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Effect of combination of tofu dregs and banana waste as a growth media on nutrient content and density of Black Soldier Fly larvae (*Hermetia illucens*)

Pengaruh kombinasi ampas tahu dan limbah pisang sebagai media tumbuh terhadap kandungan nutrisi dan densitas larva Black Soldier Fly (Hermetia illucens)

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ABSTRACT

The aim of this research was to determine the effect of the combination of tofu dregs and banana waste as a growing medium on the nutritional content and density of Black Soldier Fly (Hermetia illucens) larvae. This research uses laboratory experiments with five treatments and four replications. The growing medium used is a combination of tofu dregs and banana waste. Treatments consisted of T0 (100% tofu dregs), T1 (100% banana waste), T2 (25% tofu dregs + 75% banana waste), T3 (50% tofu dregs + 50% banana waste), and T4 (tofu dregs 75% + banana waste 25%). Parameter measured was the dry matter content, crude protein, crude fat, crude fiber, and density of Black Soldier Fly larvae. Data were analyzed using a Completely Randomized Design and if there was a real effect between treatments, it was continued with the Duncan Multiple Range Test (DMRT). The research results of the combination of tofu dregs growing media and banana waste had a significant ($P<0.05$) effect on crude fiber content and a very significant ($P<0.01$) effect on crude protein and crude fat content. Using a combination of tofu dregs and banana waste had no significant effect ($P>0.05$) on the dry matter content and density of Black Soldier Fly larvae. The conclusion of the research was the best result in T4 with a dry matter content of 27.13%, crude protein 11.81%, crude fat 8.43%, crude fiber 5.18%, and density 162.79 g/L. of black soldier fly larvae.

Kata kunci:
Limbah pisang
Larva black soldier fly
Densitas
Nutrisi
ampas tahu

ABSTRAK

Tujuan penelitian ini adalah untuk mengetahui pengaruh kombinasi ampas tahu dan limbah pisang sebagai media tumbuh terhadap kandungan nutrisi dan densitas larva Black Soldier Fly (Hermetia illucens). Penelitian ini menggunakan eksperimen laboratorium dengan lima perlakuan dan empat ulangan. Media tumbuh yang digunakan adalah kombinasi ampas tahu dan limbah pisang. Perlakuan terdiri dari P0 (100% ampas tahu), P1 (100% limbah pisang), P2 (25% ampas tahu + 75% limbah pisang), P3 (50% ampas tahu + 50% limbah pisang), dan P4 (ampas tahu 75% + limbah pisang 25%). Parameter yang diukur adalah kandungan bahan kering, protein kasar, lemak kasar, serat kasar, dan densitas larva Black Soldier Fly. Data dianalisis menggunakan Rancangan Acak Lengkap (RAL) dan apabila terdapat pengaruh nyata antar perlakuan maka dilanjutkan dengan Uji Jarak Berganda Duncan. Hasil penelitian kombinasi media tumbuh ampas tahu dan limbah pisang memberikan pengaruh nyata ($P<0,05$) terhadap kandungan serat kasar dan sangat nyata ($P<0,01$) terhadap kandungan protein kasar dan lemak kasar. Penggunaan kombinasi ampas tahu dan limbah pisang memberikan pengaruh tidak nyata ($P>0,05$) terhadap kandungan bahan kering dan densitas larva Black Soldier Fly. Kesimpulan dari penelitian ini adalah hasil terbaik pada P4 dengan kandungan bahan kering 27,13%, protein kasar 11,81%, lemak kasar 8,43%, serat kasar 5,18%, dan densitas 162,79 g/L.

INTRODUCTION

The development of livestock cultivation businesses has resulted in an increased supply of feed ingredients. In the livestock industry, feed is a basic need that must be met. The quantity of feed will affect the growth and survival of the livestock being raised. Feed has a very important role, both for ruminants, non-ruminants, and poultry. Livestock animals need food to fulfill their basic needs, reproduction, production, and health. One of the characteristics of good feed ingredients is that they have a high protein content. One alternative source of protein that can be used is Black Soldier Fly (BSF) larvae.

