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Proximate and Microbiological Evaluation of Black Soldier Flies (BSF) (*Hermetiaillucens*) Nutrition on Different Organic Substrate Media

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Abstract:

The aimed of this research is to determine the nutritional content of black soldier flies (BSF) larva biodegradation manipulation as an additive in broiler chicken feed. There are five materials were used as a substrate in this research as follows: fruit waste, food waste, tofu waste, fruit waste + food waste, and tofu waste + fruit waste. The parameters observed were nutritional content and anti-microbial (lactic acid bacteria, Salmonella sp., Escherichia coli). The method of this research used qualitative description. The result nutritional content is fruit waste 36.65, food waste 34.10, tofu waste 33.60, fruit waste + food waste 36.29, tofu waste + fruit waste 37.82. The conclusion presents the best nutrition content and anti-microbial for BSF is tofu waste + fruit waste. Since this is the first step, further analysis need to taken.

Keywords **—Black Soldier Fly Flour, Proksimat, Mikrobiologi.**

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I. INTRODUCTION

The issue of food security has become a globally compelling topic today. Food is a fundamental necessity for millions of people worldwide, making efficient and rapid solutions essential for all food-related challenges. With the global population growth, the demand for food supply is also increasing. One of the global challenges we face is how to provide food for the projected 9.1 billion people by the year 2050. On the other hand, some countries are grappling with food crises due to their inability to meet food needs, while developed or developing countries are facing the issue of food waste, which has become a global concern in recent years. This problem of food waste can disrupt the food supply chain and have implications for global environmental issues in the future [1]

The issue of waste has become a matter of concern due to its substantial daily production. Sustainable waste management is crucial to mitigate this problem. The dominant type of organic waste is food residue, including that originating from animals, plants, fruits, vegetables, agricultural waste, plantations, and fish. To prevent potential problems, it is important to manage organic waste effectively. Neglecting organic waste management can result in various issues, including disease spread, methane gas emissions, unpleasant odors, groundwater pollution, and contributions to global warming [1]. One of the best options is to reduce the accumulation of organic waste. Currently, a significant consideration is utilizing microorganisms and insects for organic waste management, as the recycling process plays a vital role in maintaining environmental sustainability.

The larvae of the black soldier fly (*Hermetiaillucens* L.) are one of the highly potential organic decomposer insects in organic waste management. The larvae of the black soldier fly have the ability to rapidly and efficiently transform organic waste into their own biomass. This process is known as bioconversion. During this bioconversion process, black soldier fly larvae

can reduce the volume of organic waste by approximately 50-60% and transform the composition of organic waste into a more nutrient-rich material [2].

Some of the products resulting from the bioconversion of organic waste by black soldier fly (BSF) larvae include: ornamental fish feed made from early-stage BSF larvae (instar), a mix of fish feed, a mix of livestock feed, and a mix of poultry feed using BSF prepupae. Meanwhile, the remaining medium consists of leftover maggot residue (Kasgot) or residues from the bioconversion process of BSF larvae, which can be used as fertilizer or compost for soil media in vegetable cultivation [3].

BSF larvae have a high protein content compared to other insect species, ranging from approximately 40-50%, with a fat content of 29-32% [4]. BSF larvae can be processed into meal to replace fish meal up to one hundred percent as a component of broiler chicken feed without causing negative effects on chicken digestibility. The composition of this BSF meal includes protein (64.59-75.32%), dry matter (57.96-60.42%), and energy (62.03-64.77%), although the best results are obtained when replacing fish meal up to 25% or 11.25% in the feed. As a source of feed raw material, insect-based products must also be free from chemical contaminants [5].

Based on the above description, where BSF larvae play a significant role in the bioconversion of organic waste and serve as an alternative protein source for livestock such as chickens, this research is necessary to obtain high-quality larvae. According to that problems this article aimed to examined the various mixed feeds made from organic waste (fruit waste, food waste, tofu residue) in specific ratios were provided to BSF larvae to determine the appropriate and optimal feed formulation for the nutritional content and biomass of BSF larvae.

II. METHOD

Materials and Equipment

Materials and equipment for proximate analysis and inhibitory power test include samples of black soldier fly larva flour, Kjeldahl tablets, concentrated H_2SO_4, 40% NaOH, borax, methyl red indicator, bromocresol green indicator, 0.01 N H_2SO_4, 0.3 N H_2SO_4, 1.5 N NaOH, 0.3 N HCl, acetone, H2O, distilled water, porcelain crucible, forceps, triangle wire, scale, oven, desiccator, Bunsen burner/stove, muffle furnace, 100 ml Kjeldahl flask, measuring glass, measuring flask, Erlenmeyer flask, Soxhlet flask, reflux condenser, Buchner funnel, spatula. As for the materials and equipment used in the inhibitory power test, they include black soldier fly larva flour, LAB isolate, Escherichia coli and Salmonella sp. bacteria, De Man Rogosa Sharp Agar (MRSA) medium for LAB production, MacConkey Agar medium for the growth of *Escherichia coli* and *Salmonella* sp. bacteria, Nutrient Agar (NA), distilled water, petri dish, incubator, 1 ml micropipette, L glass, autoclave, filter paper, and calipers.

Research Method

The method employed in this study is laboratory analysis using a quantitative descriptive approach with three treatments in the bacterial inhibition test using the disc diffusion method.

Research Procedure

The procedure for making black soldier fly larva flour involves collecting black soldier fly larvae from different growth media and rearing them for 28 days. Afterward, they are sieved to separate them from any remaining waste, then microwaved for 40 minutes at 180 degrees Celsius and allowed to cool. Subsequently, they are blended or ground until they form a flour-like consistency.

