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INSECTS SPECIES INVOLVED IN WASTE BIOCONVERSION AND USE AS ANIMAL FEED

Ţucă Ovidiu[1*], Stan Cătălin[1],
[1]University of Craiova, Faculty of Horticulture
* *Correspondence author. E-mail*: ovidiu.tuca@edu.ucv.ro

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ABSTRACT

Insect food bioconversion refers to the process of using insects to convert organic matter, such as food waste or agricultural byproducts, into more valuable products like protein-rich insect biomass, oils, and fertilizers. This practice has gained attention as a sustainable and environmentally friendly solution to address several global challenges, including food security, waste reduction, and resource conservation.Neuroptera and Diptera each with one species. Various insect species, such as mealworms, black soldier flies, crickets, and houseflies, are commonly used in bioconversion processes due to their ability to efficiently consume organic matter and convert it into valuable products.
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INTRODUCTION

As the global population continues to grow, so does the magnitude of the waste generated. One type of waste that poses a significant challenge is organic waste, particularly from sewage and wastewater treatment. Conventional waste management practices are often energy-intensive and environmentally harmful.

As the world population increases, the humanity demands and needs for food and nutrition, especially for animal protein, have also been growing (Kearney 2010). However, a sustainable and innovative solution is emerging – the use of human waste as a feed source for insects. Insect bioconversion is not only a promising method for waste reduction but also offers a sustainable source of protein and other valuable byproducts.

Using human waste as a food source for insects is an innovative and sustainable approach that holds promise in addressing several pressing global challenges. This practice, known as insect bioconversion, involves feeding organic waste materials from human sewage and wastewater treatment to insects, such as black soldier flies, mealworms, or crickets

Bioconversion of waste into high-value products is necessary for effective waste management and establishing a circular economy (Reddiex, Gosden, Bonduriansky & Chenoweth 2013). Insects have gained attention for the bio-conversion of lowvalue substrates into affordable, high-quality animal feed and organic fertilizers (Macombe et. al. 2019, Niyonsaba et. al. 2021). Insects have many advantages over plants and livestock animals, such as a short life cycle, growing on cheap feedstock (organic waste), limited land and water requirements, high conversion rate, low gas emissions, and high sustainability (van Huis & Oonincx 2017).

MATERIAL AND METHODS

The Role of Insect Bioconversion

Insect bioconversion, the process of using insects to consume organic waste materials, has gained traction as an eco-friendly alternative to traditional waste management practices. In this approach, select species of insects are fed with organic waste from sewage treatment plants, including food scraps and sludge. These insects efficiently convert the waste into protein-rich biomass, reducing the volume of organic waste that needs to be disposed of through conventional means.

Environmental Benefits

Waste Reduction: The most immediate benefit of using insect bioconversion is the significant reduction in organic waste. This practice diverts organic waste from landfills and incineration, thus mitigating methane emissions and reducing the environmental impact associated with waste disposal.

Resource Efficiency: Insects are highly efficient at converting organic matter into biomass. This efficiency minimizes the need for extensive agricultural land and freshwater resources to produce animal feed, reducing the strain on ecosystems.

Greenhouse Gas Reduction: By diverting organic waste from landfills, insect bioconversion helps reduce the release of greenhouse gases, such as methane and carbon dioxide, which are produced during the decomposition of organic waste.

Economic and Social Benefits

Protein Production: Insect biomass is a rich source of protein, making it a potential solution to address the growing demand for sustainable protein sources. Insect-based protein can be used for animal feed, pet food, and even human consumption, offering economic opportunities for protein production.

Job Creation: The establishment of insect farming and processing facilities can generate employment opportunities in waste management, agriculture, and the insect farming industry.

Local Solutions: Insect bioconversion can be implemented at various scales, from small-scale community projects to large industrial operations, making it adaptable to local contexts and needs.

RESULTS AND DISCUSSIONS

Since it became clear that insects could also be reared on larger scale to serve as a protein source for feed and food, commercial insect production has been receiving additional interest.

In the past decade, the number of farms producing insects on a larger scale has been increasing in America and Europe as well, with the former focusing *on A. domesticus* and the latter producing mainly *H. illucens* and *T. molitor* (Niyonsaba et. al. 2021).

Hermetia illucens, the black soldier fly, belong to the *Stratiomyidae* family, *Diptera order*.

The adults of *H. illucens* are about 14 - 16 millimetres long, the predominant colur is black with metallic reflections, with a reddish end of the abdomen. The antennae are about twice the length of the head. The legs are black with whitish tarsi. The wings are membranous. The larvae are about 20 -25 millimetre long.

An adult female lays eggs in crevices, decaying matter such as manure or compost. The larval stage lasts from 18 to 36 days, the pupal stage lasts from 1 to 2 weeks (Holmes et. al. 2013, Tomberlin et.al. 2002). Adults can live typically 47 to 73 days when provided with water and food, such as sugar in captivity or nectar in the wild (Nakamura et. al. 2016, Bruno et. al. 2019).

Tenebrio molitor, yellow mealworm beetle, belong to the *Tenebrionidae* family, *Coleoptera order*

Mealworms are the larval form of the yellow mealworm beetle, *Tenebrio molitor*, a species of darkling beetle. Like all holometabolic insects, they go through four life stages: egg, larva, pupa, and adult. Larvae typically measure about 2.5 centimetres or more, whereas adults are generally 1.25 to 1.8 centimetres in length. The mealworm beetle breeds prolifically. Over her adult lifespan of about 6-12 months, a female will, on average, lay about 500 eggs. After the final molt, they pupate. The new pupa is whitish and turns brown over time. After 3 to 30 days, depending on environmental conditions such as temperature, it emerges as an adult beetle.

Acheta domesticus house cricket, belong to Gryllidae family, *Orthoptera orde,*

The house cricket is typically gray or brownish in color, growing to 16–21 millimetres (0.63–0.83 in) in length. Males and females look similar, but females will have a needle from the rear, approximately the same length as the cerci.

The house cricket is an omnivore that eats a range of plant and animal matter. Crickets in the wild consume flowers, leaves, fruits, grasses and including dead members of their own species. Crickets in captivity will accept fruits (e.g. apples, oranges, bananas), vegetables (e.g. potatoes, carrots, squash, leafy vegetables), grains (e.g. oatmeal, cornmeal, cooked corncobs, alfalfa, wheat germ, rice cereal), various pet foods and commercial cricket food(Galloway 1998).

House crickets take two to three months to complete their life cycle at 26 to 32 °C (79 to 90 °F). They have no special overwintering stage, but can survive cold weather in and around buildings, and in dumps where heat from fermentation may sustain them. Eggs are deposited in whatever moist substrate is available. Juveniles resemble the adults except for being smaller and wingless (Walker 2007).

CONCLUSIONS

The use of human waste as a feed source for insects represents a sustainable and circular approach to waste management and protein production. It offers environmental benefits by reducing waste and greenhouse gas emissions, economic advantages through protein production, and social benefits such as job creation. However, successful implementation requires careful planning, research, and adherence to safety standards. Insect bioconversion has the potential to revolutionize waste management practices and contribute to a more sustainable and resource-efficient future.

While the concept of using human waste for insect feed is promising, it is not without challenges. Ensuring the safety and quality of the insect-derived products is crucial.

Insect food bioconversion holds promise as a sustainable and resource-efficient way to address some of the pressing global issues related to food waste, protein production, and environmental sustainability. However, its widespread adoption depends on continued research, changes in regulations, and increasing acceptance among consumers and industries.

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