EFFECT OF GROUNDNUT AND WATERMELON FEED WASTE ON THE GROWTH AND DEVELOPMENT OF *HERMETIA ILLUCENS*

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FEBRUARY,2025

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A PROJECT SUBMITTED TO THE DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILMENT OF THE REQUREMENT FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE (BSc. HONS) IN ANIMAL AND ENVIRONMENTAL BIOLOGY

FEBRUARY,2025

CERTIFICATION

We certify that this project 'EFFECT OF GROUNDNUT AND WATERMELON FEED WASTE ON THE GROWTH AND DEVELOPMENT OF *HERMETIA ILLUCENS'* was done by OGAH Blossom Taiye with the matriculation number LSC2006684 in the Department of Animal and Environmental Biology, University of Benin, Benin city, Nigeria.

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DEDICATION

This thesis is dedicated to God Almighty, who has been my source, sustainer and strength to my source, sustainer and strength to go through to the end of this program of study.

ACKNOWLEDGEMENT

My profound gratitude goes foremost to God Almighty for His favor, mercies, grace, wisdom and understanding, strength thus far. Special thanks to my project supervisor Prof Aigbodion for his time, guidance, supervision and engaging interactions through the process of my project work. Special thanks to my mother Mrs. Doris Effor, My partner Ukpebor Joseph Odion, my sister, Mrs. Agbadua Justina, My day one, Emmanuel Akachukwu for their love, financial support and encouragement. To my friends and teammates, Cerena, Nessa, Catherine, Paradise, Blessing, Buhari, Okene, for their love and patience.

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ABSTRACT

The rising global population, expected to surpass 9 billion by 2050, has intensified the need for sustainable animal protein sources. Traditional livestock and aquaculture feeds, such as fishmeal and fish oil, pose ecological and economic challenges, necessitating alternative protein solutions. This study evaluated the potential of *Hermetia illucens* (Black Soldier Fly Larvae, BSFL) as a sustainable feed alternative by examining the effects of groundnut and watermelon household waste on their growth performance. The experiment utilized three dietary treatments: groundnut, watermelon, and a 1:1 mixture of both. Growth parameters, including weight gain, food conversion ratio (FCR), and proximate compositions were assessed. Results show that larvae fed the mixed diet exhibited the highest weight gain (59.33g) and the most efficient FCR (3.37), compared to groundnut (21.67g, FCR = 9.23) and watermelon (10.67g, FCR = 18.74). Proximate analysis reveals that groundnut provides higher protein (6.88%) and fat (5.67%), while watermelon contributes moisture (33.98%) but lower macronutrient levels. It was found that the mixture of watermelon and groundnut was the best diet for feeding *H.illucens* larva. The lowest food conversion ratio (3.37) of mixture indicates food utilization efficiency. Proximate analysis disclosed higher value for Fat, Ash, Crude fiber, Protein and Carbohydrate (Ash 0.07, 0.32, 0.56 and 0.81) respectively. In summary, the mixture of watermelon and groundnut is appears to be a better food for raising *H.illucens* larva.

CHAPTER ONE

INTRODUCTION

1.1 Background of The Study

The global population is projected to surpass 9 billion by 2050, with Africa accounting for a significant portion of this growth (United Nations, 2015). To meet the food demands of this expanding population, food production must increase by 70%, accompanied by higher demand for animal protein, particularly poultry and fish (van Huis *et al*., 2013). However, the reliance on fishmeal and fish oil as primary feed sources for livestock and aquaculture has raised concerns. Approximately one-third of global fish catches are processed into these feeds, leading to increased pressure on wild fish stocks and a surge in fishmeal prices, which tripled between 2000 and 2015 (Tveterås & Tveterås, 2010; Seafish, 2011). With feed costs constituting 60-70% of animal husbandry expenses, alternative protein sources are essential to ensure sustainability and affordability in food production systems (FAO, 2009).

Insects have emerged as promising alternatives for high-quality protein production. They offer major advantages, such as requiring minimal space for farming, boasting high bioconversion efficiency, and thriving on organic waste streams, which aids in waste recycling (Oonincx and de Boer, 2012; Smetana *et al*., 2016). Among insects, the black soldier flies (*Hermetia illucens* L.), particularly its larvae (BSFL), has gained considerable attention for its potential in waste management and animal feed production. The BSFL are polyphagous and capable of consuming diverse substrates, including kitchen waste, manure, and human excreta, while exhibiting high fat and protein content suitable for livestock and aquaculture feed (Diener *et al*., 2011; Zhou *et al*., 2013; Wang and Shelomi, 2017).

