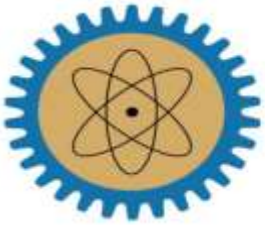

FACULTY OF AGRICULTURE AND ANIMAL SCIENCES

ASSESSING THE EFECT OF LIVESTOCK DUNG AND DOMESTIC ORGANIC WASTE AS SUBSTRATES ON THE GROWTH PERFORMANCE OF BLACK SOLDIER FLY LARVAE.

BY

OWINY PATRICK

BU/UP/2021/2110

SUPERVISOR

DR. KISYAKE HELLEN (BVM)

A RESEARCH DISSERTATION TO BE SUBMITTED TO THE FACULTY OF AGRICULTURE AND ANIMAL SCIENCES IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR AWARD OF THE DEGREE OF BACHELOR OF ANIMAL PRODUCTION AND MANAGEMENT OF BUSITEMA UNIVERSITY

SEPTEMBER 2024

ABSTRACT

Black Soldier Fly Larvae (BSFL) is increasingly recognized for their dual role as a sustainable protein source for agriculture and aquaculture feeds and as an efficient method for organic waste disposal. This study aimed to assess the effects of two different substrates—Livestock Dung (LSD) and Domestic Waste (DW)—on the growth performance of BSFL over a 14-day period. A controlled experimental setup was designed to evaluate the influence of these substrates on various growth parameters of BSFL, including length, girth, weight, survival rates, and feed conversion ratios (FCR). Larvae were reared on both substrates, and their growth performance was assessed at regular intervals using calibrated instruments, such as digital calipers and scales. The data were recorded systematically to ensure accuracy. Substrate consumption rates were measured to calculate FCR, and substrate mass was monitored over time to quantify substrate utilization. Ethical guidelines were adhered to throughout the research, ensuring the welfare of the larvae.

The primary purpose of this study was to investigate how different organic substrates (LSD and DW) affect the growth and development of BSFL, with the goal of identifying the most effective substrate for optimizing larval growth and feed efficiency. The findings from this study can inform future efforts in BSFL cultivation, supporting both sustainable protein production and organic waste management.

The findings revealed that larvae reared on DW exhibited significantly greater growth compared to those reared on LSD. On average, larvae grown on DW achieved a mean length of 1.280 cm, a girth of 0.472 cm, and a weight of 0.278 g, compared to 1.116 cm, 0.410 cm, and 0.230 g for those on LSD ($p < 0.001$). The survival rate for larvae reared on DW was also significantly higher at 95%, compared to 85% for those on LSD ($p < 0.01$). Moreover, the feed conversion ratio (FCR) was more favourable for DW, with a mean FCR of 1.5, while larvae on LSD had an FCR of 1.9 ($p < 0.05$). The study demonstrated a clear positive correlation between substrate quality and larval growth performance, with DW yielding superior growth metrics.

This research shows that domestic waste (DW) significantly enhances the growth, survival rates, and feed conversion of Black Soldier Fly Larvae (BSFL) compared to livestock dung (LSD), making DW the preferred substrate for future farming. Prioritizing DW not only improves BSFL production but also promotes effective recycling of organic waste.

DECLARATION

I OWINY PATRICK declare that the work in this research Dissertation is my personal and has not been submitted for the award of a degree in any other institution.

Signature. Date.

……  ……15/10/2024……

OWINY PATRICK

APPROVAL

This research Dissertation was written under my supervision and will be submitted to the department of animal production and management for examination with my approval as the supervisor.

Signature. ……  …… Date. ……15/10/2024……

Dr, KISAKYE HELLEN

Department of animal production and management

Busitema University Arapai campus.

DEDICATION

I dedicate this piece of work with gratitude to my parents, family members, and friends and above all to the government of Uganda for Higher Education Student Financing Board (HESFB) for providing me with financial support towards my Education. I also dedicate this piece of work to my love ones and I appreciate them for their encouragement and support as regards to my Education may the almighty God bless and reward them abundantly.