According [6], BSF larva flour contains a significant amount of protein in the form of various amino acids, as well as high levels of fat and calcium, which are beneficial for feed for poultry, a protein derivative. The amino acid content, such as isoleucine, leucine, threonine, valine, phenylalanine, and arginine in BSF flour, is presented in sufficiently high proportions, thereby supporting the growth of livestock during the feed ingredient process. Feeds made from BSF larvae are highly suitable for promoting the growth of such livestock.

Research Variables.

The observed variables in the first stage of the research are the nutritional content and the inhibition zone diameter of black soldier fly larva flour against Lactic Acid Bacteria (LAB), Escherichia coli, and Salmonella sp.

Proximate Analysis

The proximate analysis procedure is conducted to determine the nutritional value of a feed ingredient by analysing dry matter, crude fibre, crude fat, crude protein, and ash (inorganic matter).

Bacterial Inhibition Test

The bacterial inhibition test procedure is conducted using the Kirby-Bauer disc diffusion method. The criteria for bacterial inhibition are as follows:

- Clear zone diameter > mm indicates very strong inhibition.
- Clear zone diameter of 10-20 mm indicates strong inhibition.
- Clear zone diameter of 5-10 mm indicates moderate inhibition.
- Clear zone diameter < mm indicates weak inhibition.

Research Variables

The observed variables in the first stage of the research are the nutritional content and the inhibition zone diameter of black soldier fly larva flour against Lactic Acid Bacteria (LAB), Escherichia coli, and Salmonella sp.

III. RESULTSAND DISCUSSION

Proximate Analysis

The nutritional content of black soldier fly larvae (*Hermetiaillucens*) has been subjected to proximate analysis, which includes moisture content, ash content, crude protein, crude fat, and crude fiber. Five materials were used as substrates in this research, namely: fruit waste, food waste, tofu waste, fruit waste + food waste, and tofu waste + fruit waste.

Table 1.
Proximate Results

No	Sample	Water content %	Ash %	Proteins %	Crude Fat %	Crude Fibre %
1	FWW	97.30	8.89	34.10	39.27	7.96
2	FW	90.89	2.54	36.65	39.62	8.11
3	TW	96.51	12.28	33.60	36.62	7.39
4	FW + FWW	97.52	12.03	36.29	32.06	8.54
5	TW + FW	95.86	12.70	37.82	30.17	8.42

FW – fruit waste, FWW – food waste, TW – tofu waste

It can be seen in table 1 showing the results of the nutritional content of fruit waste 36.65, food waste 34.10, tofu waste 33.60, fruit waste + food waste 36.29, tofu waste + fruit waste 37.82. The combination of tofu waste + fruit waste shows the highest nutritional value. According to [7] the nutritional content in tofu dregs is: water 82.69%; ash 0.55%; fat 0.62%; protein 2.42% and carbohydrates 13.71%. [8] research showed that the greatest feed conversion efficiency was shown by the combination of tofu dregs + fruit of 10.1. Meanwhile, the smallest efficiency was seen in the combination of tofu dregs + wood sawdust, the feed of which is difficult for BSF larvae to digest.

The research results of [9] who used chicken manure with added tofu dregs as a medium for growing maggots, resulted in a significant increase in body length, body weight and maggot production compared to cow dung and goat manure added with tofu dregs. The maggots produced contain high nutritional quality and have the potential to be used as poultry feed. The research results [10], maggots cultivated using chicken manure plus tofu dregs produced maggots with a higher protein content (52.08%) based on 100% BK compared to using vegetable waste (48.77%) and fruit waste (30.30%). The results of research by Syamsuhaidi, et al (2021) show that fruit waste contains low crude protein, namely 14.18% compared to chicken manure media added with tofu dregs (19.07%) and vegetable waste (22.03%).

Inhibitory Power Test

The inhibitory power test in this study analyzed antimicrobials (lactic acid bacteria, Salmonella sp., Escherichia coli) in black soldier fly flour that had been treated with fruit waste, food waste, tofu waste, fruit waste + food waste, and tofu waste + fruit waste.

Table 2.
Antimicrobials (lactic acid bacteria, Salmonella sp., Escherichia coli)

No	Sample	Obstacles zone LAB (cm)	Obstacles zone *Escherichia Coli.sp* (cm)	Obstacles zone *Salmonella sp.* (cm)
1	FWW	0	0	0
2	TW + FW	0.84	0.54	0.77
3	FW + FWW	0.55	0.31	0.65
4	TW	0.32	0.15	0.29
5	FW	0.45	0.25	0.34

FW – fruit waste, FWW – food waste, LAB – lactic acid bacteria; TW – tofu waste

In table 2 it can be seen that the highest results were shown by tofu dregs + fruit waste with a LAB value of 0.84, E. Coli 0.54, Salmonella 0.77, and the lowest value was shown by the fruit waste treatment.

These BSF larvae are able to reduce the population of *Escherichia coli* O157:H7 and Salmonella enterica serovar Enteritis's in poultry manure and *E. coli* in dairy cow manure [11]. [12] recommend drying the prepupa first before giving it as animal feed. Processing in pellet form through a drying process can eliminate the potential for transmission of pathogenic bacteria, such as *Salmonella sp*.

IV. CONCLUSIONS

The research results show that variations in feed formulation have a significant effect on the nutritional and antimicrobial content (lactic acid bacteria, Salmonella sp., Escherichia coli) of *Hermetiaillucens* larvae. The feed formulation containing Tofu Dregs + Fruit Waste gave good results compared to all treatments.

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