Notably, the *Hermetia illucens* larvae reduce organic waste efficiently while providing nutrient-rich biomass. For instance, they convert 23% of fresh human excreta to biomass and produce high-value organic fertilizer as residue (Banks *et al*., 2014; Lalander *et al*., 2015). Their saprophagous feeding behaviour and non-pest status further enhance their suitability for controlled farming (Tomberlin *et al*., 2009). Additionally, BSFL are known to suppress the population of disease vectors like houseflies in their vicinity, highlighting their environmental benefits (Bradley and Sheppard, 1984; Liu *et al*., 2008).

However, the efficiency of BSFL farming depends significantly on the substrates used. The type and nutrient composition of the feed material influences the larvae's growth, survival, and nutrient profile. Substrates rich in essential nutrients, which are bioavailable to the larvae, enhance their development and productivity (Cohen *et al*., 2004). Research has demonstrated the versatility of BSFL in converting organic wastes into high-protein biomass, with applications in poultry, fish, and swine diets (Bondari and Sheppard, 1987; St-Hilaire *et al*., 2007).

This study focuses on the effect of groundnut and watermelon feed waste on the growth and development of *Hermetia illucens*. These locally available substrates represent cost-effective options for BSFL farming, particularly for small-scale farmers in resource-constrained settings. By evaluating the growth rate, biomass conversion efficiency, and nutrient content of BSFL reared on these substrates, this research aims to provide insights into sustainable waste management and animal feed production systems tailored to local needs. Moreover, it contributes to addressing global challenges in food security and waste recycling by leveraging the potential of insect farming (Makkar *et al*., 2014; Van Huis *et al*., 2013).

Through the utilization of BSFL, organic waste streams such as groundnut and watermelon residues can be transformed into high-value products, thus promoting a circular economy and reducing environmental impact.

1.2 Justification of The Study

This study explores the use of groundnut and watermelon feed waste as a sustainable substrate for rearing *Hermetia illucens* (Black Soldier Fly), a species valued for its ability to convert organic waste into high-protein biomass. Given the rising global demand for alternative protein sources and waste management solutions, this research aligns with the need to address food insecurity and environmental degradation. Utilizing these agricultural by-products could reduce waste accumulation, lower feed production costs, and promote circular bioeconomy practices. The findings will provide insights into optimizing larval growth while addressing sustainability challenges in agriculture and waste management.

1.4 Aim and Objectives

1.3.1 Aim:

To evaluate the effect of groundnut and watermelon household waste on the growth and development of *Hermetia illucens* larvae.

1.3.2 The objectives of the study are:

i. To assess the weight gain of *Hermetia illucens* larvae fed on groundnut and watermelon feed waste.
ii. To evaluate the food conversion ratio of larvae reared on groundnut and Watermelon.
iii. To determine the nutritional composition of groundnut and watermelon

CHAPTER TWO

LITERATURE REVIEW

2.1 Literature Review

The black soldier fly (*Hermetia illucens*, BSF) has gained global recognition as a sustainable solution to critical issues such as organic waste management, resource recovery, and renewable energy production. As a species belonging to the Diptera order and Stratiomyidae family, the BSF is an exceptional candidate for addressing environmental and economic challenges (Salomone *et al*., 2017; Zahn and Quilliam, 2017). Its larvae exhibit remarkable adaptability and efficiency in biodegrading organic waste, converting it into nutrient-dense biomass rich in proteins and fats. This biomass serves multiple applications, including animal feed and biodiesel production, positioning BSF as a cornerstone for sustainable practices in waste management and energy (Salomon *et al*., 2017).

Hermetia illucens is native to tropical and warm temperate regions but has become globally distributed due to its adaptability. Its non-invasive nature and resilience make it highly suitable for controlled farming environments. Adult BSFs resemble wasps, with black bodies and translucent wings, but they lack functional mouthparts and do not feed, relying solely on fat reserves accumulated during the larval stage. These adults live for only 5 to 8 days, focusing primarily on reproduction. This lifecycle feature further enhances the sustainability of BSF farming, as the species reproduces rapidly without requiring significant resources.

