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Role of Black Soldier Fly in Agriculture

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Introduction

Black soldier fly (BSF), *Hermetia illucens* (L.) belongs to family Stratiomyidae and order Diptera. BSF is native to the tropical, sub-tropical and warm temperate zones of America but during World War II they spread into Europe, Asia, including India and even to Australia (Rindhe *et al*., 2019). BSF larvae feed on various waste material *viz.,* cereals, manure, chicken feed, vegetable, seaweeds *etc* (Rodrigues *et al*., 2022). BSF larvae are very efficient to convert organic waste. Larvae consume manure and convert the nutrients into larval insect mass, which contains protein and fat more than 42 per cent and 35 per cent, respectively. Thus, a potential high protein, high energy animal feed can be prepared and, in the process, manure mass is reduced about 50 per cent (Newton *et al*., 2005). BSF can produce 80 times much protein as compared to broiler chickens from one acre of land (Anon., 2019).

Life cycle

Black soldier fly has complete metamorphosis. A female adult lay eggs in crevices or on surfaces or adjacent to decaying matter to protect from predators, dehydration by direct sunlight and to ensures that the larvae have their first food source nearby after hatching. Egg is creamy white in colour with 1 mm length and hatching period is about six days. Larva is creamy white to pale white with a small black head and 11 to 13.50 mm long and under gone through six larval instars in 15 to 20 days. Pupa is dark brown to black in colour, having 10 to 60 days pupal period. BSF female adult have reddish–colour abdomen and male adult have dark bronze colour abdomen. Fecundity was 555 to 650 eggs/female (Sharanabasappa *et al*., 2019). Appropriate temperature and relative humidity for rearing BSF were 26-27 ^{0}C and 60-70 per cent, respectively (Kim *et al*., 2021).

Mass rearing technique

The highest average weight gain of BSF was noticed at the end of trial in thetreatment of 25per cent fish offal + 75 per centcow manure which was at par with 50 per centfish offal + 50 per cent cow manure and 10 per cent fish offal + 90 per cent cow manure diet at Tifton (St-Hilare *et al*., 2007).

According to Meneguz *et al*. (2018) when BSF larvae reared on BRE (brewery by-product) recorded lowest mortality (9.5 ± 5.68) and time needed to reach prepupae stage (8.0 ± 0.01) and highest growth rate (0.014 ± 0.0009) and waste reduction index (5.3 ± 1.05) as compared to WIN (winery vegetable and 30% fruit waste by-product).

According to Ganvir *et al*. (2022), highest larval growth (7900%) of BSF was reached on 17th day when larvae fed on kitchen waste.

For the food stuff of pet animals

Sealey *et al*. (2011) found that growth of fish fed with the enriched BSF (25% and 50%) diets was similar with those fish fed with the fish meal-based control diet.

BSF maggot fed on ration contained 75 per cent fish meal + 25 per cent maggot meal and ration contained 50 per cent fish meal + 50 per cent maggot meal recorded highest egg weight (10.12g and 10.12g, respectively) and egg production (75.26% and 75.19%, respectively) of quail (Widjastuti *et al*., 2014).

Maurer *et al*. (2016) recorded highest laying performance (84.40%) and feeding intake of layers when feed containing 12 g *Hermetia* meal and 15.6 g soybean cake per 100g.

Dried larvae of BSF contain higher lipid (26% in DM), calcium (7.56% in DM) and Ca:P ratio (8.4) as compare to fish meal and soya meal (Rindhe *et al*. (2019).

Zhao *et al*. (2022) recorded higher (137.28 ± 1.661g) body weight in 3.0 per cent BSFL meal diet compared to control diet and obtained higher egg weight and york weight of laying hen when fed in both the substitutional group (3.0% and 1.5%) as compared to control.

For waste management

According to Sheppard *et al*. (1994), a manure management system for laying hens using the black soldier fly, converted manure to a 42 per cent protein, 35 per cent fat feedstuff, 50 per cent reduced manure accumulation and eliminated house fly breeding.

Black Soldier fly larvae reduced (40 to 62.4%) the concentrations of nutrients of fresh pig manure from (Newton *et al*., 2005).

Class 100 showed the highest WRI value, indicate that 100mg of food per larva and day was the most suitable feeding rate to efficiently reduce waste (Diener *et al.*, 2009).

Julita *et al.* (2021) found that the treatment of 100 mg/larva/day feeding rate was resulted the highest WRI both on fruits waste (1.12) and restaurant waste (1.36).

Highest waste reduction (58.00%) was found when BSF larvae fed on waste banana on 17th day (Ganvir *et al*., 2022).

Mulu *et al*. (2023) found that BSF larvae fed on substrate containing water hyacinth, fruit waste and manure mixtures in the ratio of 35:55:10 recorded highest larval growth (2050%) and waste reduction (85.4±0.05%).

Available products

In 2006, phoenix worms became the first feeder insect to be granted as U.S. registered trademark. Other companies are also marketing BSF larvae under brand names *viz*., Nutri grubs, Soldier grubs, Repti worms, Calci worms and Bio grubs. In India this product marketed under brand name of Protyn (Anon., 2023a and Anon., 2023b).

Success story

Jason Drew, a farmer in Cape Town, is growing AgriProtein, a new factory farm that will produce 8.5 billion head of *H. illucens* daily. This would be about 22 tons of Black Soldier Fly larvae, worth $10,000 once processed (Anon., 2015).

Ms. Mwangi and her five workers produce black soldier flies using potato peel waste, feeding them to chickens and pigs. This results in chickens becoming larger and more marketable and pigs reaching marketable size 1.5 to two months earlier when fed black soldier flies (Anon., 2021).

Work initiated

The Kochi Corporation is deploying black soldier fly larvae to process the 100 tonnes of food waste that arrive at the Brahmapuram plant every day (Anon., 2023c).

Conclusion

BSF is a good alternative source of animal protein, crude fat, crude fibre, amino acids and minerals for fish, layer and quail. It is a very good tool for nutritional food security. It plays an important role in a circular economy by upcycling low-value organic streams into high-value biomass. It plays an important role in the Swachha Bharat mission. The implementation of this strategy can significantly contribute to the economic prosperity of rural communities through the generation of income.

Future Thrusts

Need to….

- Standardize bio-rational feed for different animals
- Create an awareness for mass production
- Conduct research on other industrial properties
- Study the pest status in agricultural crop

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