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Maggot as a Bioconversion Agent of Cow Blood Waste and Date Pulp into Feed Raw Materials: A Chemical Profile Study

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Abstract: Cow blood waste and date residue become environmental problems if not appropriately managed. So far, there has yet to be any special management to handle the waste. On the other hand, cow blood waste and date pulp can be efficiently decomposed by maggots. This research was carried out to utilize organic waste as maggot cultivation by producing animal feed materials high in protein and fat, and to determine the best composition in the feed medium. Maggot feed treatment consisted of household organic waste as P0, mixed feed as P1, the ratio of cow blood waste to date pulp P2 (1:1), P3 (1:2), and P4 (2:1). The maggot flour obtained was analyzed for its proximate, amino acid, and fatty acid content. The results showed the lowest moisture at P3 (2.26%), the highest ash content and fat content at P0 (8.27 and 36.62%), respectively, and the highest protein content at P3 (51.66%). Chemical profile analysis showed the highest amino acids, namely glutamic acid (6.05%) and lauric acid C13:0 as the highest fatty acid. The maggot content, which is rich in protein, can be used as a raw material for livestock feed.

Keywords: blood, date pulp, feed, maggot

Abstrak: *Limbah darah sapi dan ampas kurma menjadi masalah lingkungan jika tidak dikelola dengan tepat. Selama ini, belum ada pengelolaan khusus untuk menangani limbah tersebut. Di sisi lain, limbah darah sapi dan ampas kurma dapat diurai secara efisien oleh maggot. Penelitian ini dilakukan untuk memanfaatkan limbah organik sebagai budi daya maggot dengan menghasilkan bahan pakan ternak yang tinggi protein dan lemak, serta menentukan komposisi terbaik dalam media pakan. Perlakuan pakan maggot terdiri atas limbah organik rumah tangga sebagai P0, pakan campuran sebagai P1, nisbah limbah darah sapi dengan ampas kurma P2(1:1), P3(1:2), dan P4(2:1). Tepung maggot yang diperoleh dianalisis kandungan proksimat, asam amino, dan asam lemaknya. Hasilnya menunjukkan kadar air terendah pada P3 (2,26%), kadar abu dan kadar lemak tertinggi berturut-turut pada P0 (8,27 dan 36,62%), dan kadar protein tertinggi pada P3 (51,66%). Analisis profil kimia menunjukkan asam amino tertinggi, yaitu asam glutamat (6,05%) serta asam laurat C13:0 sebagai asam lemak tertinggi. Kandungan maggot yang kaya akan protein ini dapat digunakan sebagai bahan baku pakan pada ternak..*

Kata kunci: *ampas kurma, darah, maggot, pakan*

INTRODUCTION

There are 1,644 slaughterhouses in Indonesia with the number of slaughter cattle of 868,024 per year (Badan Pusat Statistik 2022). Cows have a blood volume of 7.7% of their body weight, when slaughtered of 868,024 heads, the total blood per year is 66,837,848 tons (Segara 2015). Blood is an organic waste that decays quickly so that it can cause odors and sources of disease if left unchecked. Slaughterhouses (RPH) produce waste, one of which is blood, which is an environmental problem if not managed properly, and so far there have been no special management efforts in RPH. Usually, the blood waste produced is directly disposed of in the final disposal site. In fact, cow blood can be processed as a feed ingredient that contains high protein (Roseno 2014). One of them is blood flour has a high protein of 80-85%, crude fiber 1%, and fat 1.6% (Utomo *et al*. 2014).

In addition to blood waste, there are also date pomace that have not been properly managed which can actually be used as animal feed. The date industry produces date waste each production ranges from 300 to 500 kg. So far, date pomace has only been piled up or directly given to livestock. If the factory waste in the form of date pomace is not processed properly, then the date pomace accumulates and makes the environment polluted. The content in date pomace is in the form of protein 8.01%, energy 4,672.49 cal/g, and crude fiber 20.70%, (Fitro *et al*. 2015). The protein content is still relatively low if it is directly given as animal feed. One of the animal feeds that is high in protein is maggot. Maggot can be a decomposer agent to decompose cow blood waste in RPH (Roseno 2014). Maggot is a larva of the Black Soldier Fly (BSF) which has a high protein content of around 45-50% (Mabruroh *et al*. 2022).

