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Maggot nutrition content in various growing media (vegetable, fruit, and food processing industry): fish flour substitution

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Abstract. Vegetable, fruit, and food processing industrial waste has a low nutritional content. The quality of the nutritional content is improved by processing it through fermentation. The study was conducted experimentally using a completely randomized design (CRD) factorial pattern. There were two factors (3 x 3), namely Factor I various maggot growing media (D1 = mustard greens, cabbage, and cauliflower leaves, D2 = banana, pineapple, and papaya, D3 = coconut dregs, tofu dregs, and cassava waste) and Factor II fermentation time (L1 = 2 days, L2 = 4 days and L3 = 6 days), with three replications. The parameters of this study consisted of the nutritional content of maggot in the form of water content, dry matter, crude protein, crude fiber, crude fat, and ash. The results showed that various maggot-growing media had a significant effect ($P<0.05$) on the ash content and a very significant effect ($P<0.01$) on crude protein. No significant effect ($P>0.05$) was found on moisture content, dry matter, crude fiber, and crude fat. The duration of fermentation of maggot growing media had a significant effect ($P<0.05$) on crude protein and crude fat but had no significant effect ($P>0.05$) on moisture content, dry matter, ash content, and crude fiber. There was an interaction between various types of waste and the duration of fermentation of the media on the protein content of maggot. Still, there was no interaction with the water content, dry matter, crude fiber, crude fat, and ash.

Keywords: fermentation, food processing industrial waste, fruit, hermetia illucens, nutritional content

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1. Introduction

Feed quality is the key to the livestock business's success. Poultry feed or food is essential in the livestock business, especially chicken livestock. The availability of quality feed is very influential in increasing production power. Fish meal is a feed ingredient generally used as a source of animal protein. However, the price of fish meals often increases, and their availability is also limited. Therefore, feed exploration aims to find alternative protein sources by utilizing maggot. Black Soldier Fly (BSF) has a reasonably high crude protein content of 44.26% and crude fat content of about 29.605% [1]. Regarding cultivation, BSF is easy to maintain and does

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not require special tools. Therefore, the researchers carried out maintenance using several types of growing media based on vegetable, fruit, and industrial residues. Maggot cultivation requires the proper growing media to optimally increase the maggot population. Many efforts to reduce organic waste have been carried out by utilizing maggot as decomposing microorganisms. The maggot-growing medium determines the nutritional quality and maggot production. High-quality media will produce maggot. Increasing the nutritional content of vegetable, fruit, and feed industry waste can be done by adding bio activators such as local microorganisms (MOL) in the fermentation process. [2] stated that microbes originating from their substrate (local microbes) have a high ability to degrade substrates, increasing the nutrient content of maggot. Regarding cultivation, BSF is easy to maintain and does not require special tools. Therefore, the researchers carried out maintenance using several types of growing media based on vegetable, fruit, and industrial residues. Maggot cultivation requires the proper growing media to increase the maggot population optimally. Maggot is easy to cultivate because maggot is a decomposer creature that can decompose organic waste into its food.

2. Materials and methods

The research was conducted on Jl. Lotus Flower, No. 6 Padang Bulan Selayang II, Medan Selayang District. In January-February 2022. The tools used in this study were silos for fermentation containers, basins, buckets, ovens, trays, chopping machines, analytical scales, thermometers, pH meters, measuring cups, beaker glass, masks, gloves, tarps, plastic meters, and paper. filter, parchment paper, laboratory analysis apparatus, fat flask, soxhlet, Kjeldahl flask, distillation apparatus, electric heater/burner, Buchner funnel, vacuum pump, kiln, autoclave, petri dish, test tube, test tube rack, bunsen, hot plate, needle ose, scales, 1 kg PVC plastic, grinder, sintered glass, vacuum pump, oven, desiccator, stationery and camera for documentation

2.1 Research Method

This study uses treatment for the development of maggot on different media. The treatment is as follows, factor I; D1 (green mustard, cabbage, and cauliflower leaves), D2 (banana, papaya, and pineapple), D3 (coconut dregs, tofu pulp, and cassava). Factor II; L1 (2 days), L2 (4 days), and L3 (6 days). Each treatment used three replications.

