Black soldier fly : An alternative for waste management and feed

Introduction

The high demand and consequent high prices for fishmeal, together with increasing production pressure on aquaculture, has led to research into the development of insect proteins for aquaculture. Insects are rich source of nutrients like protein, vitamins and minerals has immense potential to be used as feed for fishes. The conversion rate of feed into protein is efficient unlike other feed sources. They can be multiplied in a faster rate in minimal space and in maximum quantities in day to day kitchen waste substrate. Insects grow and reproduce easily, and can be reared on bio-wastes. Over the last decade, studies of the replacement of fishmeal with insects in the diet of fish have emerged and the promising results have encouraged further research.

Numerous experiments with carnivorous, omnivorous, and herbivorous fishes have demonstrated that insects can be successfully incorporated in fish diets as a substitute for fish meal although there have been more studies on omnivorous species than on carnivorous ones. Feeding experiments using black soldier fly (BSF) as feed and feed supplements were conducted on the Yellow catfish (*Pelteobagrus fulvidraco*), Blue Tilapia (*Oreochromis aureus*), Nile Tilapia (*O. niloticus*), channel catfish (*Ictalurus punctatus*) revealed at effective replacement rates less than 25 to 30%. In some cases, greater rates and even total substitution have been found technically or economically feasible.

The costs of conventional feed resources like soymeal and fishmeal are very high and moreover their availability in the future will be limited. Small-scale fish farmers feed their fish with low nutritional value feeds, resulting in poor yields and less income for the household. Insect rearing could be a part of the solutions. Although some studies have been conducted on evaluation of insects, insect larvae or insect meals as an ingredient in the diets of some fishes, this field is in infancy especially in India.

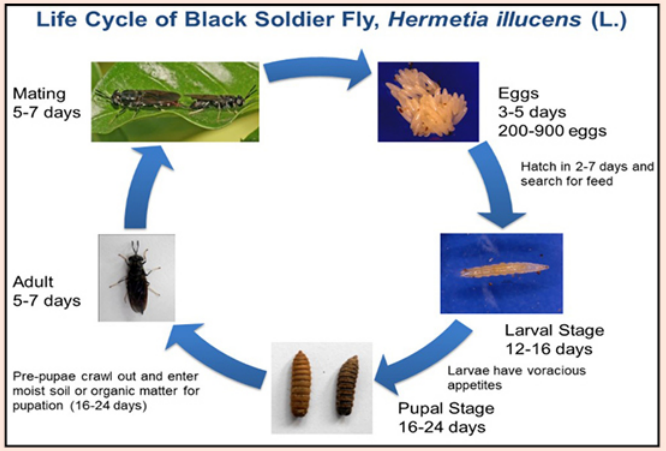
With a view to reduce the feed cost in fish farming, ICAR-CIFRI and ICAR-NBAIR are conducting experiments by supplementing the fish feed using insect as protein ingredient.

Mass culture of Black soldier fly

BSF can be mass multiplied in decaying organic wastes *viz*., agricultural wastes, food wastes, vegetable and fruit wastes, slaughter house wastes. The decaying odour of the rearing substrate attracts the adult fly for oviposition. The adult fly lays creamy white eggs in the cracks and crevices of the rearing bins. After hatching the larvae feed upon the rearing substrate and grows rapidly. Once fully matured, the final instar larvae crawl out and look for a dry substrate or soil for pupation. Adult emerges out, feed upon the nectar of flowers involves in aerial mating and oviposit in decaying organic matter.

Biology of BSF

Black soldier fly, *Hermetia illucens* is a dipteran fly insect widely used as a protein supplement in the feed formulations of aquaculture. This fly is amenable for mass production in the decaying food, agricultural and slaughter house waste could be a viable alternative to the high cost fish meal used in the fish feed formulations. The life cycle of the BSF could be completed in 23-25 days depending upon the substrate in which the culture was reared and prevailing weather conditions. Adult fly mate during flight and seeks for decaying substrates for oviposition. It lays about 200-300 eggs in the decomposing substrate in group and hatches in 2-7 days. The larvae start feeding upon the decaying organic matter and pass through six larval instars. The mature sixth instar larvae enter into pupation. The adult emerges in 4-5 days. The mature larvae and prepupae of this fly is a rich source of protein to supplement or replace protein constituent in fish feed.