The origin of Black Soldier Fly larvae (Hermetia illucens) most likely comes from America (Rhode et al., 2020). The advantages of BSF larvae include that they have an affordable price, are sustainable, do not compete with humans, and are environmentally friendly. BSF larvae also contain antimicrobial and antifungal properties so they do not carry disease agents (Raharjo et al., 2016). BSF larvae have a protein content of 25.06%, fat 21.15%, crude fiber 7.86%, and water content 4.70% (Faradila et al., 2023). The success of production and quality of larvae is largely determined by the growing medium. The growth medium will influence the nutritional content in the body and is responsible for survival and the next phase of metamorphosis (Masir et al., 2020). Rearing BSF larvae can use media containing organic materials or by-products of agro-industrial activities, such as tofu dregs and banana waste.

The tofu industry is one of the industries that is experiencing rapid development. There are 84 thousand tofu industrial units in Indonesia with a production capacity of 2.56 million tons per year (Ruhmawati et al, 2017). The large number of tofu industries will certainly correlate with the tofu dregs waste produced. The accumulation of tofu dregs waste will also cause environmental pollution (Cicilia & Susila, 2018). Therefore, tofu dregs are seen as having the potential to be used as a growing medium for BSF larvae.

Banana (Musa paradisiaca) is a popular fruit in Indonesia because it is easy to get and the price is affordable. Based on data from the Central Statistics Agency, national banana production has continued to soar in the last five years. The average increase reached 5.2% per year. In 2021, banana production in Indonesia will reach 8.74 million tons. This production increased 6.82% from the previous year which reached 8.18 million tons (Dihni, 2022). An increase in the amount of banana production will have an impact on the amount of banana waste produced. Bananas have a shelf life of ten days if placed at room temperature (Ikhsan & Tamrin, 2014). Most banana traders in Indonesia store their merchandise in open spaces with minimal handling. This causes bananas to rot quickly. Bananas that are rotten are usually thrown away immediately and pollute the environment.

Black Soldier Fly larvae research has concentrated more on various media treatments for production, not on nutritional content. Masir et al. (2020) reported that the use of tofu dregs and chicken feces on BSF larvae has an impact on the length, dry weight, and wet weight of BSF larvae. It is hoped that the use of tofu dregs and banana waste will have a positive influence on this research because the nutritional content produced can provide benefits to the livestock that consume them. This research was conducted to see the effect of a combination of tofu dregs and banana waste as a growing medium on nutrient content and density of BSF larvae.

MATERIALS AND METHODS

Research Materials

Ten grams of BSF eggs which were divided into 20 rearing boxes of 0.5 g each, tofu dregs obtained from the tofu processing home industry in Sukodono District, Sidoarjo Regency, and banana waste obtained from fruit traders at Krian Market, Sidoarjo Regency. The parts of banana waste that are used include the fruit and peel.

Research Methods

This research was designed using a laboratory experimental method designed using a Completely Randomized Design (CRD) consisting of 5 treatments and 4 replications for each treatment. The treatment in this study consisted of tofu dregs and banana waste in a predetermined ratio combination. The following is the arrangement of treatments in this study:

T0: 100% Tofu Dregs
T1: 100% Banana Waste
T2: 25% Tofu Dregs + 75% Banana Waste
T3: 50% Tofu Dregs + 50% Banana Waste
T4: 75% Tofu Dregs + 25% Banana Waste

The data obtained was analyzed using Analysis of Variance and if the data obtained showed significant differences, it was continued with Duncan's Multiple Range Test. The results of the analysis of the nutritional content of the growing media can be seen in Table 1.

Research Variables

The variables observed in this research are dry matter, crude protein, crude fat, crude fiber, and density.

