Mtafiti Monthly

A PUBLICATION OF KENYA MARINE AND FISHERIES RESEARCH INSTITUTE (KMFRI)
@KmfriResearch

ISSUE #17
SEPTEMBER, 2021

Contents

Black Soldier fly larvae (*Hermetia illucens*) as an alternative protein for fish feed

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Using organic waste to produce Black Soldier Fly larvae as a rich alternative protein source for fish feeds

Animal manure, discarded fruits and vegetables from the market are gradually turning out to be a gold mine in the production of Black Soldier Fly larvae (BSFL).

Studies indicate that BSFL is a good basis of nutrition for fish, and can replace a substantial amount of fishmeal and soybean meal as protein source for fish feeds. The quality of fishmeal commonly known as *omena* is being questioned, and with the declining capture fisheries, the idea of using insect feed such as BSFL is timely.

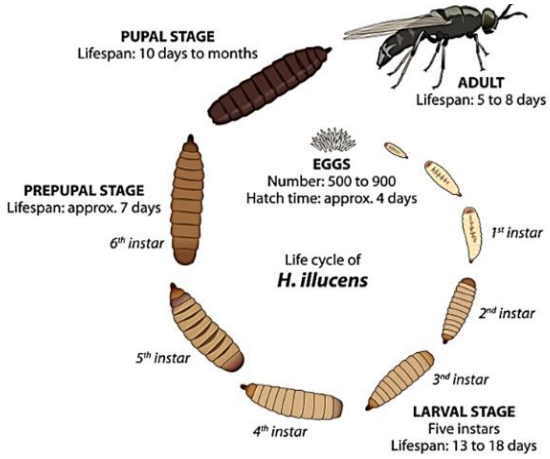
It is for this reason that the Kenya Marine and Fisheries Research Institute (KMFRI) in collaboration with Biobuu Ltd is conducting an experiment to produce Black Soldier Fly Larvae (BSFL), as an alternative protein ingredient for fish and poultry feed, with funding from Bioinnovate Africa based at the International Centre of Insect Physiology and Ecology (ICIPE).

About Black Soldier Fly…

The Black Soldier Fly (*Hermetia illucens*) is an insect, naturally occurring along the tropics and high temperature regions. It is a native insect common to the Southeast United States. BSF produces three generations after every 12 months by colonizing various decomposing and organic wastes.

The BSF has four different stages of growth namely egg, larva, pupa and adult.

Black Soldier Fly and larvae / Photo by WUR



Life cycle of black soldier fly

BSFL is a rich source of protein, effective in managing waste by extracting energy and nutrients from organic waste, hence considered environmentally friendly. Whole fat larvae contain up to 40 per cent crude protein, while defatted larvae have high protein level of up to 64 per cent.

A Black Soldier Fly produces many eggs that hatch in about 4 days and grow into pupa within 15 days. It feeds on waste and does not carry diseases. An actively feeding BSFL excretes an info-chemical that keeps away other flies, thus preventing potential insect pests and disease vectors. This helps in cutting costs of organic waste management.

They are consequently becoming most promising insects for use in fish and livestock feeds, and have the

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ability to meet the growing demand for alternative protein sources in aquaculture.

How to produce Black Soldier Fly larvae

KMFRI research scientist Ms Gladys Mwaka, who was awarded a Bioinnovate fellowship for Women Scientists, is currently investigating the effect of different waste substrates on the growth and proximate composition of the BSFL. She is attached to Biobuu Limited located in Kilifi County, Kenya, whose main goal is to convert food waste into high quality feed for fish and chicken.

A typical BSF bio-waste processing facility consists of waste pre-processing involving particle size reduction, dewatering and removal of inorganic substances, bio-waste treatment by BSFL, separation of BSFL from processed residue, and lastly, refinement of the larvae and residue into marketable products.

Market and hotel waste transported to the study site

The Black Soldier Fly (BSF) larvae feeds from different wastes that include municipal, agro-industrial, manure and feaces. Municipal waste mostly consists of discarded fruits and vegetables from the market with at least 95 per cent water content, and food leftovers from restaurants that make up the organic waste.

The agro-industrial wastes, on the other hand, are generated from food processing factories, spent grains from milling firms and by-products from slaughterhouses. Manure and faeces from pit latrines and septic tanks are usually a mixture of excreta of cows, poultry or swine manure.

"BSF that feed on wastes with quality protein and carbohydrates have high protein and fats," says Ms Mwaka.

"BSF that feeds on substrates with quality protein and carbohydrates have high protein and fats," says Ms. Mwaka.

The experiment conducted by Ms. Mwaka at Biobuu Ltd in Kilifi involved three different bio-waste treatments: market waste, hotel waste and a mixture of market and hotel waste. Hotel waste was found to produce a high volume of larvae compared to market waste, and a mixture of market and hotel waste.

From left to right, larvae produced from Market Waste (MW), Hotel Waste (HW), and a combination of Market & Hotel Waste (MHW).

In this study, BSF eggs were hatched, and the larvae fed on the different organic wastes to investigate growth and digestibility trends. The biodegradable waste was sorted and separated to avoid inclusion of any hazardous material.

"Plastic and hazardous materials are to be sorted manually and separated to ensure that waste processed is organic and biodegradable," says Ms. Mwaka.

Larvae were counted and placed in different feeding trays holding 10,000 each. To meet BSF diet requirements in all developmental stages, feeding and re-feeding was done on the fifth and eighth day until the larvae was mature for harvesting on the 13th day - the last day. The experiment used 10,000 five-day old larvae which were being fed on 15kg of wet waste - water content being 75 per cent - for 12 days.

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Counting of larvae, transfer to feeding trays

"Larvae prefer food substrates with moisture content of between 52 and 70 per cent," says Ms. Mwaka.

Larvae requires two to three weeks to grow depending on the quality and quantity of food they eat. They are harvested and separated from the waste residues manually, or by the use of a vibration gauge machine. Drying is done in an oven at 100°C temperatures for 18 hours.

The younger the larvae, the shorter the time it takes to digest different feeds. This was observed after four-day larvae took only 3 to 4 days to digest 3kgs of wastes, compared to average size larvae which took 7 to 9 days.

It has been reported that BSFL has strong mouthparts and relatively high gut enzymatic activity compared to other types of flies, hence it can effectively decompose food wastes and animal manure into biomass.

"It is necessary to ensure that BSFL produced are well separated from the residue before counting using a sieve," says KMFRI aquaculture research scientist Dr. Mary Opiyo. "For optimal growth and production of BSFL, equal measures during counting such as use of 2.5ml spoon for each bunch would help to measure the amount of feed to be given to the larvae," she adds.

Manual separation of BSFL from waste residues

Research shows different wastes contribute differently to the growth of BSF larvae. For quite some time, researchers have developed different ways to manage organic waste including macrofauna decomposition involving Black Soldier Fly Larvae, earthworms, housefly, among others.

Dr. Opiyo added that research conducted by KMFRI since 2019, has demonstrated that BSF can replace up to 50 per cent of fishmeal in the diets of Nile tilapia and African catfish without affecting growth. "BSF can also replace up to 100 per cent of soybean meal in Nile tilapia diets," she concludes.

It is important to note that feeds made using BSFL can be used for all the development stages of fish namely fingerling, post-fingerling, grow-out and broodstock.

Pelleted fish feed produced from BSFL

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