The lifecycle of *H. illucens* encompasses four distinct stages: egg, larva, pupa, and adult. Females lay between 500 and 900 eggs in clusters near decomposing organic matter, ensuring optimal conditions for larval development. These eggs hatch within four days, and the larvae begin their voracious feeding phase, consuming various organic substrates such as agricultural waste, manure, and food residues. This stage lasts approximately 14 to 28 days, during which the larvae accumulate significant amounts of proteins and fats. Subsequently, the larvae pupate in a dry environment, a process that takes 10 to 14 days before the emergence of adults. The rapid growth and reproductive cycles of BSF make it an ideal species for large-scale waste management and resource recovery systems.

Economically, the black soldier fly offers significant potential, particularly in organic waste management and resource recovery. The larvae are efficient bioconversion agents, capable of reducing large volumes of organic waste while producing valuable by-products. For instance, the bioconversion process yields frass—the excreta of larvae—which serves as a nutrient-rich fertiliser. Frass enhances soil fertility and promotes sustainable agricultural practices (Salomone *et al*., 2017; Zahn and Quilliam, 2017). Moreover, BSF larvae can be processed into high-protein feed for livestock, poultry, and aquaculture. This sustainable alternative to conventional feed ingredients such as fishmeal and soybean meal reduces reliance on overexploited marine resources and helps lower feed costs, benefitting farmers worldwide.

The fat-rich composition of BSF larvae has garnered attention for biodiesel production. As a renewable energy source, biodiesel derived from BSF fat has the potential to reduce dependence on fossil fuels, contributing to environmental conservation and energy security. Research indicates that BSF larvae offer a viable and cost-effective solution for renewable energy, aligning with global efforts to transition towards sustainable energy systems.

In terms of nutritional value, BSF larvae are a powerhouse of essential nutrients, making them an excellent protein source for animal feed and potentially human consumption. The larvae contain approximately 35–45% protein on a dry weight basis, comparable to fishmeal, and 15–49% lipids, depending on their diet. These lipids are not only useful in biodiesel production but also hold applications in the food and pharmaceutical industries. Additionally, the larvae are rich in minerals such as calcium, phosphorus, and magnesium, essential for livestock and fish growth and health. The presence of chitin, a fibrous compound in the larval exoskeleton, further enhances their value, with potential applications in pharmaceuticals and water treatment.

Human nutrition applications of BSF larvae are also being explored, particularly in regions facing food insecurity. The larvae's high protein content, coupled with a low environmental footprint, positions them as a promising ingredient for protein-rich supplements and functional foods. Furthermore, the scalability and efficiency of BSF farming make it a viable option for addressing global nutritional challenges.

The environmental importance of *H. illucens* is impressive. The species contributes to waste management by reducing organic waste volumes by up to 50%, mitigating methane emissions from landfills, and improving sanitation through pathogen reduction. BSF larvae have been shown to suppress harmful bacteria such as Escherichia coli and Salmonella spp. in waste substrates. This capability is attributed to the production of antimicrobial peptides (AMPs) in their gut. Additionally, BSF farming has a significantly lower carbon footprint compared to traditional protein sources, requiring less water and land and producing fewer greenhouse gas emissions.

Despite its numerous benefits, the potential of *H. illucens* as a vector for pathogens cannot be overlooked. Pathogens may occur in or on BSF larvae depending on the rearing substrate. For example, larvae fed on contaminated waste might harbour bacteria such as Salmonella, Listeria monocytogenes, or *Clostridium spp*. However, studies indicate that BSF larvae possess intrinsic antimicrobial properties that inhibit the growth of several harmful microbes. Proper rearing practices and sterilisation methods, such as pasteurisation, significantly reduce the risk of pathogen transmission. Regulatory guidelines in the BSF farming industry further ensure the safety of products used for animal feed or human consumption.

The growth performance of BSF larvae is influenced by several factors, primarily the composition of their feed substrate. Organic waste sources, including municipal food waste, livestock manure, and industrial by-products, provide an affordable and efficient feed solution. Research highlights that food waste accounts for 25–45% of municipal solid waste, representing an abundant and underutilised resource (Kim *et al*., 2021). Studies by Zheng *et al*. (2012) reveal that larvae exhibit enhanced growth performance when fed organic waste rich in carbohydrates and proteins. Groundnut and watermelon waste, known for their nutrient profiles, are hypothesised to stimulate larval development, improving biomass yield and fat accumulation.

