

Summary

Adult Rearing and Reproductive Biology in the Black Soldier Fly, *Hermetia illucens* (Diptera: Stratiomyidae)

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Summary

The black soldier fly (BSF) (*Hermetia illucens*) (Diptera: Stratiomyidae) is native to the warm temperate zone of America, but it is now widespread in warm regions worldwide. BSF larvae feed on a wide variety of organic matter, from fruits and vegetables to animal remains and manure. They can reduce dry manure biomass and poultry manure. Moreover, the pupae can be harvested as a suitable animal foodstuff for various animals, including chickens, swine, fish, and even predatory mites. The optimization of reproductive performance depends on several factors, such as food sources, temperature, humidity, light sources, sex ratio, and density. The rearing of adult black soldier fly requires successful reproductive performance from various studies.

The present study is composed of four main experiments:

Experiment 1: Effect of food on longevity and oviposition performance

This study examined the nutritional value of different diets on longevity and reproductive performance of black soldier flies (*Hermetia illucens*) under laboratory conditions. In addition to the control group, which received only water, four diets were used, including sugar and water (SW), pollen, sugar, and water (PSW), pollen, honey, and water (PHW), and honey with water (HW). The PSW group exhibited the highest reproductive performance, as evidenced by having the shortest pre-oviposition period, the longest oviposition period, the largest number of clutches and hatched egg clutches, and the longest longevity. Moreover, the largest number of eggs laid/ female and the longest longevity of males and females were observed in the PSW group. Nevertheless, the highest hatchability was found in SW. The numbers of successfully hatched eggs (fertilized) were greatest in the PSW and HW treatments, but the difference between those diets (SW, PSW, PHW, and HW) were not significant ($p > 0.05$).

Experiment 2: Effect of sugar on longevity and oviposition performance

Flies were fed on three types of sugar treatments: a solid type, a liquid type, and a powder type in this study. The pre-oviposition period was 4-5 days under different treatments, which had no significant differences. The oviposition periods (23-24 days) in the solid type and the liquid type were significantly longer than in powder type. The largest number of hatched egg clutches per female occurred in the liquid type of sugar treatment. No significant differences were found in hatchability among sugar types. The largest weight of egg clutches was recorded in the liquid type of sugar treatment. However, the weight of a single egg clutch was not significantly different among diets. The longevity of males was longer than females under different treatments. The liquid type and the solid type of sugar treatments improved survival for males and females more than the powder type. Sugar feeding is vital for reproductive performance for adult flies. The liquid type of sugar treatment is the best of the three different sugar treatments.

Experiment 3: Effect of optimal sex ratios for reproductive performance

The present study described the reproductive performance of adult *H. illucens* under different sex ratios. The females laid significantly higher numbers of eggs clutches with a ratio of 5 males and 1 female (high competition). Higher hatchability and fertility were not found in the no competition group (1 male and 1 female). Male competition increased egg production, hatchability, and fertility more than female competition (1 male and 5 females) and no competition.

Experiment 4: Volatiles from the artificial diet in a plastic bottle device and a wind tunnel device

The present study was carried out to obtain information on odors from artificial diets that stimulate fly larvae in a plastic bottle and a wind tunnel device. The natural crude extracts obtained from artificial feed residues for larval rearing were more effective

than other odors (food residue, hexanoic acid, hexane, isovaleric acid, isoamyl alcohol, isoamyl acetate, jack fruit, and raw banana) for the adult females in the plastic bottle device. For males, the most attractive odors were isoamyl acetate, raw banana, residue of larval diet, food residue, jack fruit, hexanoic acid, and isoamyl alcohol. Hexane did not attract either males or females in the plastic bottle device. Mated females were more attracted than unmated females in a wind tunnel device. Males did not respond to the volatile bait materials in both methods. The highest activities of females were found in flies three days after emergence. Therefore, the odors of bait materials were essential for the activity of females than that of males.

From the results of the above experiments, it was found that sugar water is the best food source for the black soldier fly adults and increasing the sex ratio of males increases mating rate. From the results of this rearing, the hatching rate of egg masses was approximately 20%, indicating many female individuals were unmated. Therefore, it is a challenge to improve the rearing method and increase the mating rate in the future. Among the chemical components were tested, the artificial food used during larval rearing was the most attractive, and it seems to contain components that attract adults. If the chemical analysis of these components is carried out, it may be possible to develop effective traps for capturing adults in the field.