Table 1. Nutrient content of Black Soldier Fly larvae growth media

Treatment	Nutrient Content				
	DM (%)	CP (%)*	CFAT (%)*	CF (%)*	Ash (%)*
T0	11.90	21.14	8.23	37.30	10.62
T1	26.39	7.34	3.99	15.75	13.73
T2	22.77	10.79	5.60	21.13	12.92
T3	19.14	14.42	6.11	26.52	12.17
T4	15.52	17.69	7.17	31.91	11.39

*Based on 100% dry matter, DM = Dry Matter, CP = Crude Protein, CFAT = Crude Fat, CF = Crude Fiber

Dry Matter

The dry matter content test was carried out using proximate analysis according to AOAC (2005) instructions with the following formula:

$$Dry\ Matter\ Content\ (\%) = \frac{(C - A)}{(B - A)} x100\%$$

Information:
A = Weight of cup (g)
B = Cup weight + sample weight (g)
C = Weight of cup + weight of sample after oven (g)

Crude Protein

The crude protein content test was carried out using proximate analysis according to AOAC (2005) instructions with the following formula:

$$Crude\ protein\ (\%) = \frac{((D - C)\ x\ N\ NaOH\ x\ 0{,}014\ x\ 6{,}25)}{(B - A)} x100\%$$

Information:
A = Weight of oil paper (g)
B = Weight of oil paper + sample (g)
C = Amount of NaOH for sample titration (ml)
D = Amount of NaOH for blank titration (ml)
6.25 = N content in protein 16%

Crude Fat

The crude fat content test was carried out using proximate analysis according to AOAC (2005) instructions with the following formula:

$$Crude\ fat\ (\%) = \frac{(D - C)}{(B - A)} x100\%$$

Information:
A = Weight of filter paper (g)
B = Weight of filter paper + sample (g)
C = Weight of glass beaker (g)
D = Weight of beaker glass + weight of sample after oven at 105 °C (g)

Crude Fiber

The dry matter content test was carried out using proximate analysis according to AOAC (2005) instructions with the following formula:

$$Crude\ fiber\ (\%) = \frac{(C - D)}{(B - A)} x100\%$$

Information:
A = Weight of filter paper (g)
B = Weight of filter paper + sample (g)
C = Weight of cup + sample after oven (g)
D = Weight of cup + sample after kiln (g)

Density

Density calculations are carried out according to the instructions of Utami & Kristanti (2017) with the following formula:

Density (g/L) =(A - B)/C

Information:
A = Weight of sample + container (g)
B = Weight of container (g)
C = Volume of container (L)

RESULTS AND DISCUSSION

Effect of Treatment on Variables

Data from research on the influence of the combination of tofu dregs and banana waste as a growing medium on proximate analysis and density of BSF larvae can be seen in Table 2.

Table 2. Effect of treatment on proximate analysis and density of Black Soldier Fly larvae

Treatment	Average ± SD				
	DM (%)	CP (%)	CFat (%)	CF (%)	Density (g/L)
T0	26.40±1.04	11.53±0.45b	7.03±0.28bc	4.49±0.17ab	158.44±6.29
T1	23.43±1.41	7.38±0.44a	6.82±0.41b	4.07±0.24a	140.61±8.51
T2	25.64±3.60	8.46±1.21ab	6.97±0.97bc	4.78±0.67ab	153.84±21.60
T3	21.79±1.87	8.14±0.69ab	5.26±0.45a	4.13±0.35ab	130.68±11.07
T4	27.13±3.83	11.81±0.36b	8.43±0.62c	5.18±0.73b	162.79±23.00

The superscript with different letters on the same line indicates a significant difference (P<0.05) and a very significant difference (P<0.01). DM = Dry Matter, CP = Crude Protein, CFAT = Crude Fat, CF = Crude Fiber

Dry Matter

Dry matter is one of the results of the division of fractions originating from feed ingredients after deducting the water content. The results of the analysis of variance in Table 2 show that the use of a combination of tofu dregs and banana waste growing media had no significant effect (P>0.05) on the dry matter content of BSF larvae. This is due to the influence of relatively the same media temperature. The results of media temperature measurements for each treatment ranged between 37-39 °C. These results are supported by research by Katayane et al. (2014) which states that apart from water content, media temperature also influences the dry matter production of BSF larvae. According to Ratni & Dewinda (2022) BSF larvae can live at temperatures in the range of 7-37 °C with the optimal temperature for BSF larvae processing their food being 30 °C. This temperature can be increased from the previously mentioned range that can still be tolerated by BSF larvae. This is because the BSF larvae will continue to move while consuming food which causes the BSF larvae to produce heat.

