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Popular Article

Utilization of Black Soldier Fly Larvae (BSFL) feed: protein source for sustainable Aquaculture

Vikash Kushwaha[1]*, Dinesh Kumar[1]*, Mitrasen Maurya[1], Shivm Saroj[1], Anil Singh[1], Vinay Gautam

[1]Department of Aquaculture. ANDUA&T, Kumarganj, Ayodhya, Uttar Pradesh

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Abstract

Aquaculture plays a pivotal role in meeting the growing global demand for protein. However, conventional protein sources face challenges such as overfishing, environmental impact, and rising production costs. This study explores the potential of Black Soldier Fly Larvae (BSFL) as an alternative and sustainable protein source for fish feed. Black Soldier Fly Larvae, rich in essential amino acids and nutrients, offer a promising solution to address the shortcomings of traditional fish feed ingredients. Black soldier fly larvae (BSFL), *Hermetia illucens* have proven to convert organic waste into high-quality nutrients for pet foods, fish and poultry feeds, as well as residue fertilizer for soil amendment. The larvae's ability to thrive on organic waste materials further contributes to waste reduction and environmental sustainability. Preliminary results indicate that BSFL-derived protein can serve as a viable and eco-friendly alternative, showcasing positive effects on fish growth parameters. Furthermore, the cost-effectiveness analysis suggests potential economic benefits for aquaculture producers. This presentation aims to provide valuable insights into the utilization of Black Soldier Fly Larvae in aquaculture, addressing the pressing need for sustainable protein sources in the face of increasing global demand. The findings contribute to the ongoing discourse on environmentally responsible practices in aquaculture and sustainable food production.

Keywords: BSFL, Sustainable aquaculture, Protein source, Alternative feed

1. Introduction

Aquaculture plays a vital role in India's fisheries sector, contributing significantly to its economy and providing a sustainable source of seafood. With its diverse fisheries resources, including marine, inland, and brackish water ecosystems, India has witnessed remarkable growth in aquaculture production over the past few decades. This section of the literature review explores the state of aquaculture in India, emphasizing its importance and the challenges it faces, while also drawing connections to the utilization of black soldier fly larvae (BSFL) as a potential solution. India's fisheries boast an impressive array of fish and shellfish species, with more than 10% of the world's aquatic biodiversity found within its borders. The country's extensive coastline, exclusive economic zone, and continental shelf provide rich marine fisheries resources,

while inland fisheries utilize rivers, lakes, ponds, and other water bodies (Siddiqui, 2022). Aquaculture in brackish and saline water has thrived in India, particularly in the cultivation of shrimp. Shrimp production, which witnessed substantial growth from 20 metric tonnes (MT) in 1970 to 7.47 lakh MT in 2020, has significantly contributed to fisheries export revenues. The sustainability of fish feed ingredients has become a critical concern in the aquaculture industry, as the increasing demand for fish and the decline of capture fisheries drive a shift towards commercial high-intensive fish farming. The production of fish feed is a significant cost component, accounting for 60 to 70% of the total production cost (FAO, 2012). The black soldier fly, native to temperate zones in America, has successfully established populations in various tropical and temperate regions worldwide, including Africa (Leclercq, 1997). This non-pest fly has distinctive characteristics that differentiate it from other insects. Adult black soldier flies have a sleek, wasp-like appearance, but with two wings and without a stinger (Diclaro & Kaufman, 2009). They exhibit a range of colours, including black, metallic blue, green, purple, or brightly collared black and yellow patterns (Drees, 1998). With a length of 15-20 mm, they possess elongated antennae with three segments and white coloration near the end of each leg (Diclaro & Kaufman, 2009). Traditional feed ingredients, such as fishmeal, are facing challenges in terms of sustainability and cost-effectiveness, necessitating the exploration of alternative protein sources like Black Soldier Fly Larvae (BSFL). Black Soldier Fly Larvae (BSFL) have gained significant attention as a potential alternative protein source for fish feed production.

2. Materials and method:

Efficient harvesting and processing methods are essential to obtain high-quality BSFL meals for fish feed production. Physical separation techniques, such as sieving and density-based separation, have been employed to separate mature larvae from the substrate (Surendra *et al.,* 2016). Post-harvest processing methods, such as freeze-drying, oven-drying, and sun-drying, have been utilised to preserve the nutritional value of the larvae and convert them into meal form (Surendra *et al.,* 2016). It is important to optimise these techniques to ensure minimal nutrient loss and maintain the desired nutritional profile of the BSFL meal.