Tailored organic waste feeds can optimise larval growth and reduce breeding costs. Li *et al*. (2011) demonstrated that nutrient-dense feeds promote microbial activity in the larval gut microbiota, facilitating efficient nutrient absorption and bioconversion processes. The fat content of larvae varies between 16% and 57.9%, depending on feed composition (Nguyen *et al*., 2019). Groundnut waste, abundant in lipids, and watermelon waste, rich in moisture and sugars, synergistically enhance larval fat levels, making them ideal for biodiesel production.

The bioconversion capabilities of BSF larvae make them an eco-friendly solution for organic waste management. Studies indicate that larvae can reduce organic waste volumes by up to 70–90%, depending on the type of waste and rearing conditions (Cičková *et al*., 2015). Salomone *et al.* (2017) conducted a life cycle assessment of BSF waste treatment, demonstrating significant reductions in greenhouse gas emissions compared to traditional composting methods. The use of biodegradable and nutrient-rich substrates such as groundnut and watermelon waste offer the potential to achieve high waste reduction efficiency while enhancing larval biomass output.

The high lipid content of BSF larvae show their potential as a biodiesel feedstock. Research by Manzano-Agugliaro *et al.* (2012) indicates that lipids extracted from insect larvae possess energy densities comparable to traditional biodiesel sources. Park *et al.* (2008) highlighted that lipid extraction from larvae fed on groundnut and watermelon waste could yield biodiesel with improved oxidative stability and combustion properties. Studies on housefly larvae (Musca domestica) further support the viability of insect-derived biodiesel as an alternative to plant-based sources (Yang *et al*., 2014).

In addition to biodiesel production, BSF larvae and their derivatives have diverse applications. Larval frass, a by-product of waste bioconversion, is recognised as a nutrient-rich fertiliser that improves soil fertility and plant growth (Zahn and Quilliam, 2017). The antimicrobial peptides derived from *H. illucens* exhibit potential in pharmaceutical and agricultural sectors, offering solutions for disease management and crop protection (Lalander *et al.*, 2016).

BSF larvae also provide a sustainable protein source for animal feed, reducing reliance on conventional feedstocks like soybean and fishmeal. Nguyen *et al*. (2019) reported that incorporating BSF larvae into poultry and aquaculture diets improves growth performance and health outcomes, enhancing the economic viability of larval bioconversion systems.

Despite their promising applications, several challenges hinder the widespread adoption of BSF in waste management and biodiesel production. These challenges include optimising feed substrates to maximise larval growth and fat yield, developing large-scale rearing systems that maintain optimal environmental conditions, and addressing regulatory barriers surrounding the use of insect-derived products in food and energy sectors. Future research should focus on refining feedstock formulations, incorporating groundnut and watermelon waste, and enhancing larval breeding technologies. Moreover, comprehensive life cycle assessments are needed to quantify the environmental and economic benefits of insect-based systems compared to traditional approaches.

The black soldier fly represents a transformative opportunity in sustainable development, addressing critical issues in waste management, renewable energy, and food security. By leveraging its unique biological and nutritional characteristics, *H. illucens* offers scalable and economically viable solutions for a wide range of industries. Continued research and innovation will be critical in overcoming existing challenges and unlocking the full potential of this remarkable species.

CHAPTER THREE

MATERIALS AND METHOD

3.1 Study Area

The study was conducted in the Prof. Aigbodion Entomological Laboratory at the University of Benin, Benin City, Edo State, Nigeria.

3.2 Collection of Black soldier Fly

Hermetia illucens larvae were collected a colony maintained in the laboratory at temperature and relative humidity of 28+-2.0*C and 70+-5.0 RH respectively. The Larve were collected at 10 days old.

3.3 Collection of Household Food Waste

Household food waste, including groundnut and watermelon waste, was sourced from Oba Market, one of the largest and busiest markets in Benin City, Edo State.

Bowl: A total of 9 Round bowls of diameter (18cm and 10cm depth) were used to contain the different food waste. Each food waste had 3 bowls housing the same density of feed and larvae.

Mosquito Net: A yard (36 inches) of lightweight mosquito net was used to cover the nine bowls containing the watermelon, groundnut and the mixture of both diets with the *Hermitia illucens* larva. The net served as a protective barrier preventing intrusion by other insects or external contaminants that could potentially alter the result of the study.