ACKNOWLEDGEMENT

With heartfelt gratitude, I appreciate my family, especially my brother Mr. OYEPA PAUL, my mother AKECH ANNET and Higher Education Student Financing Board (HESFB) for supporting me for all this while. I also express my gratitude to the staff of Busitema University and especially to my research supervisor, Dr. KISAKYE HELLEN for the academic guidance and knowledge she has given me.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

BSFL – Black Soldier Fly Larvae

RCBD – Randomized Complete Block Design

LSD Livestock Dung

DW Domestic Waste

FCR Feed Conversion Ratio

ANOVA – Analysis of Variance

HSD – Honestly Significant Difference

BSF – Black Soldier Fly

°C – Degrees Celsius

mm – Millimeter

cm – Centimeter

g – Gram

%---Percentage

CHAPTER ONE

1.0 Introduction:

1.1 Back ground:

Insect rearing, especially with regard to black soldier fly (*Hermetia illucens*) larvae, has gained a lot of attention lately since these insects can effectively turn organic waste into valuable biomass and have the potential to be a sustainable supply of protein (Makkar *et al*., 2022). Due to their exceptional nutritional value—high protein, essential amino acid content, and fat content—black soldier fly larvae can be used in aquaculture, animal feed, and even human consumption (van Huis & Oonincx, 2017).

The raising of black soldier fly larvae is one type of insect farming that shows promise for meeting the world's increasing protein needs while reducing the negative environmental effects of conventional livestock farming (Barragan-Fonseca *et al.*, 2017). Furthermore, black soldier fly larvae's capacity for bioconversion provides an environmentally beneficial method of handling organic waste, such as food scraps, animal dung, and agricultural byproducts (Nguyen *et al*., 2015). The substrate used in black soldier fly larvae rearing has a significant impact on the larvae's development, growth, and nutritional makeup (Oonincx *et al.*, 2010). Diverse organic substrates, such as food waste, animal dung, and agricultural byproducts, have been investigated for the rearing of black soldier fly larvae (Diener *et al*., 2011). Two of such substrates that show promise are livestock dung and domestic organic wastes, because of their accessibility, quantity, and nutritional value.

According to (Zheng *et al.*, 2015), livestock dung is an easily accessible organic waste material that is high in nutrients, such as proteins, carbs, and lipids. domestic organic wastes consist of a wide range of organic materials from kitchen scraps, fruit, vegetable peels, and leftover grains which serve as excellent substrates for black soldier fly larvae due to their nutrient content and moisture required for larval growth and development of BSFL. (Patel *et al*., 2022) investigated the use of domestic organic wastes mixed with other organic substrates for BSFL cultivation and found it to be a promising method for waste reduction and bioconversion. Both substrates have been investigated for their potential in black soldier fly larvae rearing, albeit to varying degrees.

While prior research has assessed the suitability of domestic organic wastes and livestock dung as substrates for the individual rearing of black soldier fly larvae, little study has directly compared

REFFERENCES

Barragan-Fonseca, K. B., Dicke, M., & van Loon, J. J. A. (2017). Nutritional value of the black soldier fly (Hermetia illucens L.) and its suitability as animal feed - a review. *Journal of Insects as Food and Feed*, *3*(2), 105–120. https://doi.org/10.3920/jiff2016.0055

Diener, S., Studt Solano, N. M., Roa Gutiérrez, F., Zurbrügg, C., & Tockner, K. (2011). Biological treatment of municipal organic waste using black soldier fly larvae. *Waste and Biomass Valorization*, *2*(4), 357–363. https://doi.org/10.1007/s12649-011-9079-1

Holmes, L. A., Vanlaerhoven, S. L., & Tomberlin, J. K. (2013). Substrate effects on pupation and adult emergence of Hermetia illucens (Diptera: Stratiomyidae). *Environmental Entomology*, *42*(2), 370–374. https://doi.org/10.1603/en12255