The study was conducted experimentally using a completely randomized design (CRD) factorial pattern. There were two factors: factor I, various maggot growing media, and factor II the length of time for substrate fermentation, each replicated three times so that 27 research units were obtained. Moisture content, dry matter, crude protein, crude fiber, crude fat, and ash content.

2.1. Research Parameters

- moisture content (KA)
- dry matter (BK)
- crude protein (PK)
- crude fiber (SK)
- crude fat (LK)
- ash content

3. Result and Discussion

3.1. Maggot Water Content

Table 1. Water content (%) of maggot (Hermetia illucens) in various media and the duration of substrate fermentation.

Treatments	Replications			Mean
	L_1	L_2	L_3	
D_1	76.67	80.33	80.33	78.11^a
D_2	81.00	81.00	81.00	80.77^a
D_3	73.67	81.00	80.33	80.55^a
Mean	78.11	80.77	80.55	

Description: Different superscripts in the same column and row showed significant differences ($P < 0.01$).

The analysis showed a very significant difference ($P < 0.01$) in the water content of maggots in various maggot-growing media. The higher the water content of the media, the higher the water content in the maggot will also be. This is supported by the statement of [1], which states that a maggot has the property of absorbing water in the growing media, affecting the maggot's water content. The highest maggot water content was obtained in the D2L2 treatment (maggots kept in fermented fruit waste media for four days) at 81%, and the lowest maggot water content was obtained in the D3L1 treatment (maggots kept in food processing industrial waste media fermented for two days) of 73,67%. This follows the results of the water content of the media analyzed, where the water content of the fruit waste media is 83.49%.

In comparison, the water content of the food processing industry waste media is 82.12% [3]. Maggot reared on fruit media (D2) containing higher water content than those maintained by food processing media (D3). The water content of maggots produced from this study using fruit, vegetable, and food processing industries was higher than the results [4], which found the average water content of Hermetia illucens maggots growing in 50% fish waste media + 50% coconut dregs. That is 64.86%. This is because the fruit waste from the media contains a high water content, resulting in a high maggot water content. While the water content of maggot in the media from which food processing waste originates is lower than that of fruit media. The water content of the media is directly proportional to the water content of the maggot maintained in the fruit media and food processing industry. This is by [2] statement that maggot has the property of absorbing water in the growing media so that it affects the water content of the maggot.

3.2. Maggot Dry Matter Content

Table 2. The dry matter content (%) of maggot (Hermetia illucens) in various media and substrate fermentation time.

Treatments	Replications			Mean
	L_1	L_2	L_3	
D_1	20.33	19.67	19.67	19.88^a
D_2	19.00	19.00	19.00	19.00^a
D_3	26.33	19.33	19.67	21.77^a
Mean	21.88	19.33	19.44	

Description: Different superscripts in the same column and row showed significant differences ($P < 0.01$).

The analysis showed that the treatment of various growing media, the duration of fermentation, and the interaction of the two treatments were not significantly different ($P>0.05$) on the dry matter content of maggot. The application of various growing media to maggot obtained the dry matter content of maggot with the highest average in treatment D3 (26.33%) and the lowest in treatment D2 (19.00%). This shows that the food processing media produces dry maggot matter higher than fruit media. The increase in dry matter in the treatment of food processing industrial waste is due to maggot consuming supplement media and being replaced in the body. The higher the utilization of food handling industrial waste, the higher the dry maggot matter produced. [8] Research [5] showed that the dry matter of maggot growing in laying hens' feces was 32.72%. These results indicate that laying hens feces media is higher in producing dry maggot matter compared to food processing industry media obtained dry maggot matter by 26.33%. The dry matter produced from this study by utilizing organic products, vegetables, and food handling efforts was lower than [3] study, which found the standard dry matter content of maggot (Hermetia illucens) that developed in coconut cake media was 37.67% and that utilizing oil palm cake media that is 37.94%.