Maggots can degrade organic waste better than other insects with a harvest time of about 10 – 15 days (Monita *et al*. 2017). Maggot can degrade organic waste using the bioconversion method. The bioconversion method, which is one of the processes that converts organic waste into high-value products with the help of microorganisms (Yuwita *et al*. 2022). Maggot can decompose various types of organic waste, such as fruit peels, vegetable residues, fruit residues, tofu factory waste residues, dates, palm oil, coffee grounds and tea (Giffari *et al*. 2021). Maggots can reduce organic waste by up to 70%, compared to using other insects (Muhayyat *et al*. 2016).

Maggot can be used as feed for livestock but maggot cannot be used as the main feed, but can be mixed with commercial feed, such as bran so that it can reduce production costs in animal feed such as chickens, quails, fish and others. In addition, maggot also produces casgot that can be used as an organic fertilizer for plants that are pesticide-free and good for consumption. Kasgot can also be used as a medium for the development of earthworm cultivation. This activity can create the concept of a circular economy. The circular economy is an industrial model that focuses on reducing, reusing, and recycling in waste management (Kristianto & Nadapdap 2021).

The circular economy focuses on reducing, reusing, recycling into the same product or into other products (Syarif *et al*. 2022). The content of essential fatty acids in maggot flour, namely lauric acid is 13.39% (Widianingrum *et al*. 2021). Analysis of proximates such as protein and fat content in maggots with cow blood waste and date pulp is not yet known. The importance of further research is related to the chemical profile of maggot flour with cow blood waste feed and date pulp to obtain information on the content of maggot flour. This chemical profile is the basis for seeing the potential of maggots in converting waste into valuable products.

MATERIALS AND METHOD

Materials

The materials used are, BSF eggs from maggot farmers in Bogor City, rice bran, date pomace from a date juice factory in Bogor City, cow blood from the Dramaga Slaughterhouse, and household organic waste. Materials used in the laboratory, namely aquaade, selenium, H_2SO_4 95-97%, Conway indicator, NaOH 40%, boric acid 2%, HCl 0.1 N, benzene solvent, weighing paper, BF_3 and filter paper.

Sample Preparation and Maggot Cultivation

Maggot eggs hatch first in a dry container using bread, and bran. After 3-5 days the maggots are transferred to the development medium, each of which has been filled with varied feed. Maggots are cultivated using *bioponds*. The types of feed vary as research factors, including:

P0: Household organic waste with maggot eggs 2 g
P1: Household organic waste 500 g: cow blood waste 500 g: date pulp 500 g (1:1:1), with maggot eggs 2 g.
P2: 750 g of cow blood waste mixed with 750 g (1:1) of date pulp, with 2 g of maggot eggs.
P3: 500 g of cow blood waste mixed with 1 kg (1:2) of date pulp, with 2 g of maggot eggs.
P4: 1 kg of cow blood waste mixed with 500 g (2:1) of date pulp, with 2 g of maggot eggs.

Then harvesting is carried out after 15 days, then sifted with a coarse sieve to separate from the kasgot, then weighed to find out the harvest. If the maggot produced is dirty, it needs to be washed first. In addition, when harvesting, about 0.5 — 1 kg is left to be used as pupa and then become flies, and lay eggs again, for one cycle it takes 42 days. Maggots that are 15 days old are harvested to be dried using a *microwave* for 15 minutes at 450 watts of power. Then it is mashed using a blender, then a proximate analysis is carried out to determine the quality of maggot for animal feed.

Moisture Content Analysis

The moisture content analysis was carried out by the gravimetric method (AOAC 2012). First, porcelain cups are dried in the oven at a temperature of (105$\pm$ 2 ℃) for 30 minutes. Then it is put into a desicator and then an empty cup is weighed (W_1) and then 5 – 10 g of maggot flour sample is put into a cup, then weighed again (W_2). Sample in the oven at 105 for 3 hours. The cup is inserted into the desicator until it reaches the last room temperature to be weighed again (W_3).

$$\text{Moisture content (\%)} = \frac{(W_2 - W_3)}{(W_2 - W_1)} x\ 100\% \ ...(1)$$

Note:
W_1 = empty porcelain cup weight (g)
W_2 = weight of porcelain cup and sample (g)
W_3 = weight of porcelain cup and sample after drying (g).