Crude Protein

Protein is one of the important nutrients needed to increase livestock productivity. The results of the analysis of variance in Table 2 show that the use of a combination of tofu dregs and banana waste growing media had a very significant effect (P<0.01) on the crude protein content of BSF larvae. This indicates that the protein content in the growth medium has a positive effect on the quantity and quality of BSF larvae protein produced. These results are to the opinion of Murni & Septianingsih (2015) who stated that variations in the growing media used had an impact on the high and low amounts of BSF larval protein produced. It is known by Maulana et al. (2021) and Faradila et al. (2023) that the protein content of BSF larvae obtained is greatly influenced by the nutritional content in the growth medium. The crude protein content in the growth medium will be utilized by BSF larvae to form protein in their bodies.

The results of further DMRT tests showed that the highest crude protein value was found in T4 which was very significantly different from T1 but not significantly different from T0, T2, and T3. At T0 given media in the form of 100% tofu dregs, the crude protein content was lower than T4. This is because the high protein value does not guarantee the nutritional requirements for the growth of BSF larvae contained in media suitable for larval growth. Likewise, tofu dregs have a protein content of 21.14%. The tofu dregs media used for the growth of BSF larvae has a high water content, this can be seen when the tofu dregs media used is still wet. According to Muhayyat et al. (2016), growing media with high water content will only inhibit the growth of BSF larvae. Fajri et al. (2021) explained that in the process of rearing BSF larvae, protein plays an important role in the formation of new cells. Therefore, if BSF larvae lack protein in the growth medium, it will inhibit their growth and development.

Crude Fat

Crude fat is an efficient energy source and plays an important role in livestock metabolism. The results of the analysis of variance in Table 2 show that the use of a combination of tofu dregs and banana waste growing media had a very significant effect (P<0.01) on the crude fat content of BSF larvae. This explains that the fat content in the growth medium also influences the amount of fat content in BSF larvae. These results follow the opinion of Purba et al. (2021) who stated that the growth of BSF larvae is greatly influenced by the nutritional composition of the feed, especially macromolecules, such as carbohydrates, fats, and proteins. Macromolecules, especially protein and fat, will be converted into larval biomass.

The DMRT further test results showed that the highest crude fat value was found in T4 which was significantly different from T1 and T3 but significantly different from T0 and T2. The cause of the high crude fat content in BSF larvae is due to the low water content in the larva's body. This result is supported by the opinion of Azir et al. (2017) who explained that the low fat content in BSF larvae is caused by the high water content in the larvae. Water content has an inverse relationship with fat content, that is, the higher the water content, the lower the fat content. In BSF larvae, fat is needed as an energy source to grow and develop until it becomes an adult fly.

Crude Fiber

Crude fiber is one of the important substances in essential ingredients which functions to stimulate the peristaltic movement of the digestive tract so that the process of digestion of food substances runs well. The results of the analysis of variance in Table 2 show that the use of a combination of tofu dregs and banana waste growing media had a significant effect (P<0.05) on the crude fiber content of BSF larvae. This proves that the crude fiber content in the growing medium also influences the fiber content produced. These results are in line with the opinion of Azis et al. (2022) who explained that the crude fiber content of BSF larvae is influenced by the crude fiber content of the feed provided, thus triggering the high crude fiber produced.

The results of further DMRT tests showed that the crude fiber value in treatment T4 was significantly different from T1, but not significantly different from T0, T2, and T3. The highest value of crude fiber content is found in T4 and the lowest is found in T1. The cause of the low levels of crude fiber in BSF larvae is due to the food breakdown process that occurs in their bodies. According to Li et al. (2015) and Fonseca et al. (2017), BSF larvae can digest substrates containing high crude fiber because in the digestive tract of the larvae, there is the enzyme amylase, lipase, and protease activity and there are microorganisms that can convert lignin into cellulose as an energy source through the enzyme lignocellulose produced. Apart from the growth medium, the chitin found in the larva's body also influences the crude fiber content of the larvae itself. Chitin is the most abundant natural polymer in the world after cellulose, which is found in exoskeletons in crustacean animals, insects, fungi, and Mollusca. Chitin has a positive correlation with body weight of BSF larvae.