3.2. Maggot Crude Protein

Maggot crude protein was different due to treatments. The analysis showed that the maintenance of maggot on various media and fermentation time had a very significant effect ($P<0.01$) on the crude protein content of maggot, and there was an interaction between treatments. “Table 3” shows that the crude protein content of maggot in the D1L2 treatment (maggot kept in vegetable waste media with a fermentation time of 4 days) was 35.34%, and the lowest was found in the D2L2 treatment (maggot kept in fruit waste media with four days of fermentation). by 25.37%. The media protein content influences the highest maggot protein content. This is consistent with the results of the protein analysis of the highest growth media in the media of green mustard, cabbage and fermented cauliflower leaves.

Table 3. The crude protein (%) of maggot (Hermetia illucens) in various media and substrate fermentation time.

Treatments	Replications			Mean
	L_1 (%)	L_2 (%)	L_3 (%)	(%)
D_1	32.71	35.34	34.03	34.03^C
D_2	32.88	25.37	34.58	30.94^B
D_3	27.14	29.32	30.28	28.91^A
Mean	30.91	30.01	32.96	

Description: Different superscripts in the same column and row showed significant differences ($P < 0.01$).

The average maggot protein in the fermented growing media is from vegetable waste media (D1) at 19.07%, fruit media (D2) at 8.14% and food processing media (D3) at 7.38%. [3]. Duncan's other test results showed that maggot protein maintained in vegetable waste media with a fermentation period of 4 days (D1L2) was not significantly different from maggot protein maintained in fruit waste media with six days of fermentation (D2L3). Maggot protein kept in food processing waste media with two days of fermentation (D3L1) was not significantly different from that of maggot protein kept in fruit waste media with four days of fermentation (D2L2). This is because the food processing waste media has the same protein content as the fruit waste media. The protein-growing media for food processing industrial waste is 27.14%, and the fruit-growing media is 25.34%. The research results showed that the crude protein of maggot harvested at 30 days was 35.34% lower than the research conducted by [10], which obtained the crude protein of maggot, which was obtained at 45.87% at the age of 25 days. However, it is higher when compared to research [11], where the protein content obtained is 31.96% using fish waste media. Likewise, 75% tofu waste media + 25% chicken manure has a protein content of 32.90% [12], which is higher than research conducted using vegetable waste media of 34.03%.

3.3. Maggot Crude Fiber Content

The treatments of various growth media, the duration of fermentation, and the interaction of the two treatments were not significantly different ($P > 0.05$) on the crude fibre content of maggot. Table 4 shows that the highest crude fibre content of maggot was found in maggot reared on fruit waste growing media which was fermented for four days (D2L2) of 15.40%. The lowest crude fibre content of maggot was found in maggot, which was kept in the growing media of food processing waste fermented for two days (D3L1) of 9.02%.

Table 4. The crude fibre content (%) of maggot (Hermetia illucens) in various media and substrate fermentation time.

Treatments	Replications			Mean
	L_1 (%)	L_2 (%)	L_3 (%)	(%)
D_1	11.96	10.12	14.79	12.29a
D_2	11.52	15.40	12.67	13.20a
D_3	9.02	13.17	12.35	11.51a
Mean	10.83	12.90	13.27	

Description: Different superscripts in the same column and row showed significant differences ($P < 0.01$).