Ash Content Analysis

The analysis of ash content was carried out by the gravimetric method (AOAC 2012). using the gravimetric method. Empty porcelain cups are dried at (105 ± 2°C) for 30 minutes using the oven. Then it is cooled with a desicator and weighed (W_1). Then 2 – 5 g of maggot flour sample is put into a cup and weighed (W_2). Then it is laid over the flame of the burner, then opened into the kiln at a temperature of 600 for 2 hours. Then it is cooled with a desiccant until it reaches room temperature, then weighed (W_3).

$$\text{Ash content (\%)} = \frac{(W_3 - W_1)}{(W_2 - W_1)} x\ 100\% \ ...(2)$$

Note:
W_1 = empty porcelain cup weight (g)
W_2 = weight of porcelain cup and sample (g)
W_3 = weight of porcelain cup and sample after firing (g)

Fat Content Analysis

The analysis of crude fat content was carried out by Soxhlet extraction method and gravimetry (AOAC 2012). A total of 2-5 g of water-free (dry) maggot flour samples are put in a sleeve lined with cotton (W_1), then the empty *soxhlet* pumpkin is put in the oven at a temperature of (105±2°C) for 30 minutes, then cooled in a desiccant and weighed W_2. Then the *soxhlet* tool is assembled, and the sleeve is placed in the *soxhlet* column, 100 ml of petroleum benzene solvent is added and extracted for 6 hours until the fat solvent evaporates. Pumpkins containing fat residues are dried in the oven at (105±2°C) for 2 hours. Then the pumpkin is put into the desicator and weighed W_3. Crude fat content can be calculated by the following formula:

$$\text{Crude fat (\%)} = \frac{(W_3 - W_2)}{W_1} x\ 100\% \ ...(3)$$

$$\text{Crude fat (\%)} = \frac{\text{Lemak kasar kering (\%) x } (100 - \text{air\%})}{100} \ ...(4)$$

Notes:
W_1 = sample weight (g)
W_2 = empty flask weight (g)
W_3 = weight of the pumpkin containing fat residues (g)

Protein Content Analysis

Crude protein content analysis (AOAC 2012) used the kjeldahl method which consisted of 3 stages, namely destruction, distillation, and titration. At the destruction stage, 0.1 g of maggot flour is put into 100 ml of Kjeldahl pumpkin, then selenium is added as much as 2 tablespoons and 10 ml of H_2SO_4 (95 - 98% b/v) is added. After that, heating is carried out using a bunsen burner until a clear solution with a slight greenish tint is obtained. In the distillation stage, the results of the destruction that have been left to cool are transferred to a 500 ml kjeldahl flask, then 150 ml of aquaades and 50 ml of 40% NaOH are then assembled on the distillation apparatus 20 ml of 2% boric acid (H_3BO_3) is put into the erlenmeyer and 3 drops of Conway indicator are added, then connected to the condenser until the pipe is dipped in.

Distillation begins with heating, the solution in the erlenmeyer flask is turquoise and distilled for 5 – 10 minutes. Then in the titration stage, the distillate obtained is titrated with HCl 0.1 N which has been standardized to pink. The same thing is done in the kjeldahl tube, but without the addition of a sample as a blank. The volume of titration of the sample (V_s) and blanks (V_b) obtained was recorded. The percentage of protein content can be determined by calculating the percent nitrogen using the following formula:

$$\text{Protein content (\%)} = \frac{(V_s - V_b)\ x\ [HCl]\ x\ 0.014\ x\ f_p\ x\ f}{W} x\ 100\% \ ...(5)$$

Notes:
Vs = volume of HCl required for sample titration (ml)
Vb = HCl volume for blank titration (ml)
[HCl] = HCl concentration (N)
0.014 = molecular weight N
W = sample weight (g)
F = 6.25 for all fodder, feed and compound feed

Amino Acid Profile Analysis

Amino acid profile analysis was performed using *the* High-Performance Liquid Chromatography (HPLC) method. Amino acid standards are made with internal standards. Maggot flour is weighed as much as 10-15 mg into *a* 10 ml headspace vial, then hydrolyzed with 2 ml of HCl 6 N solution then added nitrogen gas and then in the oven for 24 hours at a temperature. Then it is transferred while being filtered into the rotaf flask. After that, the sample in the rotaf uses 120°C evaporasy rotaf until it is concentrated. Then 10 ml of HCl 0.01 N was added and then homogenized slowly. Then the solution was filtered with a 0.45 μm syringe filter and accommodated by the filtrate. A standard internal solution is added and goes into the derivation stage. Finally, the sample is injected into the HPLC.

Fatty Acid Level Analysis

Fatty acid analysis using the Gas Chromatography (GC) method In the derivation stage, the fat extract was weighed as much as 0.02—0.03 g put into a 10 ml threaded tube and then added 1 ml of NaOH 1 M in 0.5 N methanol. A total of 2 ml of BF_3 solution is added, then the threaded tube is tightly closed. A threaded tube containing fat extract is put in a water bath to a temperature of 70 – 80 for 25 minutes, and is beaten occasionally. Extraction stage. The threaded tube is cooled to room temperature and 2 ml of saturated NaCl and 1 ml of isooctane are added, beating vigorously. The solution will be separated into two layers without emulsion in between. The uppermost layer (organic phase) is inserted into a 2 ml vial and then injected into the GC instrument.