Wood: Four pieces of woods (each 9 inches long) were used in this study. Each piece was carefully placed at each edge of the mosquito net. The purpose of the wood was to was used to keep the mosquito net in its place, effectively preventing insects or any other external bodies from entering into the treatment.

3.4 Treatment preparation

The following treatment were applied to *Hermetia illucens* (see fig. 1 & 2).

i. Groundnut: Groundnut was ground with a little amount of water to form a pasty consistency. The groundnut was removed from its shells before processing.
ii. Watermelon and groundnut mixture: 1:1 ratio mixture of both diets was used as a control diet.
iii. Watermelon: Watermelon was peeled and mashed into a semi-liquid state without any additional ingredient. The different diets served as substrate and growth medium for the Black Soldier Fly Larvae. The feeds ere weighed at 200g each and for the 1:1

mixture of both groundnut and watermelon, it was 100g to 100g (200g).

Plate 1 Helmintia illucens **feeding in their different treatment groups**

Plate 2 **Filtration of *H. Illucens* from feed**

3.4.1 Experimental Design

3.4.2 Experimental Setup

The arrangement for this experiment required the use of 9 round bowls (18cm diameter and 10cm depth) which initially contained the different diets after which larvae of 15g was carefully measured using a digital scale and added. Three treatment groups were established:

i. Groundnut diet had 3 bowls all housing the same density of Larvae (15g).
ii. The mixture of groundnut and watermelon diet had 3 bowls housing the same density of Larvae (15g).
iii. Watermelon diet also had 3 bowls housing the same density of Larvae each (15g).

The round bowls were labelled according to their content in thid format; diet, weight of Larvae, age of larvae and date. (for example: Groundnut, 15g, 20-08-2024). The bowls were covered with a net material to prevent external bodies from contaminating the experiment and this net was held in place using 4 equal woods (One at the left, one at the ride, another at the top while the last one holding it at the bottom).

3.5 Proximate Analysis of the Diet

To assess the nutritional composition of the feed materials, a comprehensive proximate analysis was conducted following the standard methods outlined by the Association of Official Analytical Chemists (AOAC, 2000). This analysis provided insights into the moisture, ash, crude lipid, crude fibre, crude protein, and carbohydrate contents of the feed materials.

3.5.1 Moisture Content

The moisture content of the feed was determined by drying 5 g of each sample in a hot air oven set at 105°C for 24 hours. The weight of the sample before and after drying was recorded, and the moisture content was calculated as a percentage of the initial weight. This parameter was critical in understanding the water content of the feed, which influences the larvae's ability to consume and metabolise the nutrients effectively.

3.5.2 Ash Content

To determine the ash content, 2 g of each feed sample was ignited in a muffle furnace at 550°C until a constant weight was achieved. The remaining residue, which represents the inorganic mineral content of the feed, was weighed and expressed as a percentage of the initial sample weight. This analysis provided valuable information on the mineral composition of the feed materials.

3.5.3 Crude Lipid Content

The crude lipid content was analysed using the Soxhlet extraction method. A 5 g sample of each feed was placed in an extraction thimble and subjected to continuous extraction with petroleum ether for 6 hours. After the extraction process, the solvent was evaporated, leaving behind the lipid residue, which was weighed to determine the crude lipid content. The results were expressed as a percentage of the sample weight.

3.5.4 Crude Fibre Content

Crude fibre analysis involved sequentially digesting 2 g of each feed sample with 1.25% sulphuric acid and 1.25% sodium hydroxide solutions. The residue obtained after digestion was dried, weighed, and then ashed in a muffle furnace. The difference in weight before and after ashing represented the crude fibre content, which was expressed as a percentage of the sample weight. This parameter was essential in evaluating the indigestible portion of the feed materials.

3.5.5 Crude Protein Content

The crude protein content of the feed was determined using the Kjeldahl method. A 2 g sample of each feed was digested with concentrated sulphuric acid in the presence of a catalyst to convert organic nitrogen into ammonium sulphate. The resulting solution was distilled, and the liberated ammonia was titrated with 0.1 N hydrochloric acid. The nitrogen content was then multiplied by a conversion factor of 6.25 to calculate the crude protein content, expressed as a percentage.

3.5.6 Carbohydrates (Non-Fatty Extract)

The carbohydrate content was calculated by difference, subtracting the sum of moisture, ash, crude lipid, crude fibre, and crude protein contents from 100%. This analysis provided a comprehensive understanding of the feed's energy-providing components.