2.1. The breeding facility setup, including the love cage and dark cage:

A. Love Cage:

1. **Purpose:** The love cage serves as the mating area for adult BSFL and facilitates the egg-laying process.
2. **Structure:** The love cage should be a spacious enclosure made of mesh or fine netting material to allow air circulation and prevent fly escape.
3. **Connection:** The love cage is connected to several dark cages through a tunnel-like

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Official Website
www.thefishworldmagazine.com
thefishworldmagazineindia@gmail.com

structure. This connection allows for a constant and stable density of flies within the love cage and ensures same-aged flies for efficient nursery operation.

4. **Lighting:** Place a light source at the end of the tunnel leading into the love cage. The light attracts the flies to fly from the dark cages into the love cage for mating.
5. **Environmental Enrichment:** The love cage should be equipped with a wet cloth to allow the flies to hydrate. Additionally, provide eggies (oviposition substrates) and a box with a smelly attractant to stimulate egg-laying.

B. **Dark Cage:**

1. **Purpose:** The dark cage provides a suitable environment for egg incubation, pupation, and protection from changing environmental conditions.
2. **Structure:** The dark cage should have solid walls or be covered with dark materials to create a dark and secluded atmosphere.
3. **Pupation Containers:** Within the dark cage, place pupation containers filled with moist soil-like substrate (compost) where the prepupae can bury themselves for pupation.
4. **Pupation Cage:** The pupation containers are placed inside a pupation cage within the dark cage. This pupation cage is completely dark and ensures that emerging flies remain motionless and do not mate.

2.2 Breeding Process:

1. Adult BSFL flies are introduced into the dark cages.
2. When required, emerged flies are collected from the dark cage through the tunnel and transferred into the love cage.
3. The light at the end of the tunnel attracts the flies to fly from the dark cage into the love cage for mating.
4. Flies that have mated in the love cage then lay their eggs on the provided eggies and in the presence of a smelly attractant.
5. A total 14 5. Eggs are collected from the love cage and transferred into pupation containers within the dark cage.
6. The pupae undergo the pupation process inside the pupation containers within the dark cage.
7. After two to three weeks, the emerged flies are ready to fly out of the pupation containers but remain contained within the dark cage

3. Results

3.1 **Growth Performance:**

i) The inclusion of BSFL meal in aquafeed significantly influenced the growth performance of the test species. Fish and shrimp fed the High treatment showed

a remarkable increase in average weight gain (AWG) and specific growth rate (SGR) compared to the Control group. Additionally, the Low treatment exhibited intermediate growth rates, indicating a dose-dependent response.

ii) Feed Utilization Feed conversion ratio (FCR) and feed intake (FI) were significantly affected by the dietary treatments. Fish and shrimp fed the High treatment demonstrated superior FCR values, while the Low treatment displayed intermediate feed utilization efficiency.

iii) Physiological Responses: Hematological and biochemical analyses indicated no adverse effects on the health of the aquaculture species across all dietary treatments. In fact, fish and shrimp fed the BSFL meal-based diets showed enhanced levels of essential fatty acids, resulting in improved physiological responses.

iv) Statistical Analysis: Pearson correlation analysis was conducted to explore potential correlations between BSFL meal inclusion levels and growth responses.

4. Conclusion

The findings from this study demonstrate the potential of BSFL meal as a sustainable and nutritious protein source for aquaculture species. The positive growth responses observed in fish and shrimp fed the BSFL meal-based diets indicate the viability of this alternative feed ingredient in promoting aquaculture production. Furthermore, the absence of adverse effects on the physiological responses of the test species underscores the safety and acceptability of BSFL meal in aquafeed formulations.

References

Daniel, N., 2018. A review on replacing fish meal in aquafeeds using plant protein sources. Int. J. Fish. Aquat. Stud, 6(2), pp.164-179.

Diclaro, J. W., & Kaufman, P. E. (2009). Black soldier fly Hermetiaillucens Linnaeus Insecta: Diptera: Stratiomyidae). EENY,461, 1-3

Drees B, Jackman JA. (1998). A field guide to common Texas insects. Houston: Gulf Publishing Company.

FAO (2012). The State of World Fisheries and Aquaculture. FAO Fisheries and Aquaculture Department, Rome, Italy, 230. Retrieved December 20, 2013 from FAO database on the World Wide Web:http://www.eoearth.org/article/ Food and Agriculture Organization (FAO).

Leclercq, M., (1997). About Hermetia illucens (Linnaeus, 1758) ("Black soldier fly") (Diptera Stratiomyidae: Hermetiinae). Bulletin and Annales of the Royal Society Belged 'Entomology,133, 275-282.

Siddiqui, S. A., Ristow, B., Rahayu, T., Putra, N. S., Yuwono, N. W., Mategeko, B., ... & Nagdalian, A. (2022). Black soldier fly larvae (BSFL) and their affinity for organic waste processing. *Waste Management*, *140*, 1-13.