RESULT AND DISSCUSION

Maggot Cultivation and Harvest

The cultivation of black soldier flies produces maggots and kasgots. Maggot cultivation is carried out with five treatments, namely household organic waste as P0 and feed variations from household organic waste, date pulp, and cow blood as P1, P2, P3, and P4. This variation is carried out to determine the content and quality of the best maggot. Maggots are harvested on the 15th day, if they are not harvested for 3 weeks, then the maggot will change color to brownish-black. Maggot harvesting is carried out manually, namely sifting or separated between the maggot and the casgot using a shovel/spoon. The nutrients that maggots need to reproduce are high carbohydrates and proteins. Maggot protein is affected by the feed given, if the medium is high in protein, then maggot will also have a high protein content (Maulana & Fenita 2021) . In Table 1, the weight of dry maggot production decreases far from the weight of wet maggot, this illustrates the high water content in the body of maggots so, if dried with Microwave The weight will be reduced. P1 crops with a weight of 500 g with a shrinkage weight of 76.99% were obtained, this is because the nutritional needs of maggot were met during maggot cultivation. Adequate nutrition in the medium leads to a total increase in maggot production (Cicillia & Susila 2018).

The lowest weight was obtained in the P2 variation with a weight of 320 g, this is because the medium dries easily, so that the development of maggots can be inhibited and the water content is small. The growth and development of maggots will be optimal in culture media that contains substrates that provide the necessary and quality nutrients (Neneng *et al*. 2023). The nutrients that maggots need to reproduce are high carbohydrates and proteins. Maggot will have an effect on either medium or feed that has high protein (Maulana *et al*. 2021). In Table 3.1, the weight of dry maggot production decreases from the weight of wet maggot, this illustrates the high water content in the body of maggot, so a drying process is needed by Microwave to reduce the moisture content.

Based on Figure 1(A), the drying is done using a microwave for 10-15 minutes. In drying occurs rapid dehydration, which is marked by the resulting maggots having a voluminous body this is due to the increased pressure inside the larvae and to release the pressure resulting in bloating and crispy larvae. In Figure 1(B), there is slow dehydration in processing water, slow evaporation and larvae shrink until they reach a constant weight with less volume and stiff texture. Products that are voluminous and crispy are preferred in the market and attract customers to buy such products. In Figure 1 (C) is the product of drying maggots in a *microwave* for 15 minutes and a power of 450 watts. Based on the shelf life, using a dry maggot pouch remains crispy for 6 months so it is still good to use as animal feed.

Table 1. Maggot production weight on different feed variations.

Treat	Weight of wet Maggot (grams)	Dry Maggot Weight (grams)	Shrinkage Weight (%)
P0	375.0	86.28	76.99
P1	500.0	164.58	67.08
P2	320.0	76.26	76.17
P3	360.0	95.40	73.50
P4	400.0	113.74	71.57

Note: P0 (household organic waste), P1 (mixture of household organic waste: cow's blood: date pulp) P2 (cow's blood with date pulp 1:1), P3 (cow's blood with date pulp 1:2), P4 (cow's blood with date pulp with a ratio of 2:1).

(A) (B) (C)

Figure 1. Condition of dried maggot with *microwave* (A), Dried maggot with roasted (B), and (C) Dried maggot products using *microwave.*

Proximate Analysis

Moisture Content in Maggot Flour

The crushed maggot flour is then tested, proximate analysis consisting of moisture content, ash content, fat content and protein. Determination of moisture content by gravimetric method until the sample reaches a fixed weight (Monica & Sa'diyah 2023). Figure 2 shows the results of the water content where the highest moisture content is obtained in the P1 treatment of 3.37%, this is because the water content in the P1 maggot feed is fulfilled during cultivation. The moisture content at P0, P2, P3, and P4 is low, this is because it is in accordance with the feed medium given during maggot cultivation. The lowest moisture content is P3 of 2.26%, this is because the feed given dries easily so that the weight and moisture content produced are low, the nutritional content of maggots is influenced by the feed eaten by the maggots themselves.