3.6 Analysis of Data

The data collected from the study were analysed and presented using a combination of descriptive statistics and graphical representations. Growth parameters, including larval weight gain and survival rate, were summarised and compared across the three treatment groups. Proximate composition data were also analysed to determine the nutritional quality of the feed materials and their effect on larval development.

CHAPTER FOUR

RESULTS

Table 4.1: Mean weight gain of *Hermitia illucens* larva raised on Watermelon and Groundnut.

	Weight in gram			
Diet	Initial weight	Final weight	Weight gain	%
Watermelon	15	25.67	10.67	2.74
watermelon/Groundnut	15	74.33	59.33	11.15
Groundnut	15	36.67	21.67	7.95

The mean weight gain of *Hermitia illucens* larva raised on watermelon and groundnut is shown in Table 1. The weight of larva that fed on watermelon, groundnut and mixture of both were 10.67, 59.33 and 21.67 respectively.

There was significant difference ($P<0.05$) in weights with the mixture of both diets having the highest weight gain.

Table 4.2. Food conversion Ratio of *Hermitia illucens* larva raised on Watermelon and Groundnut

	Mean Weight in gram		
Diet	Food total	Larva total	Conversion Ratio
Watermelon	200		
Groundnut	10.67	18.74	
Watermelon/Groundnut	200	59.33	3.37

The food conversion ratio of *Hermitia illucens* raised on watermelon, groundnut and the mixture of both diets were 18.74, 3.37 and 9.23 respectively. This indicates that the mixture of watermelon and groundnut is the best diet for feeding *Hermitia illucens* larva.

	Sample Concentration%				
Diet	Moisture	Fat	Ash	Crude fibre	protein
Watermelon	98.21	0.03	0.07	0.32	0.56
Groundnut	2.89	5.67	2.13	1.86	3.85

Table 4.3: proximate analysis of water melon and groundnut

The proximate analysis evaluating moisture, Fat, Ash, Crude fibre, Protein and Carbonhydrate in watermelon were 98.21%, 0.03%, 0.07%, 0.32%, 0.56% and 0.81% respectively. (Table 3). In the same order, that of groundnut were moisture 2.89%, 5.67%, 2.13%, 1.86%, 3.85% and 83.60% respectively. There was significant difference ($P<0.05$) in the comparison of both food, only moisture was higher in watermelon, the reverse being the case in others.

4.3 Weight Gain Per Diet

The mean percentage weight gain of *H. illucens* fed with Watermelon, Groundnut and the mixture of Watermelon and Groundnut were 10.67%,21.67% and 59.3% respectively. Only larva of Hermetia illucens fed with with the mixture of watermelon and groundnut diet showed a difference in the weights. Whereas there was no significant difference between Watermelon and Groundnut diet.

The proximate composition of the diets used in feeding Hermetia illucens was analyzed for moisture, fat, ash, crude fiber, protein, and carbohydrate (Nitrogen-Free Extract, NFE). The moisture content was 98.21% for watermelon and 2.89% for groundnut. Fat content was significantly higher in groundnut (5.67%) compared to watermelon (0.03%). Ash content was 2.13% in groundnut and 0.07% in watermelon. Crude fiber was 1.86% in groundnut and 0.32% in watermelon. Protein content was 3.85% in groundnut and 0.56% in watermelon. Finally, carbohydrate (NFE) was 83.60% in groundnut and 0.81% in watermelon.

These results suggest that groundnut is a more nutrient-dense feed compared to watermelon, particularly in terms of protein and carbohydrate content, which are essential for larval growth and development. This may explain why larvae fed on a mixture of groundnut and watermelon performed better in terms of weight gain and food conversion efficiency.

CHAPTER FIVE:

DISCUSSION

5.1 Discussion

The results of this study indicate that diet composition significantly influences the growth performance, survival rate, and food conversion efficiency of Hermetia illucens larvae. The combination of groundnut and watermelon yielded the highest weight gain and the best food conversion ratio (FCR), suggesting that a mixed diet provides a more balanced nutrient profile.

The mean weight gain of larvae fed on watermelon, groundnut, and a mixture of both was 10.67g, 21.67g, and 59.33g, respectively. The significantly higher weight gain in larvae fed on the mixed diet suggests a synergistic effect of both feed components, enhancing nutrient availability and absorption. Previous studies have highlighted that dietary diversity improves insect growth rates by providing a more comprehensive range of essential nutrients (Kierończyk et al., 2022).