Nutritional profile

Black soldier fly prepupae, *Hermetia illucens* consists of 32.53% protein content, 22.10% lipid content and 21.56% ash content on dry weight basis.

Black soldier fly as an aquacultural feed

Black soldier fly can be easily mass produced at farm level in turn can serve as protein rich feed for the fishes. If the use of insects as fish feed can be popularized and commercialized, the overexploitation for fishmeal can be reduced and consequently the increasing market price of fish meal can also be reduced to an extent.

NBAIR in collaboration with ICAR-CIFRI has developed BSF based pellet fish feed and evaluated the growth parameters of Tilapia, amur carp and Pangas fish using BSF feed. Fishes fed with BSF based feed recorded significant gain in weight with lower feed conversion ratio and the technology is under field evaluation.

Black soldier fly for organic waste management

Black soldier fly (BSF) (*Hermetia illucens* (L.) is an insect which can be used as a detritivore in larval stages and in adult stage, it is neither a pest nor a vector and does not cause any nuisance or harm. It plays an important role as an essential decomposer in breaking down organic substrates and returning nutrients to the soil.

The larval stage of BSF is capable of bioconversion of organic wastes in shorter time. BSF can be reared on kitchen waste and fruit and vegetable wastes. It is encouraging that BSF can be reared on restaurant, hotel and municipality green wastes too. The survival percentage, prepupal weight, residence time, dry matter reduction and bioconversion rates are best on kitchen wastes. The organic waste biomass is reduced to the tune of 50-95% by using BSF. BSF rearing on organic wastes reduces odours emanating from wastes due to quicker conversion of biomass, reduces housefly and other flies breeding and also reported to reduce pathogenic microflora. A technology has been evolved by utilising BSF to decompose farm waste which is attracting farmers, private firms, urban residential people and poultry farmers.

The BSF compost produced on kitchen waste is superior to farm yard manure, vermicompost and sheep manures, because of high amount of N, P, K along with other micronutrients and can be converted in 60 days. BSF compost has been recorded to be very good for establishment of nursery plants like tomato, chilli, brinjal, cabbage and horticultural crops. Leachate during decomposition and bioconversion process is also equally nutritive which can be used for fertilizing soils through irrigation water. ICAR-NBAIR has termed the BSF compost as BLACK GOLD due to its qualities. Mass rearing of BSF is a cleaner and greener alternative to recycle organic wastes by producing nutrient rich compost.

The potential of black soldier fly, *Hermetia illucens* for farm waste degradation and bioconversion of organic waste in to compost and other byproducts has been worked out at ICAR-NBAIR, Bengaluru and the research and development has yielded

- Protocol for rearing of the insect, black soldier fly, *Hermetia illucens*
- Designing of equipment/structure for rearing insects and waste degradation

The technology developed includes designing of special equipment/structures for degradation of waste with less space and capital requirement (less than 5 lakhs). Technology has targeted stake holders like poultry sector, fish farming sector, farmers, contract farming companies, farmer federations, municipalities and panchayats. The technology has business potential of reducing bulky organic wastes up to 90%, yielding matured compost which can be utilized as fertilizer for crop nutrition especially in establishment of nurseries. Also, the technology yields the insect larvae as primary output of the solid waste conversion (where the weight of the prepupae for meal could be around 20kg/100 kg solid waste conversion), which can be used as a valuable nutrient additive in poultry feed and fish meal.

No specific training needed for this technology adoption, except creating awareness on benefits and technology know-how to the stakeholders/clientele.

Technology evaluated with designed structure has net overall benefit: cost ratio of 1.173 and net composting benefit: cost ratio of 0.94.

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