The absorption of water content in the larval phase is needed for growth and maggots have properties such as absorbing water in the feed medium (Andika *et al*. 2023) The lowest water content is at P2 of 2.26%, this is because the feed given dries easily so that the weight and water content produced are low, the maggot content is influenced by the feed eaten by the maggot itself. The moisture content in maggot flour is appropriate, namely, the maximum moisture content in animal feed ingredients is 13% (SNI 2022). Excessive moisture content will affect the storage time, the higher the moisture content, the shorter the storage time will be and can cause mold in the feed and have poor feed quality (Marbun *et al*. 2019).

Ash Content in Maggot Flour

The determination of ash content was carried out by the gravimetric method. Maggot flour is burned with *a bunsen burner* until the sample has turned into charcoal and there is no more smoke with the aim that when put into the kiln, the sample does not smell and the combustion becomes more perfect. Then the sample is in the kiln with the aim of removing all the organic matter contained in the maggot flour so that what remains is an inorganic substance called ash (Kusmiati 2018). Based on Figure 3, the ash content in the maggot flour produced is below the maximum limit that has been set. The ash content in animal feed has a maximum limit of 13% (Indonesian National Standard 2022). The P0 ash content also has the highest content of 8.27%, which shows that maggot flour with household waste feed has a higher mineral content than other treatments. The ash content in maggot with a ratio of 35% has an ash content of 8.51% (Monica & Sa'diyah 2023).

The smallest ash content is in the P3 treatment, which is 4.35%, this shows that cow blood waste has a low mineral content. Based on the literature on the ash content in blood flour (2.79%) (Sipahutar *et al*. 2015). The determination of ash content in maggot

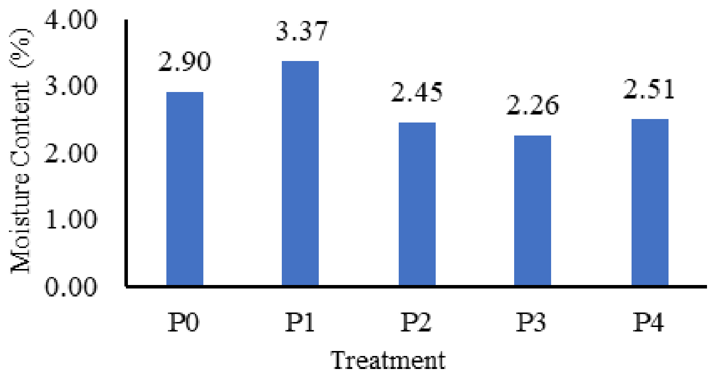


Figure 2. Moisture content in maggot flour.

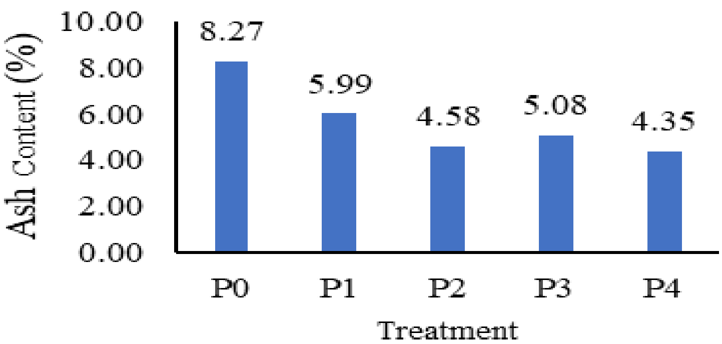


Figure 3. Ash content in maggot flour.

flour aims to see the mineral content in feed, the lower the mineral content, the better the quality of the feed, on the other hand if the ash content is high in the feed has poor quality or there are toxic minerals in the feed (Pangestuti & Darmawan 2021)

Fat Content in Maggot Flour

Fat is one of the feed substances needed during livestock growth which functions as a reserve of energy sources. One of the feeds that has high fat is maggot, which is easy to cultivate. The fat content in maggots is quite high so that maggots are good to be used as raw materials for animal feed. Determination of crude fat content using the soxhlet and gravimetric methods. Based on Figure 4, the highest fat in the P0 treatment is 36.62%, this shows that if you want maggots with high fat content, you can be given household waste feed media. Pthere is a P0 treatment, namely household waste, the fat content produced is quite high. The smallest fat content was in the P2 treatment, which was (25.98%). Based on research by Anggraini (2022), fat in maggot with household feed (10.46-32.39%).

The crude fat content has a minimum level to be used as animal feed, which is at least 4% (Indonesian National Standard 2022). Based on the analysis of the fat content produced is quite high, this can increase livestock productivity if not used excessively. High fat can serve to survive.