The food conversion ratio (FCR), which measures the efficiency of feed utilization, was 3.37 for the mixed diet, 9.23 for groundnut, and 18.74 for watermelon. A lower FCR value indicates more efficient feed utilization, meaning that larvae fed with the mixed diet required less feed to gain weight. This aligns with previous findings that nutrient-rich diets enhance larval metabolism and conversion efficiency (Albalawneh et al., 2024).

The proximate analysis further supports these results. Groundnut had the highest protein content (6.88%), while watermelon had significantly lower protein levels (0.56%). Protein is crucial for larval development, as it supports tissue growth and metabolism (Ellison et al., 2021). Additionally, the fat content was highest in groundnut (5.67%), which likely contributed to its superior growth outcomes compared to watermelon alone. Watermelon, while rich in moisture (33.98%), had lower macronutrient content, which may explain its lower contribution to larval weight gain.

The Kolmogorov-Smirnov (K-S) test confirmed that the observed differences in weight gain were statistically significant, reinforcing the conclusion that diet composition directly influences H. illucens development. The K-S test is commonly used to assess normality and distribution differences, further validating the reliability of the findings (Drezner et al., 2008).

5.2 Conclusion

This study demonstrates that diet composition plays a crucial role in the growth performance of H. illucens larvae. Among the tested diets, the combination of groundnut and watermelon proved to be the most effective, leading to the highest weight gain and the best food conversion efficiency. These findings suggest that a mixed diet provides a balanced nutrient profile, enhancing larval growth and development. This has practical implications for H. illucens farming, where optimized feed formulations can improve productivity and sustainability. Future studies could explore additional dietary combinations and their impact on other parameters such as reproductive success and biochemical composition.

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APPENDIX I.

WEIGHT GAIN IN REPLICATES OF *HERMITIA ILLUCENS* LARVA REARED ON WATERMELON AND GROUNDNUT.

WEIGHT IN GRAM				
DIET	REPLICATE	INITIAL	FINAL	GAIN
WATERMELON	1	15	26	11
	2	15	28	13
	3	15	23	8
WATERMELON/ GROUNDNUT				
	1	15	60	45
	2	15	74	59
	3	15	84	69
GROUNDNUT				
	1	15	37	22
	2	15	36	21
	3	15	37	22

APPENDIX II

Parameters	1	2	3	N
Observed frequency	10.67	59.33	21.67	91.67
Expected frequency	30.56	30.56	30.56	
Cummulative observed Frequency	10.67	70.00	91.67	
commulative expected frequency	30.56	61.12	91.67	
Difference between cummulative observed and cummulative	**19.89**	8.88	0	

A. KOLMOGOROV SMIRNOV ONE SAMPLE TEST FOR ANALYSIS

Calculated value=19.89/91.67 =0.217

Tabulated value=1.36/√91.67=1.36/9.57445

=P<0.05 significantly different.

50.33/21.67=2.74 is more than 1.548 which is the ratio equivalent of X2

B. KOLMOGOROV SMIRNOV ONE SAMPLE TEST FOR FOOD CONVERSION

Diet	Food total weight (g)	Larva total weight (g)	Conversion Ratio
Watermelon	200	10.67	18.74
Watermelon/Groundnut	200	59.33	3.37
Groundnut	200	21.67	9.23

	Watermelon	Mixture	Groundnut	
Parameters	1	2	3	N
Observed Frequency	18.74	3.37	9.23	3.34
Expected Frequency	10.45	10.45	10.45	
Cummulative Observed Frequency	18.74	22.11	31.34	
Cummulative Expected Frequency	10.45	20.90	31.34	
Difference between Cumulative Observed and Cumulative Expected	8.29	1.21	0	

Calculated value=8.29/31.34=0.265

Tabulated value=1.36/√31.34=1.36/5.5982=0.243

$P<0.05$Significantly different.

18.74/9.23=2.03.

APPENDIX III

PROXIMATE ANALYSIS

Moisture 98.21–warermelon=33.98

2.89–groundnut

Fat 5.67 –groundnut=189

0.03–watermelon

Ash 2.13–groundnut=30.43

0.07–watermelon

Crude fibre 1.86–groundnut=5.81

0.32–watermelon

Protein 3.85–groundnut=6.88

0.56–watermelon

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Carbohydrate (N.F.E) 83. 60 –groundnut=103.21

0.81–watermelon