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Maggot Production of Various Organic Wastes (Vegetables, Fruits, Food Processing Industries): Potential as Alternative Feed Substitutes for Fish Meal

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Abstract. Maggot is an alternative to fish meal because it has a fairly high protein content, is easy to cultivate and is able to decompose organic waste into its own food. The better the quality of the maggot growing media, the higher the maggot production will be **.** Vegetable, fruit and food processing industrial waste is an organic waste that is commonly encountered but its nutritional quality is low. To improve the nutritional quality, fermentation was carried out using local microorganisms (MOL). The purpose of this study was to examine the effect of various types of vegetable, fruit and food processing industrial waste media and different fermentation times on the production of maggot (*Hermetia illucens*). This study was conducted experimentally using factorial randomized block design (RAK) method with 2 factors (3×3), namely factor 1 for various organic wastes (D1 = vegetable waste, D2 = fruit waste, D3 = food processing industrial waste) and factor 2 for fermentation time (L1 = 2 days, L2 = 4 days, L3 = 6 days), with 3 replicates. The parameters of this study consisted of biomass weight, feed consumption, waste reduction index/WRI, feed conversion efficiency/ECI, and survival rate/SR. The results of variance showed that organic waste and fermentation time had a very significant effect ($p<0.01$) on the parameters of maggot production. It was concluded that the production of maggot (*Hermetia illucens*) was best in the D1L1 treatment with a biomass weight of 1522.33 g, feed consumption 66.06%, WRI 2.20%, ECI 0.42%, and SR 89.52%.

Keywords: decompose, fermentation, maggot production, nutritional quality, organic waste

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1. Introduction

Provision of quality feed is one of the important aspects in livestock business. At this time there is still competition between food and feed, especially protein sources so that the supply of feed has not been resolved. Breeders usually use fish meal as a source of protein, but fish meal is often found to have an increasing price, its availability is sometimes limited, and its quality is uncertain. Because of the need for research to get a substitute feed for fish meal. Maggot is a substitute feed ingredient that has been widely studied. Maggot is the larva of the *Hermetia illucens* or black soldier (BSF) from the *Stratiomyidae*. In research [1] the protein content of larvae ranged from 44.26% while in research [2] the protein content of maggots ranged from 40-50%. Besides having good nutritional quality, maggot is also easy to cultivate. Maggot can

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grow and develop in garbage and organic waste because maggot has the ability to decompose waste into food. Organic waste is a type of waste that is composed of organic compounds and is degradable, that is, it can naturally or easily be decomposed by living bodies or especially microorganisms [3]. To increase the nutritional content of organic waste, bioactivators such as local microorganisms (MOL) can be added in the fermentation process. The ability to degrade a substrate will be higher if using microbrae derived from the substrate itself [4].

2. Materials and Methods

The research was carried out on Jalan Bunga Teratai No. 6 Padang Bulan Selayang II, Medan Selayang District. This research was carried out from October to December 2021.

The tools used were plastic, rubber, analytical scales, basins, buckets, silos for fermentation containers, trays, thermometers, pH meters, gloves, tarpaulins, plastic meters, filter paper, oil paper, maggot growing container size 80×50×20 cm. stationery and camera for documentation. The ingredients used are banana (30kg), papaya (30kg), pineapple (30kg), cabbage (30kg), cauliflower leaves (30kg), mustard greens (30kg), coconut pulp(30kg), tofu pulp (30kg), cassava (30kg), fine bran, molasses(3kg), local microorganisms (MOL) 3kg, BSF eggs(40.5gr) and salt.

2.1. Methods

The study was conducted experimentally using a completely randomized design (CRD) factorial pattern with 2 factors (3 x 3)

Factor I: various organic waste media

D_1 = Cabbage, Cauliflower Leaves, mustard greens

D_2 = Banana, papaya, pineapple

D_3 = coconut dregs, tofu dregs, onggok

Factor II: Fermentation

L_1 = 2 days

L_2 = 4 days

L_3 = 6 days

2.2 Research Parameters

- Maggot weight
- Feed consumption
- Waste reduction index
- Feed conversion efficiency

- Percentage level of survival

3. Results and Discussion

3.1 Effect of Various Maggot Growing Media and Fermentation Time on Maggot Biomass Weight

Table 1. Maggot biomass weight (g) black army fly cultivation of vegetables, fruit and waste processing pagan fermented

waste media	Fermentation			Average
	L_1	L_2	L_3	
D_1	1522.33^{F}	1332.67^{E}	1247.00^{DE}	1367.33
D_2	832.67^{A}	1118.00^{CD}	926.33^{AB}	959
D_3	1029.67^{BC}	1244.00^{DE}	1003.67^{BC}	1092.44
Average	1128.22	1231.56	1059.00	

Note: different superscripts in the same column and row show very significant differences ($p<0.01$)

The results of the analysis of variance show that the best combination of treatment with various organic waste media and fermentation time is waste organic vegetables with 2 days of fermentation (D_1L_1) because the research that has been done is that organic waste media with 2 days of fermentation has good energy content with 20.32% crude protein and 5.053 % crude fat so that maggot will consume more feed. plenty and sufficient for growth and development. High quality substrate will produce more maggot because it contains sufficient nutrients for maggot growth [5]. Maggot will grow longer if the nutritional quality of the substrate is low [6].

