Jurnal Peternakan Integratif

Maggot Black Soldier Fly (Hermetia illucens) Nutritional Content Using Various Culture Media

A. Lestari, T.H Wahyuni, E. Mirwandhono, N. Ginting*

Animal Production Program Study, Faculty of Agriculture, University of North Sumatra, Padang Bulan, Medan 20155

* corresponding author: nurzainahginting @ gmail.com

Abstark: Maggot BSF (black soldier fly) *(Hermetia illucens)* has a high crude protein content of 42.1%. The purpose of this study was to investigate the nutritional content of maggot as a substitute for fish meal by using various culture media. This research method used a completely randomized design of 5 treatments 4 replications P0 = 100% fermented rice bran, P1 = 50% fermented coconut dregs + 50% fermented rice bran, P2 = 50% fermented tofu dregs + 50% fermented rice bran, P3 = fermented rice bran 50% fermented palm kernel kernel + 50% fermented rice bran, P4 = 25% fermented coconut dregs + 25% fermented rice bran + 25% fermented tofu dregs + 25% fermented palm kernel cake. The parameters studied were moisture content, ash content, crude protein, crude fat and carbohydrates. Based on the results of the study, it was found that the use of culture media with a combination of 25% fermented rice bran + 25% fermented coconut dregs + 25% fermented tofu pulp + 25% fermented palm kernel meal was the best combination.

Keywords: bsf maggot, fermentation, nutritional content

Received [2 Desember 2020] Revised [17 February 2021] Accepted [2 March 2021]

1. Introduction

In animal husbandry business, feed is the most important component, feed costs hold the highest percentage in production costs, namely 60-70% [1]. Feed is one of the determining factors for the success of livestock business, especially smallholder breeders. Protein components have an important role in an animal feed formula because they are involved in the formation of growth tissue and are actively involved in viral metabolism such as enzymes, hormones and antibodies [2].

Table 2. The nutritional content of maggot black soldier fly media for palm kernel meal [3].

Life (Days)	Nutritional Content (%)			
	Dry Matter	Coarse Protein	Coarse Fat	Coarse Ash
5	26,61	61,42	13,37	11,03
10	37,66	44,44	14,60	8,62
15	37,94	44,01	19,61	7,65
20	39,20	42,07	23,94	11,36
25	39,97	45,87	27,50	9,91

Calcium minerals contained inmaggot flour BSF can reach a digestibility value of 88%. The quality and quantity of larval development media greatly affects the nutrient content of the body and the survival of the larvae at each instar [4].

Maggot *Black Soldier Fly* is one of the insects that is starting to be studied for its characteristics and nutrient content. These flies originated in America and then spread to subtropical and tropical regions of the world [5].

The optimum growth temperature of BSF is $30^{O}C$-$36^{O}C$. Larvae BSF cannot survive temperatures less than $7^{O}C$ and temperatures of more than $45^{O}C$ [6]. Humidity is also reported to have an effect on the laying capacity offlies *BSF*. About 80% of female flies lay eggs in conditions of more than 60% humidity and only 40% of female flies lay eggs when the humidity conditions are less than 60% [7].

In nature, female flies will be attracted to the smell of aromatic compounds from organic waste (attractants) so they will come to that location to lay eggs. The attractants are obtained from the fermentation process by adding water to organic waste, such as BIS waste, vegetable or fruit waste or the addition of EM4 (bacteria) and rumen microbes [8].

Feeding waste to larvae aims to stop the spread of bacteria that cause disease, such as Salmonella spp. This means that the risk of disease that can be transmitted between animals and animals, and between animals and humans can be reduced [9].

2. Method

Tools and Materials

Masks, digital scales, rulers, aqua cups, stationery, scissors, plastic, plastic clips, gloves, cameras, porcelain cups, $105^{O}C$ oven, desiccators, soxhlet extraction, collecting flask *(boiling)*, filter paper, soxhlet tube, digestion device, kjehldahl extraction device, Erlenmeyer, test tube, measuring cup and dropper pipette. BSF maggot seeds, rice bran, tofu dregs, palm kernel meal, EM4, water, test tube, selenium, H2SO4, H2O2, H2O, penolphtalen, 50% NAOH, borax acid (H3BO3) 3%, mix indicator, HCl 0, 01 N and organic solvents (Hexana / Diethyl ether / Petroleum Benzene).