Protein Content in Maggot Flour

Protein levels were analyzed using the kjeldahl method with three stages, namely destruction, distillation, and titration. At the destruction stage, the weighed sample is then added selenium with the aim of accelerating the reaction or increasing the boiling point. Then add H_2SO_4 and then heat it using a bunsen burner for 30 minutes or until it changes color to clear greenish. Distillation stage, the sample is added aqueous and NaOH, when adding NaOH the tube must be closed immediately so that the ammonia is not decomposed by air and directly heated, ammonium sulfate is decomposed into ammonia (NH_3). Then NH_3 is captured by the standard acid i.e. boric acid. In the titration stage, the distillate is titrated using standardized HCl. The use of HCl titrants to determine the amount of ammonia reacts with hydrochloric acid. The final result is marked by a color change from turquoise to pink slices. Here are the reactions that occur (Equations 6, 7, 8, and 9).

$\text{N-Organic} + H_2SO_4 \rightarrow (NH_4)_2SO_4 + H_2O + CO_2 + SO_2$ Compound... (6)

$(NH_4)_2SO_4 + 2NaOH \rightarrow NaSO_4 + 2NH_3 + H_2O$...(7)

$NH_3 + H_3BO_3 \rightarrow NH_4H_2BO_3$...(8)

$NH_4H_2BO_3 + HCl \rightarrow NH_4Cl + H_3BO_3$...(9)

Based on Figure 5, the highest protein level in P2 treatment is as follows: 51.66%. Based on the rate literature Maggot has a nutritional content including protein 42.1%, fat 24-30%, ash content 14.6%, fiber 7.0%, calcium 5%, porpoise 1.5%, and nitrogen 1.4% (Jayanthi *et al.* 2017). A mixture of cow's blood and date pulp can increase protein levels, because blood has a high protein content of 79.3% (Ramadan *et al.* 2021). However, the addition of blood to maggot feed must be considered because it has a very low

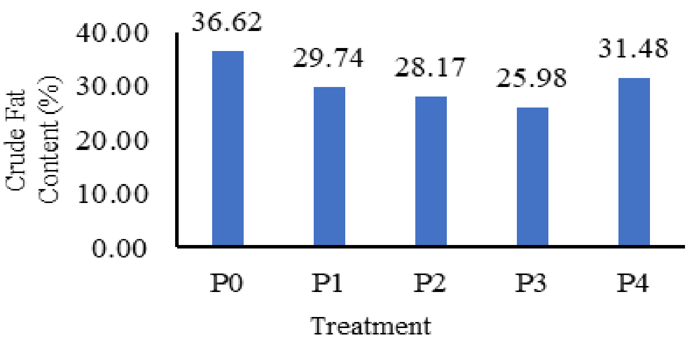


Figure 4. Crude fat content in maggot flour.

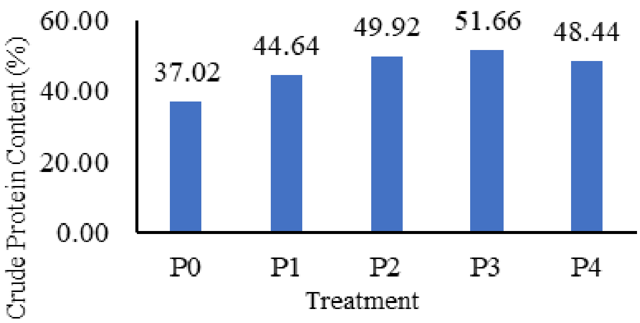


Figure 5. Crude protein content in maggot flour.

digestibility, this is caused by blood that clots to become clay and hard, so that it inhibits digestibility and decreases production and affects the quality of maggots (Utomo *et al.* 2014). Maggot treatment P3 is with a ratio of blood waste: date pulp (2:1) has a lower protein content than P1 and P2 treatment, this is because the ability of maggots to decompose blood clots that become clay and hard is not optimal so that it affects the content of maggot produced. It is the blood after boiling to become hard and clayey.