This is because the crude fibre content in fermented fruit growing media is challenging to degrade into simpler molecules than fermented food processing waste media, so crude fibre in fruit waste media is higher than in food processing waste. Duncan's other test results showed that maggot protein maintained in vegetable waste media with a fermentation period of 4 days (D1L2) was not significantly different from maggot protein maintained in fruit waste media with six days of fermentation (D2L3). Maggot protein kept in food processing waste media with two days of fermentation (D3L1) was not significantly different from that of maggot protein kept in fruit waste media with four days of fermentation (D2L2). This is because the food processing waste media is relatively the same in protein content as the fruit waste media, where the protein growing media for food processing industrial waste is 27.14% and fruit growing media is 25.34%. The crude fibre content of maggot that was kept in the growing media of food processing waste that was fermented for two days was lower than the results of the study of [13], where the crude fibre content obtained was 15.07%, this is presumably due to differences in the growing media used. Used. Research by [13] used 50% tofu dregs + 50% chicken faeces which were easily degraded into simpler molecules.

3.5. Maggot Crude Fat Content

Table 5. The crude fat content (%) of maggot (Hermetia illucens) in various media and substrate fermentation time.

Treatments	Replications			Mean
	L_1 (%)	L_2 (%)	L_3 (%)	(%)
D_1	34.67	23.31	16.60	24.86^a
D_2	24.41	31.43	24.73	26.86^a
D_3	43.50	26.24	13.97	27.91^a
Mean	34.19^B	26.99^B	18.43^A	

Description: Different superscripts in the same column and row showed significant differences ($P < 0.01$).

The results of the analysis showed that there was a very significant difference ($P < 0.01$) in crude fat maggot on the duration of substrate fermentation. The highest crude fat content of maggot was found in maggot, which was kept in food waste media that was fermented for two days, which was 43.50% (D3L1). This follows the fat content of the growing maggot media, where the fat content of the food processing industry media obtained the highest value. The lowest fat content was found in maggot, which was kept in food waste media that was fermented for six days, which was 13.97% (D3L3). This is because the longer the media is fermented, the crude fat content decreases, according to [7], which states that the fermentation process can reduce fat content in the feed. Various types of media had no significant effect ($P>0.05$) on maggot fat content. The duration of fermentation of maggot live media had a very significant effect ($P<0.01$) on maggot fat content, and there was no interaction ($P>0.05$) between fermentation time and maggot live media. According to [14], water content has an opposite relationship with fat content. The higher the water content, the lower the fat content.

3.6. Maggot Ash Content

Table 6. The ash content (%) of maggot (*Hermetia illucens*) in various media and substrate fermentation time.

Treatments	Replications			Mean
	L_1 (%)	L_2 (%)	L_3 (%)	(%)
D_1	11.04	12.46	14.62	12.71^B
D_2	10.71	10.15	10.52	10.46^A
D_3	9.14	9.25	7.92	8.77^A
Mean	10.30	10.62	11.02	

Description: Different superscripts in the same column show very significant differences ($P < 0.01$)

The analysis showed a significant difference ($P<0.01$) in the maggot ash content in various growing media. “Table 6” shows that given various growth media to maggot, the maggot ash content was obtained with the highest average in treatment D1 (12.71) and the lowest in treatment D3 (8.77). This is following the ash content in the maggot growing media, the highest ash content is in D1 (12.87), and the lowest is in D3 (3.58) [3]. According to [8], it is stated that the higher the degraded organic matter, the lower the ash content and conversely, the lower the degraded organic matter, the higher the ash content. According to [9], when inorganic materials (ash) are reduced, organic materials containing essential supplements such as protein, fat, carbohydrates, and vitamins will increase. Duncan's other test results showed that the ash content of maggot that was kept in vegetable waste media (D1) was very significantly different from fruit media (D2) and food processing media (D3). The ash content of the maggot is directly proportional to the ash content of the maggot maintenance media. [15] The mineral content of the substrate/material used and the addition of inoculum in the fermentation, in line with the minerals donated, affect the ash content.

4. Conclusion

The use of different growing media produces maggots with different nutritional content. Maintenance of maggot in the media of fermented vegetable waste resulted in higher nutrient content of maggot than in the media of fruit and the food processing industry. Media fermentation time should be conducted over four days.

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