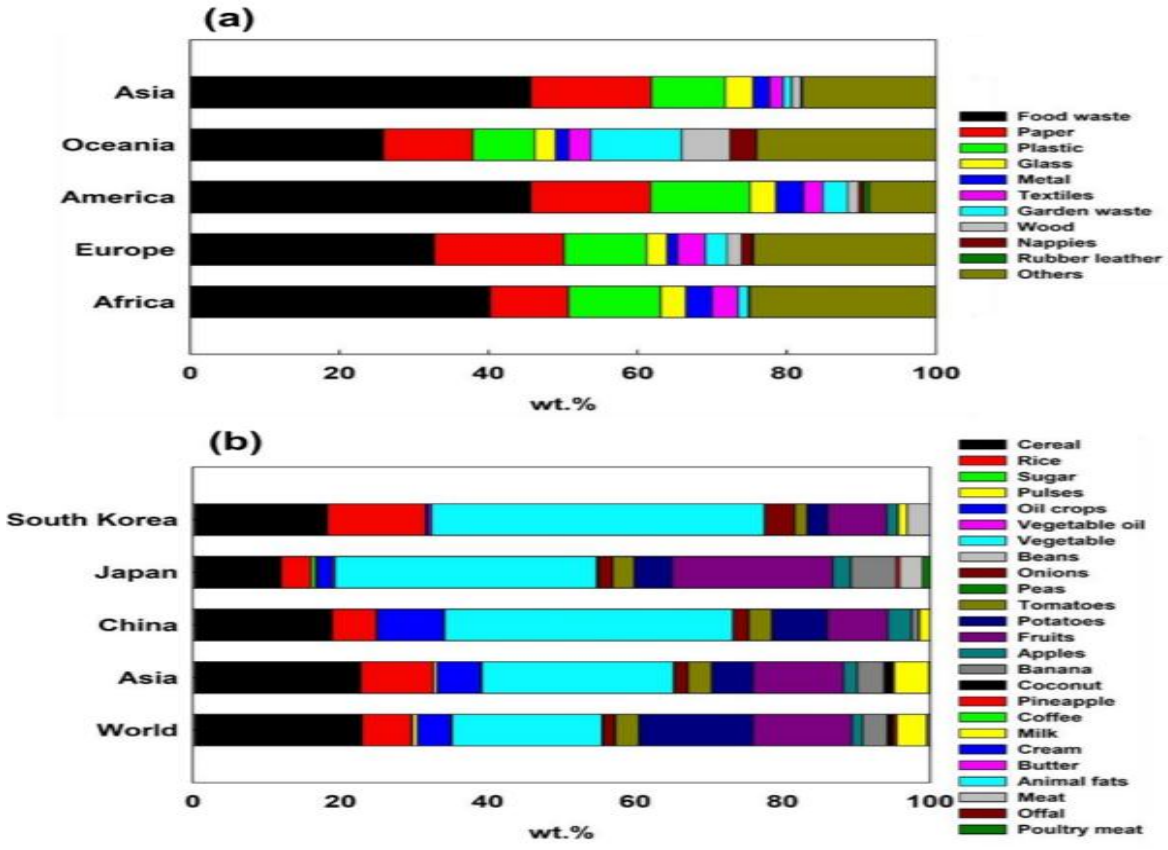

Figure 1: a) Different compositions of wastes in different continents b) Typical food waste worldwide. (Kim et al., 2021)

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In the past, the poultry sector has gained popularity due to its superior environmental and economic benefits compared to other livestock production systems. Therefore, it is of special interest to focus on refinement and innovation along the value chain to further improve the sector's sustainability. The move to sustainable protein sources in chicken feed is a serious concern. In this aspect, insects are the rising stars of the future. For example, the black soldier fly (Hermetia llucens) has been proposed for cultivation as a multipurpose mini livestock for feed. These flies' larvae have the ability to convert low-quality organic waste streams into desirable body mass. Furthermore, because the larvae have bioactive chemicals and chickens are naturally drawn to them, they are said to be good for their health and well-being.

Life cycle and development of BSF

Hermetia illucens is a true fly (Diptera) belonging to the Stratiomyidae family. Though it originated in the Americas, it today thrives in tropical and temperate climates all over the world. A complete life cycle of BSF has been shown in figure 2.

