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Insects: The Promising Protein Factory and Waste Valoriser Revolutionizing Aquaculture

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As the global population rapidly grows to 10 billion by 2050, the need for sustainable and efficient food production has never been pressing. The most recent statistics indicates that, global aquaculture production hit a record-breaking 130.90 million tons in 2022 (SOFIA, 2024). The aquaculture sector, which is already indispensable in providing global food demands, is facing growing challenges, including rising feed costs, pollution, and the need to reduce its dependence on traditional fishmeal and soybean meal. In this cross-roads, the arrival of insects is a boon to the industry because they represent an understated yet revolutionary subject in the quest for sustainable aquaculture. Insects, particularly black soldier flies (*Hermetia illucens*) and mealworms (*Tenebrio molitor*) have emerged as strong options for inclusion in aqua feeds (Singh et al., 2023). Their protein content is comparable to fishmeal, indicating a remarkable amino acid profile required for aquatic animals' growth and health. According to studies, insect protein can effectively substitute up to 50% of fishmeal in diets for a number of fish species without affecting growth performance or feed efficiency (Siddaiah et al., 2023). This substitution not only reduces pressure on wild fish species, but also promotes to create a more balanced and resilient food system. Furthermore, insects are not only a feasible protein source; they are also high in lipids, vitamins, and minerals, which boost the nutritional content of aqua-feeds (Ardra et al., 2024). The inclusion of them in fish diets has been related to improved intestinal health, disease resistance, and even better quality products in terms of flavour and texture. As research reveals the many benefits of insect-based feed, the potential for wider adoption in the industry grows tremendously.

In addition to their nutritional value, insects provide an innovative approach to a long-standing problem in aquaculture: the management of waste as they possess excellent bioconversion abilities (Singh et al., 2023). Black soldier fly larvae have the ability to effectively consume and convert organic waste, such as agricultural by-products, food scraps, and specific types of manure, into biomass that is rich in high-quality protein and lipids. This approach not only reduces the volume of waste but also lessens greenhouse gas emissions and minimizes the environmental impact of aquaculture operations. By incorporating insects into the waste management systems of fish farms, a closed-loop system is established that illustrates the principles of circular economy. Aquaculture-generated organic waste can be recycled as feed for fish by recycling it into insect biomass. This mutually beneficial interaction reduces the necessity for external feed inputs and waste disposal, promoting a more sustainable and economically feasible industry model.

Plants and animals can benefit from the insect frass, which is made up of leftover substrate, shell fragments shed by the larvae, and faeces from the larvae (Romano et al., 2024). They have been reported to have a variety of minerals and can be used as organic fertilizers with comparable results to synthetic ones. As insect production grows in several countries, it has the potential to reduce pressure on fertilizer manufacturing while also rejuvenating organic agriculture. The use of frass has also benefited integrated fish-plant culture in aquaponic environments by improving plant nutritional status. The sugar and manganese content of sweet banana peppers (*Capsicum annuum*) and sweet potato (*Ipomea batatas*) is reported in aquaponics system by frass application (Romano et al., 2022). Furthermore, chitin derived from insect shell is thought to boost plant health and prevent insect pests when blended in soil (Sharp, 2013). However, the quality of frass generated depends on the substrate being used. The other use of frass is its potential as feed ingredient. In an initial attempt to use frass in fish feed, it came to light that up to 45% of frass can be used in fish diets without

significantly affecting tilapia fish growth performance (Webster et al., 2016). Similarly, in other fish, such as channel catfish (*Ictalurus punctatus*), its incorporation can reach up to 30%. As in catfishes, a higher protein demand is apparent; frass from insects fed plant substrate is expected to impede fish growth and physiology due to low frass protein levels and phytotoxic chemicals prevalent in plants (Yildirim-Aksoy et al., 2020).