Method

The research method used was a completely randomized design (CRD) consisting of 5 treatments and 4 replications in order to obtain 20 experimental units. Each experimental unit had 1 kg of media content. The treatments studied were as follows:

P0 = 100% Fermented Rice Bran

P1 = 50% Fermented Coconut Dregs + 50% Fermented Rice Bran

P2 = 50% Fermented Tofu Dregs + 50% Fermented Rice Bran

P3 = 50% Fermented Palm Kernel Meal + Fermented Rice Bran 50%

P4 = Fermented Rice Bran 25% + Fermented Coconut Dregs 25% + Fermented Tofu Dregs 25% + Fermented Palm Kernel Meal 25%

Parameters observed

The parameters observed were proximate analysis, among others: moisture content, levels ash, crude protein, crude fat and carbohydrates.

Proximate Analysis

1. Ash Content Analysis [10]

$$KAb = (C + B2) - C$$

$$\% KAb = \frac{(C + B2) - (C)}{S} \times 100\%$$

Note:

C: Weight empty cup

B2: Sample after furnace

S: Sample weight

KAb: Ash content

2. Moisture analysis [10]

$$KA = A2 – A1$$

$$\% KA = \frac{(C + A1) - (C + A2)}{S} \times 100\%$$

$$\% BK = 100\% - \% KA$$

Note:

A1: Sample after oven

A2: Sample before oven

C: Weight of empty cup

S: Weight of sample

3. Analysis of Crude Protein Content [10]

$$\% PK = \frac{VT - VB}{S} \times 4{,}37812$$

Note :

PK = Crude protein

VT = Volume of titration

VB = Volume of blank

S = Weight of sample

4. Analysis of Crude Fat Content [10]

$$\% LK = \frac{D2 - D1}{S} \times 100\%$$

Note:

LK: Crude fat

D2: Weight of boiling fat

D1: Weight initial boiling

5. Carbohydrate analysis [10]

% Carbohydrate = 100% - (% K. Water +% K. Ash +% K. Protein +% K. Fat)

Note:

K: Level

Research implementation

Research was carried out by making fermentation coconut dregs, tofu dregs, rice dedeaks, palm kernel cake and rice bran were fermented with EM4 respectively. After fermenting, the media was weighed as much as 1 kg (according to treatment). Then the eggs are inserted Black Soldier Fly (Hermetia Illucens*)* and harvested for up to 14 days after which the samples are sent to the laboratory to be tested for their nutritional content.

Data Analysis

Data were analyzed by using diversity analysis. If the results have a very real or very real effect, a further test is carried out, namely the Duncan Mean Range Test (DMRT).

3. Discussion Results

Moisture content of Black Soldier Fly (Hermetia Illucens) maggot

The moisture content of maggot Black Soldier Fly (BSF) is showed in "Table 1":

Table 1. Water content of maggot *black soldier fly (Hermetia illucens)* in various media

Ttreatments	Repetitions				Total	Average
	I	II	III	IV		
PO	7,75	8,04	9,36	7,49	32,64	8,16^{tn}
P1	9,00	9,88	10,05	9,36	38,29	9,57^{tn}
P2	9,48	9,13	8,42	9,07	36,10	9,02^{tn}
P3	10,09	8,57	8,80	9,23	36,69	9,17^{tn}
P4	8,32	9,96	8,62	9,24	36,14	9,03^{tn}

Note: tn = showed no significant difference (P> 0.05);

Based on the results of the analysis of variance, it showed that the use of different media had no significant effect (P> 0.05) on the moisture content of the maggot. The lowest water content of maggot is in treatment P0 with an average of 8.16% and the highest water content of maggot is in treatment P1 with an average moisture content of 9.57%. There was a difference in water content, presumably because the media used did not contain much water. So that it affects the maggot water content. It is known that maggots don't like wet conditions, this can cause maggots not to grow properly. According to [11] maggot has characters which include absorbing water in the media so that it greatly affects the moisture content in the maggot. According to [12], if the growth media used contains high water, it can inhibit maggot proliferation in the growth media.