Lalander, C., Diener, S., Zurbrügg, C., & Vinnerås, B. (2019). Effects of feedstock on larval development and process efficiency in waste treatment with black soldier fly (Hermetia illucens). *Journal of Cleaner Production*, *208*, 211–219. https://doi.org/10.1016/j.jclepro.2018.10.017

Makkar, H., Heuzé, V., & Tran, G. (2022). Locusts and grasshoppers: nutritional value, harvesting and rearing for animal feed, and other applications. *CABI Reviews*, *December*. https://doi.org/10.1079/cabireviews202217038

Nguyen, T. T. X., Tomberlin, J. K., & Vanlaerhoven, S. (2015). Ability of Black Soldier Fly (Diptera: Stratiomyidae) Larvae to Recycle Food Waste. *Environmental Entomology*, *44*(2), 406–410. https://doi.org/10.1093/ee/nvv002

Oonincx, D. G. A. B., van Itterbeeck, J., Heetkamp, M. J. W., van den Brand, H., van Loon, J. J. A., & van Huis, A. (2010). An exploration on greenhouse gas and ammonia production by insect species suitable for animal or human consumption. *PLoS ONE*, *5*(12), 1–7. https://doi.org/10.1371/journal.pone.0014445

Patel, K., Munir, D., & Santos, R. M. (2022). Beneficial use of animal hides for abattoir and tannery waste management: a review of unconventional, innovative, and sustainable approaches. *Environmental Science and Pollution Research*, *29*(2), 1807–1823. https://doi.org/10.1007/s11356-021-17101-5

Purschke, B., Scheibelberger, R., Axmann, S., Adler, A., & Jäger, H. (2017). Impact of substrate contamination with mycotoxins, heavy metals and pesticides on the growth performance and composition of black soldier fly larvae (Hermetia illucens) for use in the feed and food value chain. *Food Additives and Contaminants - Part A Chemistry, Analysis, Control, Exposure and Risk Assessment*, *34*(8), 1410–1420. https://doi.org/10.1080/19440049.2017.1299946

Sheppard, D. C., Tomberlin, J. K., Joyce, J. A., Kiser, B. C., & Sumner, S. M. (2002). Rearing methods for the black soldier fly (diptera: Stratiomyidae). *Journal of Medical Entomology*, *39*(4), 695–698. https://doi.org/10.1603/0022-2585-39.4.695

Spranghers, T., Ottoboni, M., Klootwijk, C., Ovyn, A., Deboosere, S., De Meulenaer, B., Michiels, J., Eeckhout, M., De Clercq, P., & De Smet, S. (2017). Nutritional composition of black soldier fly (Hermetia illucens) prepupae reared on different organic waste substrates. *Journal of the Science of Food and Agriculture*, *97*(8), 2594–2600. https://doi.org/10.1002/jsfa.8081

Tiquia, S. M., Wan, H. C., & Tam, N. F. Y. (2002). Microbial population dynamics and enzyme activities during composting. *Compost Science and Utilization*, *10*(2), 150–161. https://doi.org/10.1080/1065657X.2002.10702075

Tomberlin, J. K., & Sheppard, D. C. (2002). Factors influencing mating and oviposition of black soldier flies (Diptera: Stratiomyidae) in a colony. *Journal of Entomological Science*, *37*(4), 345–352. https://doi.org/10.18474/0749-8004-37.4.345

van Huis, A., & Oonincx, D. G. A. B. (2017). The environmental sustainability of insects as food and feed. A review. *Agronomy for Sustainable Development*, *37*(5). https://doi.org/10.1007/s13593-017-0452-8

Zheng, C., Liu, Y., Bluemling, B., Mol, A. P. J., & Chen, J. (2015). Environmental potentials of policy instruments to mitigate nutrient emissions in Chinese livestock production. *Science of the Total Environment*, *502*, 149–156. https://doi.org/10.1016/j.scitotenv.2014.09.004