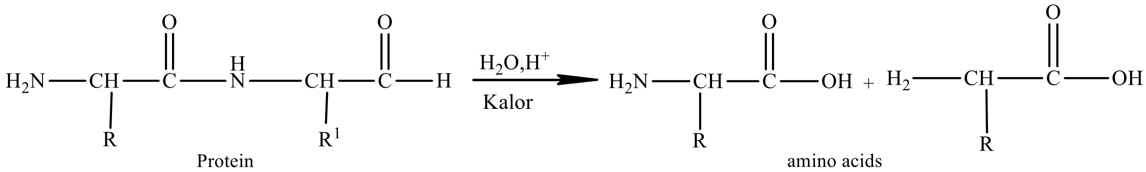
According to Amandanisa & Suryadarma (2020), the protein content in maggot flour can reach 40-50%. The use of maggot flour in animal feed can improve the productivity and health of livestock because protein helps in the formation of body tissues and metabolism (Laila *et al.* 2023). Maggot is a source of protein that can be used as a raw material for animal feed that is high in protein and organic fertilizer from the casgot or leftovers from maggot. Maggot can reduce dependence on conventional feed sources such as soybeans or fishmeal. Maggot is an alternative feed that meets the needs of 40-60% protein sources and is easy to breed (Nurhayati *et al.* 2022). Protein content is also influenced by the medium which correlates with an increase in protein levels if the medium is high in protein (Cicillia & Susila 2018).

Amino Acid Analysis

Amino acids are the main components of proteins that play an important role in metabolism (Devi *et al.* 2023). There are two categories of amino acids, namely essential amino acids and non-essential amino acids. Essential amino acids are a group of amino acids that must be provided in animal feed because essential amino acids are only a small amount in the body of livestock or are not produced in livestock, while non-essential amino acids can be produced by the body itself (Umar 2021). Essential amino acids need to be supplied from the outside in the form of food or drinks. One of the amino acid content in animal feed comes from maggot.

Amino acid profile analysis has a hydrolysis stage using strong acids to aim for strong acids to be able to provide acidic conditions in peptide bond breaking. The process of acid hydrolysis under these conditions can perfectly break peptide bonds from complex proteins into simpler compounds (Farida *et al.* 2023). The following reactions occur at the hydrolysis stage (Farida *et al.* 2023). The working principle of HPLC is that the post column with the sample injected in the system is on, the sample then enters the detector stage and produces a chromatogram. The detector used is a fluorescence detector so that a chromatogram with 17 amino acids is produced (Equation 10).

Based on Figure 6, the chromatograms of P0, P1, P2, and P3 have chromatograms that are almost similar to the highest peak, namely P2, this is because the protein in P2 has the highest level and the lowest peak is P0. The level of amino acids can be seen from how high the peak produced, the higher the peak, the greater the amino acid content, so that feed with high protein content will affect the peak produced (Farida *et al.* 2023). On the chromatogram, it can be seen that methionine, arginine, and isoleucine in P3 have low levels, this is because blood starch has very low levels so that the more blood waste is given, the more



... (10)

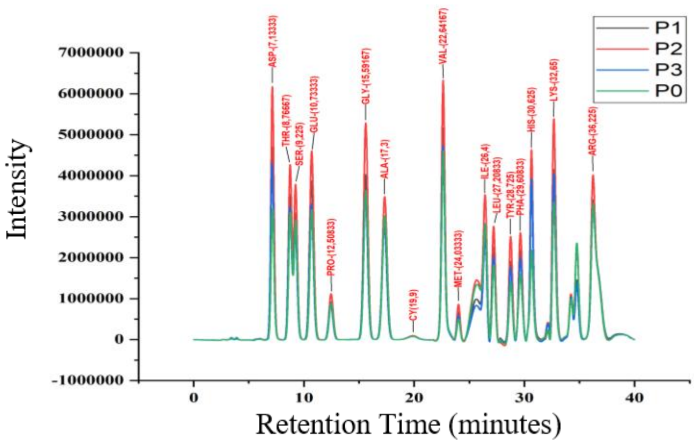


Figure 6. Amino acid chromatogram in maggot flour.
Note: P0 (household organic waste), P1 (blood waste: date pulp (1:1)), P2 (Blood waste: date pulp (1:2)), P3 (blood waste: date pulp (2:1)).

it will affect the amino acids. Blood meal has a very low content of the amino acids isoleucine, methionine, and arginine, so it is necessary to be careful in adding blood starch to animal feed, this can reduce and affect livestock productivity (Utomo *et al*. 2014).

The highest amino acid chromatogram is in valine and the lowest is cystine. Essential amino acids present in the body are made with ordinary organic amino acids such as, serine, alanine, tyrosine, asparagine acid, arginine, syrocyne, glycine, norkucine, citrulline, and proline (Lestari *et al*. 2023). In Table 2, the total amino acids in maggot flour are the highest in the P2 treatment, which is 48.85%, the second P3 is 45.11%, the third P1 is 44.72%, and the last P0 is 35.06% . This is because the protein content of P2 is also the highest, while P0 has the lowest protein content. The results of the researcher's analysis showed that the glutamic acid content was higher than that of the Cicillia & Susila (2018) study, which was 6.05%. Based on research by Cicillia & Susila (2018), the content of glutamic acid in maggot flour is 3.86%.

