



CHRIST
(DEEMED TO BE UNIVERSITY)
BANGALORE - INDIA

Notice for the PhD Viva-Voce Examination

Ms Subhashini R M (Registration Number: 1981802), PhD scholar at the School of Sciences, CHRIST (Deemed to be University), Bangalore will defend her PhD thesis at the public viva-voce examination on Wednesday, 11 December 2024 at 11.30 am in Room No. 044, Ground Floor, R & D Block, CHRIST (Deemed to be University), Bengaluru - 560029.

Title of the Thesis : **Studies on the Culture Conditions,
Nutritional Value of the Black Soldier Fly,
Hermetia illucens (Diptera: Stratiomyidae)
and its Suitability as Aquaculture Feed**

Discipline : **Zoology**

External Examiner - I : **Dr P Janakiram**
Professor and Head
Fish Health Division
Department of Marine Living Resources and Zoology
Andhra University, Visakhapatnam -530003
Andhra Pradesh

External Examiner - II : **Dr Anilkumar G**
Senior Professor
School of Bio Science and Technology
Vellore Institute of Technology, Vellore
Tamil Nadu – 632014

Supervisor : **Dr Krishnakumar V**
Assistant Professor
Department of Life Sciences
School of Sciences
CHRIST (Deemed to be University)
Bengaluru – 560029
Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Place: Bengaluru
Date: 05 December 2024

Registrar

ABSTRACT

The Black Soldier Fly (BSF), *Hermetia illucens*, has emerged as a promising solution in aquaculture due to its remarkable ability to convert organic waste into protein-rich biomass. This has garnered interest among aquaculturists seeking cost-effective and sustainable alternative ingredients for aqua feed. However, fully harnessing the potential of this insect requires a deeper understanding of its life cycle and nutritional composition. A key challenge in utilising BSF larvae (BSFL) for aquafeed production is the lack of standardized culture systems. This study addresses this gap by establishing a comprehensive culture system using two common organic wastes, fruit waste (FW) and vegetable waste (VW), as rearing substrates. By evaluating the growth performance of BSFL reared on these substrates, the research sheds light on optimal conditions for large-scale BSF production.

The study investigated the impact of FW and VW substrates on BSFL growth through a thorough analysis of growth performance, morphometric measurements and Scanning Electron Microscopy (SEM). Results showed that BSFL reared on FW exhibited better growth (40 days) than those reared on VW (46 days). Morphometric analysis and SEM identified five larval stages and the prepupa, pupa, and adult stages. Additionally, the study analysed the nutritional composition of BSFL at different developmental stages, such as Instar 3 through instar 5, prepupa and pupa, including protein, carbohydrate, lipid, amino acids and fatty acids. This provided insights into how variations in substrate impact the nutritional quality of BSFL at different stages, which is crucial for ensuring that BSFL-derived feed meets the dietary requirements of target aquaculture species. Significant differences were found in the proximate composition of the substrates (FW & VW), resulting in significant variations in BSFL nutrition. BSFL reared on FW exhibited higher nutritional content especially crude protein ($54.16 \pm 0.64\%$), than those reared on VW, except for crude lipids ($2.20 \pm 0.01\%$). The mineral content of the BSFL was higher than that of the substrate diets.

In addition to nutritional analysis, the study also assessed the suitability of BSFL as a feed ingredient for whiteleg shrimp, *Litopenaeus vannamei*, a popular shrimp species in aquaculture. The post larvae (PL) of *L. vannamei* were fed with diets containing varying proportions (0%, 25%, 50%, 75% and 100%) of defatted prepupa of BSF, replacing fish meal (FM) over a period of 30 days and their growth performance, survival rate, specific growth rate (SGR), feed conversion ratio (FCR), biochemical composition, hepatopancreas histology and the titre of 20-hydroxyecdysone were assessed. The feeding trial experiment revealed that the PL fed with a diet containing 50% BSF had better survival rates (92.67%), SGR (37.03%), FCR (1.49%), final body weight gain (11.13%), crude protein ($22.29 \pm 0.30\%$), carbohydrate ($2.98 \pm 0.15\%$) and crude lipid ($0.17 \pm 0.002\%$) compared to other dietary groups. Additionally, the histological structure of the hepatopancreas of the shrimp fed 50% BSF was significantly improved. Substituting 50% of FM with defatted BSF prepupa appears to be a viable approach for enhancing *L. vannamei* aquaculture. The study also found that the amount of ecdysteroid was highest in FW-prepupa and Group 2 shrimp.

The study also investigated the chitin yield extracted from BSFL, which was raised on FW and VW at different developmental stages. The extracted chitin was found to possess chemical structures and physicochemical properties similar to those of commercial chitin samples. Furthermore, the study evaluated the potential use of frass obtained from BSFL culturing in agricultural practices. This research significantly advances our knowledge of BSF biology and nutrition. It highlights the potential of BSFL as a sustainable protein source for aquafeed production. By converting organic waste into valuable biomass, BSFL not only provides a solution for waste management but also contributes to the development of a more sustainable aquaculture industry.

This study's findings underscore the importance of considering BSFL as a viable alternative feed ingredient in aquaculture, especially in light of increasing environmental concerns and the need for sustainable practices.

Keywords: *Insects, Chitin and chitosan, Feed formulation, Sustainability, Waste Management, Shrimp*

Publications:

1. **Subhashini Manjunatha Rampure** and Krishnakumar Velayudhannair (2023). Influence of agricultural wastes on larval growth phases of the black soldier fly, *Hermetia illucens* (Diptera: Stratiomyidae): An integrated approach Journal of Applied and Natural Science, 15(2), 860 - 869. <https://doi.org/10.31018/jans.v15i2.4656>
2. **Subhashini Manjunatha Rampure**, Krishnakumar Velayudhannair and Nidhin Marimuthu (2023). Characteristics of chitin extracted from different growth phases of black soldier fly, *Hermetia illucens*, fed with different organic wastes, International Journal of Tropical Insect Science, 43, 979-987. <https://doi.org/10.1007/s42690-023-00997-6>
3. **Subhashini Manjunatha Rampure**, Krishnakumar Velayudhannair and Majesh Tomson (2022). Black soldier fly, *Hermetia illucens* (Diptera: Stratiomyidae) larvae as an alternative protein source in aquaculture diet - Advances in Agricultural Entomology (Volume - 17)
4. Steny VJ, Krishnakumar V and **Subhashini RM** (2021). A Review of Pharmaceutical Compounds as an Emerging Aquatic Pollutant. Pharmaceutical Drug Regulatory Affairs Journal. 5(1).

<https://doi.org/10.31018/jans.v15i2.4656>