Ash Content of Maggot Black Soldier Fly (Hermetia Illucens)

Maggot ash content cultured on various media can be seen in "Table 2".

Table2.The ash content of maggot the black soldier fly(hermetia illucens) on various media

Treatments	Repetitions				Total	Average
	I	II	III	IV		
PO	6,50	8,37	9,63	6,82	31,32	7,83^{tn}
P1	8,79	8,92	10,32	8,10	36,13	9,03^{tn}
P2	8,05	8,90	8,08	8,27	33,30	8,32^{tn}
P3	9,05	8,32	9,53	9,99	36,89	9,22^{tn}
P4	8,80	9,21	10,06	9,33	37,40	9,35^{tn}

Note: tn = indicates not significantly different (P> 0.05);

Based on the results of the analysis of variance, it showed that the use of different media had no significant effect (P> 0.05) on the ash content of the maggot. Based on the results of the research, the lowest maggot ash content was P0 treated with an average maggot ash content of 7.83%. The highest ash content was in the P4 treatment, namely with an average maggot ash content of 9.35%. There is a difference in the ash content, presumably in the media used for the research, first the fermentation process is carried out. As it is known that fermentation can reduce the ash content of fermented materials. So that the resulting media contains less ash content, so the maggot eats less ash content, the maggot eats more organic material so that the ash content produced by the maggot is low. According to [13] the fermentation treatment was able to reduce the ash content in the substrate. According to [14] the ash content is a description of the organic matter content. The lower the ash content represents a higher organic matter content.

Crude Protein Content of Black Soldier Fly Maggot (Hermetia Illucens)

The proteint content of maggot *BSF* cultivated in various media can be seen in "Table 3"**.**

Table 3. The crude protein content of maggot the black soldier fly (hermetia illucens) on a variety of media

Treatment	Repetitions				Total	Average
	I	II	III	IV		
PO	41,95	45,28	45,93	46,11	179,27	44,82^{tn}
P1	44,26	44,48	43,89	46,09	178,72	44,68^{tn}
P2	46,13	49,10	40,44	43,28	178,95	44,74^{tn}
P3	43,90	45,12	43,13	42,75	174,90	43,72^{tn}
P4	44,04	44,11	45,26	44,11	177,52	44,38^{tn}

Note: tn = indicates not significantly different (P> 0.05);

Based on the results of the analysis of variance, it showed that the use of different media had no significant effect on the protein content of maggot (P> 0.05). "Table 3" shows that maggot contains the highest protein treated by P0 with an average value of 44.82%. The lowest maggot protein content was treated by P3 with an average of 43.72%.

The difference in the nutritional value of maggot is due to the fermentation process that can increase the nutrients contained in the media so that the media affects the nutrient content of maggot. This is thought to be when the fermentation process is assisted by fermentation microbes which can increase the protein content of a material. It is known that if the media's nutritional content is good, it will produce good maggot nutrition too. According to [15] the quality and quantity of larval development media greatly affects the nutrient content of the body and the survival of the larvae at each instar. According to [16] the supporting factors for the amount of protein contained in maggot are the composition of the ingredients added to the maggot growing media.

Black Soldier Fly (Hermetia Illucens) Maggot Crude Fat Content

BSF maggot fat content cultivated in various media can be seen in "Table 4".

