Marine Insect Revolution: Seaweed Fly Larvae (SWFL) for Sustainable Aqua Feed

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Abstract

Aquaculture of commercially important species demands high quality aquafeed with sustainable nature. In this regard, Seaweed Fly Larvae (SWFL) is emerging as a promising nutrient dense aquafeed ingredient containing 60% crude protein (CP) with 3.5% lysine and 1.5% methionine, and 17% lipids with 4% EPA and DHA. SWFL proved to be superior and can be used as a partial replacement for Defatted Black Soldier Fly Larvae (BSFL) and fish meal in commercial aquafeed in near future.

Keywords: SWFL, Aquafeed, Ingredient, Protein source

Introduction

Aquaculture is emerging as a sustainable source to meet out the daily protein requirements of majority of the population in the world. According to the Agri-Food Outlook 2023 report by Alltech, aqua feed production constitutes approximately 52.9 million tons. Intensive culture of commercially important fish species demands the need of high quality protein rich ingredients. Aqua industries are into the research of developing sustainable and commercially viable alternatives to Fish Meal without compromising the nutritional requirements of the targeted species. Seaweed Fly Larvae (*Coelopa frigida*) a novel protein rich source and its possibility of incorporation in commercial aqua feeds is discussed here.

Production of SWFL

SWFL production on laboratory scale there is a requirement of 10 L capacity food storage boxes maintained at 25°C with 60 % humidity and 12:12 light dark cycle. For culturing of SWFL, sex ratio of 50:50 to be introduced in each box. During setting the boxes, it should be kept in mind that the lids of the boxes are having a hole for aeration and partly covered with paper towels to avoid escape of flies. For their feeding about 2 kg of seaweed is required. To accelerate rate of decomposition process and increase surface, the seaweed may be used in minced form. After 4 days of rearing, larvae get developed enough for collection. There is a need for pat dry the larvae using tissue paper and then freeze on dry ice (Biancarosa *et al*., 2018) for further use.

Mating behaviour influence for scaling SWFL production

Polyandrous homokaryotypic females of seaweed fly exhibit higher fecundity and survival, and also produce genetically fit offsprings when compared to Monoandrous homokaryotypic females (Dunn *et al*., 2005).

This systematic mating behaviour study provides insight for large scale commercial production of SWFL.

Dietary requirements of SWFL

In wild, SWFL relies on the bacterial flora and decomposed seaweed substrate serves as the principal dietary source of energy for its development. It includes certain bacterial species of marine origin and some from pure bacterial culture like *Escherichia coli*, *Bacillus subtilis* and *Saccharomyces cerevisiae* (Cullen *et al.,* 1987). SWFL fed with seaweed *Fucus serratus* showed 70 % higher growth as compare to the SWFL fed with *Laminaria digitata* (Biancarosa *et al*., 2018)

(Fig 1)

(Fig 2)

(Fig 3)

Graphical illustration of SWFL incorporation in commercial aquafeed

(Source : Fig 1: Seaweed Fly with a mass of larvae on rotting seaweed, Dorset, UK; Fig 2: Seaweed Fly Larvae life cycle (Mérot et al., 2020); Fig 3: Commercial Aquafeed (PC: Karthik R)

Proximate composition of SWFL

In comparison with marine insect meal, terrestrial insect meals are often lack of sufficient n-3 PUFA (Lourenço *et al.*, 2024). SWFL (*Coelopa frigida*) on dry matter basis contains 60% crude protein (CP) with 3.5% lysine and 1.5% methionine, and 17% lipids with 4% EPA and DHA found to be superior over Defatted Black Soldier Fly Larvae (BSFL) with 57% CP, 1.6% lysine, and 0.5% methionine and slightly lower than commercial Fish Meal with 67% CP, 5.3% lysine, and 2% methionine (Warwas *et al.*, 2024).

Limitations and Mitigation strategies for SWFL as Aquafeed ingredient

Chitin content of SWFL acts as an immunostimulant exhibiting antimicrobial, anti-inflammatory, and immunostimulatory effects (Kamilya *et al*., 2020). In some species, SWFL Chitin content lowers the nutrient digestibility by its antinutritional property (Warwas *et al.*, 2024). This can be mitigated by the manual removal of pupae and substrate from larvae or by using fungal based chitinase enzymes like *Aeromonas veronii* "ChiB565" as a feed additive (Zhang *et al.*, 2014). High level of heavy metals like Arsenic and Cadmium are concern in feed safety (EFSA, 2015, Biancarosa *et* al., 2018). Selection of ideal seaweed substrate with low level of heavy metals can significantly reduce accumulation heavy metals in the larvae, thereby improving the overall safety and nutritional value of SWFL.

Feeding trails on fishes

It was reported that inclusion of SWFL in the rainbow trout (*Oncorhynchus mykiss*) diet improved feed intake when compared to BSFL (Black soldier Fly Larvae) containing diet. But its higher values of FCR (Feed Conversion Ratio) indicated lower bioavailability (Warwas *et* al., 2024) of the diet. Therefore, partial replacement of Fish meal with SWFL may be preferable and effective for preparation of fish diet, but further research is required for optimization of formulation to improve its overall utilization efficiency.

Conclusion

Limited literature and data are available on SWFL as an aquafeed ingredient. SWFL is a nutrient dense, sustainable and cost effective aquafeed ingredient that can ease the pressure over exploitation of fishery resource for fishmeal preparation. Gut microbiota of wild harvested SWFL and its significance need to be evaluated. Proximate composition analysis, standardization and large-scale production of SWFL technologies are the key research areas which will accelerate their adoption in mainstream feed production. Adequate inclusion of SWFL into aquafeed formulations and its commercialisation will support a more circular and eco-friendly approach towards aquaculture sector.

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