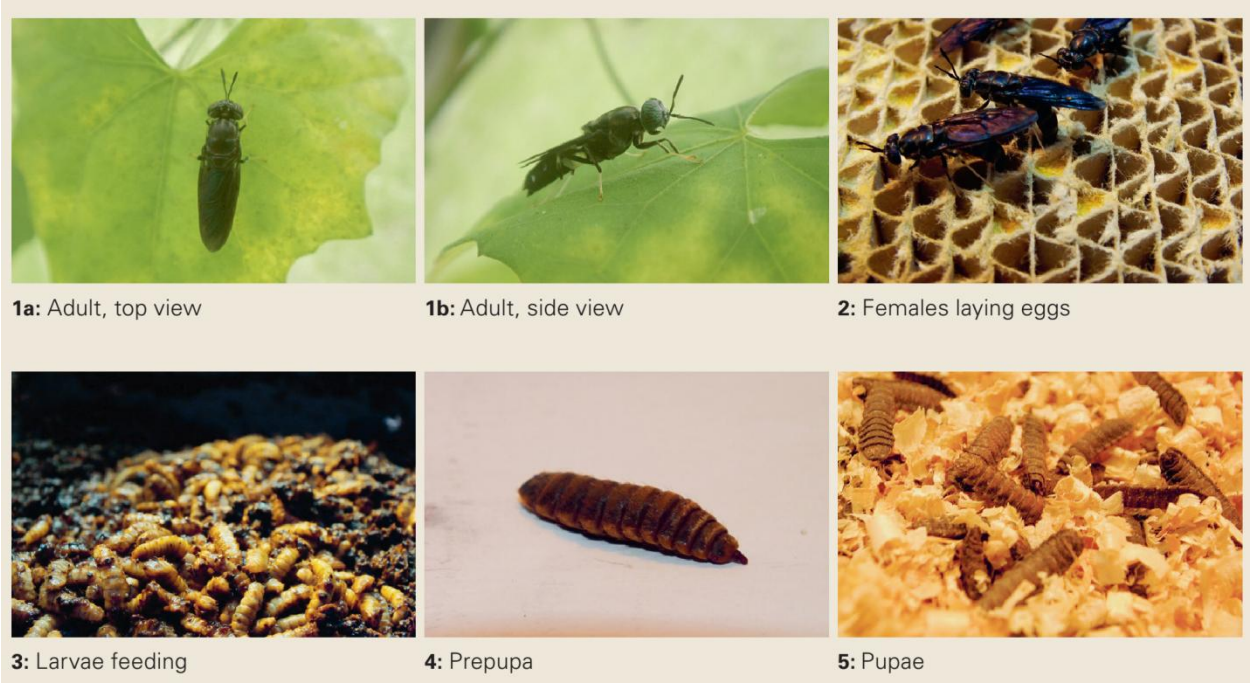

Figure 2: Developmental stages of BSF (taken from Dortmans et al., 2021)

Why to choose BSF?

There are various attributes of BSF that make it a promising organism for food and feed. Some of these attributes are given below:

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- Larvae and residue are created from waste biomass. The larvae have a protein content of 35% and a crude fat content of 30% (based on dry mass). The insect protein is of excellent grade and is a valuable feed source for livestock. It has been proven in feed studies to be a viable alternative to fish meal.
- When utilized in agriculture, the residue, which is comparable to manure, comprises nutrients and organic matter and helps to improve soil conditions.
- A very high waste to biomass conversion rate.
- Disease-transmitting bacteria, such as Salmonella spp., have been demonstrated to be inactivated by feeding waste to larvae. This means that employing this technology on a farm or treating animal waste in general reduces the danger of disease transmission between animals and between animals and people (e.g. chicken manure or slaughterhouse waste). However, rather than pathogen inactivation, the majority of risk reduction is achieved by material reduction (80%).
- Very easy to maintain and operate the raring facilities in low and medium income countries like India.

Suitability and record for human consumption

Entomophagy, or the eating of insects, has been done by humans on every inhabited continent throughout history and continues now. Insects are more prevalent in the diets of some current civilizations, whereas they are forbidden or at the very least unappealing in others. It's difficult to locate evidence of BSF intake by humans. Part of the problem is that ethnologists aren't always entomologists, and locals who consume an insect aren't always likely to use its scientific name, making exact identification of the species impossible. Only one clear incident of humans consuming BSF was discovered. More than 60 species of insects are consumed in Malaysia's Sabah province on the island of Borneo, primarily by specific sections of the indigenous Kadazan-Dusun people, who make up nearly a third of Sabah's population. One of these is BSFL, which is eaten raw with tapai, a locally produced fermented beverage. The larvae are recovered from the fermented tapioca utilized in the beverage's production.

Dried entire BSFL, BSFL oil, and macerated, milled BSFL are available for purchase from companies that produce these for livestock feed. According to one edible insect blogger, the dried, whole BSFL has a harsh and unappealing fishy odour, and we can confirm that the

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live insects smell no better. The flavour is better than the smell: earthy, chocolate-malty, with a silky, melt-in-your-mouth texture and mild fish undertones. Defatting had a minor negative impact on flavour, with the oil taking on more chocolate or malt notes. Other consumers have expressed less positive feelings about the BSFL flavour in personal communications with these writers, despite the fact that cooking methods alter BSFL flavours, like they do most other meals.

Conclusion and future perspectives

BSFL are palatable, nutritious, and, awaiting the development of large-scale biorefineries, can theoretically be reared more sustainably than current farmed insects (and, hence, current farmed animals). As a result, they are a potential protein source for humans in the future as well as in developing countries. However, in human food systems, its principal use will most likely be to minimize and recycle waste biomass linked with the production and consumption of other foods, from farm to table to toilet, with auxiliary uses like animal feed or biodiesel feedstock. Legal restrictions already limit the use of waste-fed BSFL as animal feed, let alone as a human diet, and these will not change unless safety evaluations show that it is safe. Other obstacles to making BSFL acceptable to humans include sensory and cultural, as they are for all insects. It is conceivable to turn BSFL into human food, but there is no guarantee that this is the best answer to food poverty or that BSFL will ever lose its saprophagous reputation.

References

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Kim, C.H., Ryu, J., Lee, J., Ko, K., Lee, J.Y., Park, K.Y. and Chung, H., 2021. Use of black soldier fly larvae for food waste treatment and energy production in Asian countries: a review. *Processes*, *9*(1), p.161.