The use of insect protein and the valorization of waste would have far-reaching economic implications. Unlike conventional livestock and crop farming, insect farming makes substantially less use of water, land, and energy. Reduced feed costs are made possible by their adaptability in being grown on a variety of substrates, including low-value organic waste. Because of their low production costs and high yields, insects are a great option for feed companies and aquaculture businesses looking for ways to save expense. Aligning with global efforts to tackle climate change and biodiversity loss, there has been a shift towards insect-based solutions, which has benefits for the environment. Sustainable management of organic waste reduces pollution and improves resource efficiency, while reducing reliance on wild-caught fish for fishmeal alleviates pressure on marine ecosystems. The aquaculture operations may help establish a more sustainable future by adopting insect farming practices, which significantly reduce its environmental impact.

Insects have much of promise, but there are a lot of obstacles to their widespread use in aquaculture. Insect protein is an important ingredient in animal feed, but there is a lack of consistency and oversight in the regulations that control its use. The extent to which insect-based products are accepted by the public is also greatly affected by this factor. In order to overcome these obstacles and establish an environment that is conducive to innovation, extensive research and educational programme are necessary.

The most significant hurdle to insect utilization in fish diets is the volume of production required for commercial feed manufacturing, and only a few countries now have commercial facilities for this purpose. Insect meal, while valuable, requires identification of local strains as concerns about biodiversity challenges emerge (Ebeneezar et al., 2021). The success of insect breeding and growing is also heavily influenced by a number of physical and biological parameters, including the illumination intensity in the facilities. This line requires extensive research. The emergence of microbiome and omics in research can be linked to insect feeding in fishes in order to understand how different substrates ingested by larvae modify the microbial flora, which is then reflected in aquatic species. Aside from frass and feed, various applications of insect byproducts can be studied for therapeutic and cosmetic sectors, similar to the model used in nations such as Singapore.

In conclusion, aquarists have an opportunity to reconsider waste management and protein production from an environmentally friendly perspective through insects. They enhance the economic resilience of aquaculture sectors by efficiently transforming organic waste into valuable feed supplies, while tackling significant environmental issues. One instance of promoting sustainability and innovation to meet future food needs is by integrating insects into the aquaculture supply chain. Stakeholders in the aquaculture business should promptly use this chance to contribute towards developing a more sustainable industry for future generations.

References

1. Ardra M., et al. "The effect of fishmeal replacement with organic acid fermented black soldier fly (Hermetia illucens) larvae meal on growth, nutrient utilization, metabolic enzyme activity, antioxidant status and immunity in Pangasius (Pangasianodon hypophthalmus)". Aquaculture 591 (2024): 741114.
2. Ebeneezar S., et al. "Nutritional evaluation, bioconversion performance and phylogenetic assessment of black soldier fly (Hermetia illucens, Linn. 1758) larvae valorized from food waste". Environ Tech & Innov 23 (2021): 101783.
3. FAO. The State of World Fisheries and Aquaculture 2024. Towards Blue Transformation. Rome, FAO (2024).
4. Romano N., et al. "Applications of black soldier fly (Hermetia illucens) larvae frass on sweetpotato slip production, mineral content and benefit-cost analysis". Agronomy 21 (2022): 928.
5. Romano N., et al. "Type of black soldier fly (Hermetia illucens) larvae frass influences the nutritional value when included in a prepared diet for Mozambique tilapia (Oreochromis mossambicus)". Aquaculture 589 (2024): 740946.

6. Sharp RG. "A Review of the Applications of Chitin and Its Derivatives in Agriculture to Modify Plant-Microbial Interactions and Improve Crop Yields". Agronomy 3.4 (2013): 757-793.
7. Siddaiah GM., et al. "Dietary fishmeal replacement with Hermetia illucens (Black soldier fly, BSF) larvae meal affected production performance, whole body composition, antioxidant status, and health of snakehead (Channa striata) juveniles". Animal Feed Science and Technology 297 (2023): 115597.
8. Singh SK., et al. "The current state of research and potential applications of insects for resource recovery and aquaculture feed". Environmental Science and Pollution Research (2023).
9. Yildirim-Aksoy M, Eljack R and Beck BH. "Nutritional value of frass from black soldier fly larvae Hermetia illucens, in a channel catfish, Ictalurus punctatus, diet". Aquaculture Nutrition 26 (2020) 812-819.

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