The lowest yield was in the combination of fruit media with a fermentation time of 2 days. This was thought to be due to the relationship between complete nutrition and nutrition with maggot production. From the research that has been done, the crude protein content is 6.8% and crude fat is 2.01%. This energy content is not sufficient for maggot growth needs. A quality substrate produces more maggot. On vegetable media, the longer the fermentation, the lower the maggot biomass weight [7].

3.2 Effect of Various Maggot Growing Media and Fermentation Time Feed Consumption Maggot

Table 2. Maggot feed consumption (%) black army fly cultivation of various vegetable, fruit, and food processing industries with different fermentation times

Waste media	Fermentation			Average
	L_1	L_2	L_3	
D_1	66.06^{E}	59.99^{CD}	61.27^{D}	62.44
D_2	60.54^{D}	66.69^{E}	56.44^{BC}	61.22
D_3	51.92^{A}	58.53^{CD}	$54, 82^{AB}$	55.09
Average	59.51	61.74	57.51	

Note: different superscripts in the same column and row show a very significant difference (P<0.01)

The best treatment D_2L_2 shows the effect of feed consumption maggot up to 66.69%. It is suspected that the nutrient content of the media increases so that it is good for consumption of maggot and fruit waste also has a distinctive aroma. According to statement [8], the breakdown of carbohydrates into lactic acid produces a unique sour taste in fermented products. From the research conducted, the content and roughness in this treatment was smaller, namely 7.56%.

The lowest feed consumption value was found in the D_3L_1. This is presumably because the treatment has much higher crude fiber than the other treatments, which is 20.35%. The higher the crude fiber, the slower the rate of digestion and absorption of nutrients. Fermentation of organic matter can increase its nutritional content (increase protein content, and decrease fiber content [9].

3.3 Effect of Various Maggot Growing Media and Fermentation Duration on Waste*reduction index* (WRI)

Table 3. Waste*reduction index* (WRI) of black army fly maggot cultivation of various vegetable, fruit, and food processing industries for a long time different fermentation.

Waste media	Fermentation			Average
	L_1	L_2	L_3	
D_1	2.2^{D}	1.93^{BC}	1.91^{BC}	2.01
D_2	2.02^{C}	2.22^{D}	1.82^{AB}	2.02
D_3	1.73^{A}	1.947^{C}	1.82^{AB}	1.83
Average	1.98	2.03	1.84	

Note: different superscripts in the same column and row show a very significant difference (P<0.01)

Best treatment D_2L_2 shows the best effect on increasing the value of the waste reduction index/WRI. It is suspected that there is an increase in the nutritional quality of the organic waste media which causes the reducing ability of the media to increase. The higher the WRI value, the better the efficiency in reducing substrate [10].

The lowest waste reduction index value/WRI was in the treatment of industrial waste and 2 days of fermentation. This is presumably due to low media consumption so that it takes a long time for maggot development to occur. The increase in consumption value will increase the ability of maggot in reducing waste used as a growth medium. WRI value is directly proportional to maggot consumption [11], the higher the feed consumption, the higher the WRI value.

3.4 Effect of Various Maggot Growing Media and Fermentation Time on Consumed Food Conversion Efficiency (ECI)

Table 4. Consumed Food Conversion Efficiency (ECI) Maggot Black Army Fly Cultivating Various Vegetable, Fruit, and Industrial Media food processing with different fermentation times.

Waste media	Fermentation time			Average
	L_1	L_2	L_3	
D_1	0.42^{D}	0.31^{C}	0.30^{C}	0.35
D_2	0.20^{A}	0.32^{C}	0.19^{A}	0.24
D_3	0.20^{A}	0.28^{BC}	0.21^{AB}	0.23
Average	0.2733	0.3	0.23	

Note: different superscripts in the same column and row show a very significant difference ($P<0.01$)

Treatmentbest D_1L_1 shows that the media can be well consumed by maggot. The lowest value in the D_2L_3 showed that the efficiency of the feed consumed had not been able to increase maggot body weight gain. The efficiency of feed conversion is low because the media cannot be completely converted into maggot weight gain [11]. The high ECI value illustrates an increase in feeding during maintenance and increase in body weight of maggots.

3.5 Effect of Various Maggot Growing Media and Fermentation Time on the Percentage Level of Survival Rate (*Survival Rate*/ SR)

Table 5. *survival rate*(SR) of maggot black army fly cultivation of various vegetable, fruit, and food processing industries for a long time different fermentation.

Waste media	Fermentation			Average
	L1	L2	L3	
D_1	89.52	89.22	90.78	89.84^{a}
D_2	92.40	91.46	92.68	92.18^{b}
D_3	94.84	94.58	94.38	94.59^{c}
Average	92.15	91.85	92.61	

Note: different superscripts in the same line show a very significant difference ($P <0.01$)

The best treatment D_3L_1 shows that BSF maggot is able to maintain live in the food processing industry media. It is suspected that the industrial waste of food processing with 2-day fermentation contains low water content. Feed media with high water content will cause aerobic conditions [12]. The anaerobic decomposition of organic matter will produce NH_3 (ammonia) and CH_4 (methane) which can inhibit feed consumption and will affect growth [13].

The value of the percentage of life (*survival rate*/ SR) in vegetable media is lower. In the research that has been done, the water content of vegetables ranges from 88.66 to 89.23%. High water content will prevent larvae from reducing feed. The water content of the larval growing medium must be low because the larvae cannot grow if the water content is high [14].

4. Conclusion

Based on the results of the study, it is known that of the three organic wastes used and the three levels of fermentation time, vegetable waste (D1) and 2 days of fermentation (L1) are the optimal and efficient treatments to increase maggot production.

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