Table 4. The fat content BSF maggot (hermetia illucens) cultivated on a variety of media

Treatment	Repetitions				Total	Average
	I	II	III	IV		
P0	25,56	18,97	17,82	24,13	86,48	21,62^{tn}
P1	20,64	22,78	18,08	20,56	82,06	20,51^{tn}
P2	15,26	14,73	24,86	19,44	74,29	18,57^{tn}
P3	19,52	19,63	20,21	20,11	79,47	19,87^{tn}
P4	18,46	17,47	15,26	16,84	68,03	17,01^{tn}

Note: tn = indicates not significantly different (P> 0.05);

It can be seen in "Table 4**"** that the lowest maggot fat content is found in the P4 treatment, the average value is 17.01% and the highest maggot fat content is found in the P0 treatment, the average value is 21.62%. There are differences in fat content, it is assumed that the media used is different. The media used does not contain high fat because the media is fermented first so that it can reduce the fat content of the ingredients. It is known that the nutritional content in the media affects the nutritional content of the resulting maggot. According to [17] fermentation can reduce fat content in feed. The

decreased fat content is due to the fact that some of the microbes used in fermentation are lipopolitical (can hydrolyze fat), microbes require fat as an energy source and lipase enzyme activity. According to [18] the crude fat content of the media greatly affects the crude fat content of the resulting maggot. The higher the crude fat in the media, it will increase the resulting crude maggot fat, on the contrary, if the crude fat is low, it will produce low crude maggot fat. Therefore, the media content greatly affects the maggot content.

Maggot Black Soldier Fly (Hermetia Illucens) Carbohydrate Content

The carbohydrate content of black soldier fly cultivated in various media can be seen in Table 5 below:

Table 5. The carbohydrate content of BSF maggot (hermetia illucens) on a variety of media

Treatment	Repetitions				Total	Average
	I	II	III	IV		
PO	18,24	19,34	17,26	15,45	70,29	17,57^{bc}
P1	17,31	13,94	17,66	15,89	64,8	16,20^{c}
P2	21,08	18,14	18,2	19,94	77,36	19,34^{ab}
P3	17,44	18,36	18,33	17,92	72,05	18,01^{bc}
P4	20,38	19,25	20,8	20,48	80,91	20,23^{a}

Note: Superscripts in the same column show very significant differences (P <0.01);

Based on the results of the analysis of variance, it showed that the use of different media had a significant effect (P <0.01) on carbohydrate content. The range of carbohydrate content inmaggot *bsf* using various media is between 16.20% -20.23%. There is a difference in carbohydrate content presumably because the processing of this medium is carried out by fermentation and possibly different due to the analyzing process. According to [19] which states that fermentation can increase the quality of the nutritional value of feed ingredients, because the fermentation process occurs chemical changes in organic compounds (fat, fiber, carbohydrates, proteins and other organic materials) through enzymes produced by microbes. According to [20] states that in general the nutrient content in the media greatly affects the nutritional content of maggots because it provides sufficient nutrients for maggot growth.

Protein Content of BSF maggot (Hermetia Illucens) cultivated in various media

The protein content of BSF maggot cultivated in various media can be seen in "Table 5".

Table 5. Protein content of BSF maggot (Hermetia illucens) cultivated in various media

Treatments	Protein
P0	15,24%
P1	16,19%
P2	16,87%
P3	16,46%
P4	19,26%

4. Conclusion

Based on the research the use of culture media with a combination of 25% fermented rice bran + 25% fermented coconut dregs + 25% fermented tofu dregs + 25% fermented palm kernel meal is the best combination.

REFERENCES

[1] Retnani, Y. Feed Industry Process. Bogor. PT Publisher IPB Press. ISBN: 978-979 - 493-616-0. 2014

[2] Beski Ssm., Ra Swick, and Pa Iji. Specialized Protein Products In Broiler Chicken Nutrition: A Review. Anim Nutr. 1: 47-53. 2015

[3] Rachmawati., D. Buchori, P. Hidayat., S. Hem., And Mr. Fahmi. Development and Nutritional Content of *Hermetia Illucens* (Linnaeus)(Diptera: *LarvaeStratiomydae*) in Oil Palm Cake. J Entomol Indones. 7: 28-41. 2010.