Density

Density is calculated by weighing the feed ingredients into a volume of space. The results of the analysis of variance in Table 2 show that the use of a combination of growing media for tofu dregs and banana waste had no significant effect (P>0.05) on the density of BSF larvae. The research results show that the density value tends to increase in media with high protein levels. The increase in density value is caused by BSF larvae absorbing nutrients in the growth medium to form body tissue and other biological structures. This shows that the use of tofu dregs and banana waste has a good influence on the density of BSF larvae.

Media that contains good nutrition will have a positive effect on the growth of the larvae themselves. This is in line with the opinion of Amran, Nuraini, & Mirzah (2021) who stated that media that has high nutrition will increase larval density. Factors that influence the success of larval production are the nutritional content of the substrate and environmental conditions. In general, quality substrate will result in greater larval production because it can provide sufficient nutrition for larval growth and development.

CONCLUSIONS

Using a combination of tofu dregs and banana waste as a growing medium can affect the

crude protein, crude fat, and crude fiber content, but does not affect the dry matter content and density of BSF larvae. Using 75% tofu dregs and 25% banana waste gave the best results with a dry matter content of 27.13%, crude protein 11.81%, crude fat 8.43%, crude fiber 5.18%, and density 162.79 g/ L.

REFERENCES

Amran, M., Nuraini, N., & Mirzah. (2021). Pengaruh Media Biakan Fermentasi dengan Mikroba yang Berbeda terhadap Produksi Maggot Black Soldier Fly (Hermetia illucens). Jurnal Peternakan, 18(1), 41-50.

AOAC (Association of Official Analytical Chemists). (2005). Official Methods of Analysis of Association of Official Analytical Chemists. AOAC Inc, Washington DC. 1141.

Azir, A., Harris, H., & Haris, R. B. K. (2017). Produksi dan Kandungan Nutrisi Maggot (Chrysomya megacephala) Menggunakan Komposisi Media Kultur Berbeda. Jurnal Ilmu-ilmu Perikanan dan Budidaya Perairan, 12(1), 34-40.

Azis, R. A., Nurhayatin, T., & Hadist, I. (2022). Pengaruh Umur Panen terhadap Kandungan Protein Kasar Lemak Kasar dan Serat Kasar Maggot Hermetia illucens. JANHUS Jurnal Ilmu Peternakan Journal of Animal Husbandry Science, 6(2), 94-103.

Cicilia, A. P., & Susila, N. (2018). Potensi Ampas Tahu terhadap Produksi Maggot (Hermetia illucens) sebagai Sumber Protein Pakan Ikan. Jurnal Anterior, 18(1), 40-48.

Dihni, V. A. 2022. Produksi Pisang di Indonesia (2017-2021). Retrieved January 25, 2023, from https://databoks.katadata.co.id/datapublish/2022/06/16/indonesia-hasilkan-jutaan-ton-pisang-tiap-tahun-ini-rinciannya.

Fajri, N. A., Kartika, N. M. A., & Mariani, Y. (2021). Tingkat Bobot Maggot BSF pada Media Kotoran Ayam dan Kotoran Sapi. AGRIPTEK (Jurnal Agribisnis dan Peternakan), 1(3), 77-83.

Faradila, S., Syamsuddin, N. M., Jariyah, A., & Wahyuni, S. (2023). Media Tumbuh yang Berbeda terhadap Tingkat Produksi dan Kandungan Nutrisi Maggot Black Soldier Fly. Buletin Veteriner Udayana Volume, 15(3), 490-497.

Fonseca, K., Dicke, M., & Van Loon, J. (2017). Nutritional Value of the Black Soldier Fly (Hermetia illucens L.) and Its Suitability as Animal Feed. Journal of Insects as Food and Feed, 3(2), 105-120.

Ikhsan, A. M., & Tamrin, K. M. (2014). Pengaruh Media Simpan Pasir dan Biji Plastik dengan Pemberian Air Pendingin terhadap Perubahan Mutu pada Buah Pisang Kepok (Musa normalis L). J. Tek. Pertan. Lampung, 3(2), 173-182.

Katayane, F. A., Bagau, B., Wolayan, F. R., & Imbar, M .R. (2014). Produksi dan Kandungan Protein Maggot (Hermetia illucens) dengan Menggunakan Media Tumbuh Berbeda. Zootec, 34, 27-36.

Li, W., Li, M., Zheng, L., Liu, Y., Zhang, Y., Yu, Z., & Li, Q. (2015). Simultaneous Utilization of Glucose and Xylose for Lipid Accumulation in Black Soldier Fly. Biotechnology for Biofuels, 8(1), 1-6.

Masir, U., Fausiah, A., & Sagita, S. (2020). Produksi Maggot Black Soldier Fly (BSF) (Hermetia illucens) pada Media Ampas Tahu dan Feses Ayam. AGROVITAL: Jurnal IlmuPertanian, 5(2), 87-90.

Maulana, Nurmeiliasari, & Fenita, Y. (2021). Pengaruh Media Tumbuh yang Berbeda terhadap Kandungan Air, Protein, dan Lemak Maggot Black Soldier Fly (Hermetia illucens). Bulletin of Tropical Animal Science, 2(2), 150-157.

Muhayyat, M. S., Yuliansyah, A. T., & Prasetya, A. (2016). Pengaruh Jenis Limbah dan Rasio Umpan pada Biokonversi Limbah Domestik Menggunakan Larva Black Soldier Fly (Hermetia illucens). Jurnal Rekayasa Proses, 10(1), 23-29.

Murni, M., & Septianingsih, E. (2015). Optimasi Pemberian Kombinasi Maggot dengan Pakan Buatan (Pelet) terhadap Pertumbuhan dan Sintasan Ikan Nila (Oreochromis niloticus). Prosiding FORUM INOVASI TEKNOLOGI AKUAKULTUR, 345-355.

Purba, J., Kinasih, I., & Putra, E. (2021). Pertumbuhan Larva Lalat Tentara Hitam (Hermatia illucens) dengan Pemberian

Pakan Susu Kadaluarsa dan Alpukat. Biotropika, 9(1), 88-95.

Raharjo, E. I., Rachimi, & Muhamad, A. (2016). Pengaruh Kombinasi Media Ampas Kelapa Sawit dan Dedak Padi terhadap Produksi Maggot (Hermetia illucens). Jurnal Ruaya: Jurnal Penelitian dan Kajian Ilmu Perikanan dan Kelautan, 4(2), 41-46.

Ratni, N., & Dewinda, I. (2022). Pemanfaatan Larva Black Soldier Fly (BSF) dalam Pengolahan Air Lindi (Leachate). INSOLOGI: Jurnal Sains dan Teknologi, 1(5), 614-622.

Rhode, C., Badenhorst, R., Hull, K.L., Greenwood, M.P., Baster-van der Merwe, A.E., Andere, A.A., Picard, C.J., & Richards, C. (2020). Genetic and Phenotypic Consequences of Early Domestication in Black Soldier Flies (Hermetia illucens). Animal Genetics, 51(5), 752–762.

Ruhmawati, T., Sukandar, D., Karmini, M., & Roni S. T. (2017). Penurunan Kadar Total Suspended Solid (TSS) Air Limbah Pabrik Tahu dengan Metode Fitoremediasi. Jurnal Permukiman, 12(1), 25-35.

Utami, K. B., & Kristanti, N. D. (2017). Evaluasi Nilai Kecernaan In Vitro Bahan Kering dan Bahan Organik Biskuit Biosuplemen Daun Katuk (Sauropus androgynus L. Merr) untuk Sapi Perah FH. J. Ilmu-Ilmu Peternakan, 28(1), 51-58.