[4] Finke, MD Complete Nutrient Content Of Four Species Of Feeder Insect. Zoo Biology 00: 1-15. Retrieved 7 August 2015. 2012

[5] Cickova H., Gl Newton., Rc. Lacy, and M. Kozanek. The Use Of Fly Larvae For Organic Waste Treatment. Waste Manag. 25: 68-80. 2015

[6] Popa, R., T. Green .. Dipterra Lcc E-Book 'Biology And Ecology Of The Black Soldier Fly'. Dipterra Lcc. 2012

[7] Tomberlin, JK, DC Sheppard. Factors Influencing Mating Anad Oviposition Of Black Soldier Flies 9diptera: Stratiomydae) In A Colony. Journal Of Entomological Science, 37 (4), 345-352. Http://Doi.Org/10.18474/0749-8004-37.4.345. 2002

[8] Tomberlin JK, DC Sheppard and JA Joyce. 2002. Selected Life-History Traits Of Black Soldier Flies (Diptera: Stratiomyidae) Reared On Three Artificial Diets. Ann Entomol Soc Am. 95: 379-386.

[9] Dortmans BMA, S. Diener., BM Verstappen., And C. Zurbrugg. *Organic Waste Processing Using Black Soldier Fly (Bsf).* Eawag. Swiss Federal Institute Of Aquatic Science And Tecnology, Dubendorf, Switzerland. 2017

[10] Association Of Official Agricurtural Chemist. *Methods Of Analysis.* Association Of Official Agricultural Chemists. Washington DC. 2005

[11] Fahmi, MR Optimization of Bioconversion Process Using Mini-Larva Hermetia Illucens to Meet Fish Feed Needs. Proceedings of the National Seminar on the Indonesian Biodiversity Society. March 2015. Depok, Indonesia. Thing. 139-144. 2015

[12] Rizki, S., P. Hartami and Erlangga. Maggot Population Density Levels In Different Growing Media. *Journal of Acta Aquatica*, 4: 1 (April 2017): 21-25 ISSN. 2406-9825. 2017

[13] Styawati, NE, Muhtaruddin and Liman. *The Effect of Long Fermentation of Trametes sp. Against Dry Matter, Ash and Crude Fiber Content of Smooth Cayenne Varieties of Pineapple Leaves.* Lampung: Department of Animal Husbandry, Faculty of Agriculture, University of Lampung. 2013

[14] Aminah S., LK Nuswantara., BIM Tampoebolon and S. Sunarso. *Quality Improvement of Coconut Coir Through Fermenation Technology Using Selected*

Fiber Digestive Microbes From Buffalo Rumen Fluid. Animal Science Vol. 18 (1), March 2020: 44-52, pISSN 1693 - 8828 eISSN 2548-9321. . 2020

[15] Makkar Hps, G. Tran., V. Heuze., And P. Ankreas. State Of The Art On Use Of Insects As Animal Feed. Anim Feed Sci Technol. 197: 1-33. 2014

[16] Azir, A., H. Helmi., And KSR Bayu. Production and Nutritional Content of Maggots (Chrysomya Megacephala) Using Different Culture Media Composition. Journal of Science of Fisheries and Aquaculture. Vol. 12, No. 1. 2017

[17] Daelani. *The Effect of Long Fermentation on Protein, Fat, Fatty Acid Composition and Phytic Acid in Tempe Making*. University of Sumatra. Field. 2008

[18] Aldi M., F. Farida., T. Syahrio., And Erwanto .. The Effect of Media Application on Water, Protein and Fat Content of Different Maggots Produced as Feed. Journal of Animal Husbandry Research and Innovation. Vol. 2 (2): 14-20. 2018

[19] Ali N., Agustina., And Dahniar. Provision of Fermented Bran With Em4 As Broiler Chicken Feed. *Journal of Agricultural Sciences* Vol 4 No 1.. 2019

[20] Arif. M., NA Ratika., And M. Lamid. Effect of Combination Media of Coconut Meal and Fermented Rice Bran on the Production of Maggot Black Soldier Fly (Hermetia Illucens) as a Source of Fish Feed Protein. Fisheries and Marine Scientific Journal. 3: 17-20. 2012