The highest amino acid content is glutamic acid at 6.05%, aspartic acid at 5.41%, alanine and tyrosine at 3.68%. Feed with a high content of glutamic acid functions as an antioxidant that forms immunity, helps the body's metabolism and one of the Feed Additive Safe alternative to animal feed (Maslami *et al*. 2023). The amino acid lysine is the highest at P2 at 3.48% which functions to help calcium absorption in bone formation and functions as the main limiting amino acid that has a vital role in metabolism to synthesize proteins or compose other important components (Saputra *et al*. 2021). Lysine amino acid has a minimum level based on SNI (2022), which is 1.20%. The amino acid methionine functions to accelerate the growth and development of livestock or increase livestock weight (Saputra *et al*. 2021). The amino acid methionine is minimal based on SNI (2022), which is 0.45%. Amino acids are very important for the body of cattle, namely to build protein polypeptide chains and have a function as cell metabolism. The amino acid content in maggot flour is quite complete so that it can be used as a raw material for animal feed.

Fatty Acid Analysis

Fatty acids are a type of essential fatty acid that cannot be produced by the body and need to be supplied from food or feed. One of them is maggot. Maggot has a fat content ranging from 29 – 32%

Table 2. Amino acid profile content in maggot flour variations.

No	Essential amino acids	%(w/w)			
		P0	P1	P2	P3
1	Threonine	1.50	1.87	2.02	1.85
2	Arginine	1.91	2.07	2.12	2.16
3	Histidina	1.97	3.10	3.07	3.29
4	Leucines	1.99	2.59	2.72	2.51
5	Lysina	2.33	3.15	3.48	3.21
6	Isoleusina	1.40	1.67	1.81	1.61
7	Phalalanina	2.16	2.60	2.71	2.70
8	Valina	2.11	2.52	2.87	2.60
9	Methinine	0.39	0.59	0.69	0.55
	Non-Essential Amino Acids				
1	Aspartic Acid	2.98	4.64	5.41	4.70
2	Glutamic Acid	4.32	5.75	6.05	5.34
3	Serina	1.77	2.01	2.20	1.99
4	Glycine	1.98	2.37	2.75	2.30
5	Alanina	3.32	3.37	3.68	3.65
6	Tyrosine	2.21	3.15	3.68	3.25
7	Prolina	2.35	2.85	3.13	2.93
8	Sistina	0.38	0.44	0.47	0.47
	Total AA (%w/w)	35.06	44.72	48.85	45.11

Note: P0 (control), P1 (cow's blood with date pulp 1:1), P2 (cow's blood with date pulp 1:2), P3 (cow's blood with date pulp 2:1).

(Amandanisa & Suryadarma 2020). The fatty acid structure consists of a straight hydrocarbon chain with one methyl group (CH_3) at one end and a hydroxyl group (COOH) at the other end (Jacoeb *et al*. 2014). Fatty acids can be differentiated based on the degree of saturation, namely unsaturated fatty acids and saturated fatty acids. Unsaturated fatty acids have a lower melting point than saturated fatty acids, and have double bonds between carbons whereas saturated fatty acids do not have double bonds between carbons.

Fatty acid analysis is performed by injection into the GC instrument. This GC uses the motion phase of hellium, nitrogen, and hydrogen with a FID detector. FID detectors respond to all hydrocarbon gases, are sensitive, and have a wide measurement range. There are 37 fatty acid standards for the identification of fatty acids in maggot flour. Based on Figure 7, the results of the P0, P1, P2, and P3 chromatograms produce almost the same chromatograms. The chromatogram with the highest peak is lauric acid, the higher the peak, the higher the concentration. The next highest peak is palmitic acid, C16:0 then oleic acid, C18:1n9c while the lowest peak is pentadecanoic acid, C15:0. The dominant fatty acid content is lauric acid of 12.126% in organic waste of food scraps while oleic acid is 7.249% (Majid *et al*. 2023).

Retention time and peak were carried out to obtain information about the type of fatty acids in the sample that was adjusted to the standard (Kusmiati 2018). According to Widianingrum *et al.* (2021) The highest essential fatty acid in maggot flour is lauric acid at 13.39%. Lauric acid can function as an immunomodulator and antimicrobial (Widianingrum *et al*. 2021). In Table 3 lauric acid was the highest in the P3 variation of 43.01% and the lowest in the P1 variation of 39.27%. Animal feed that has a high

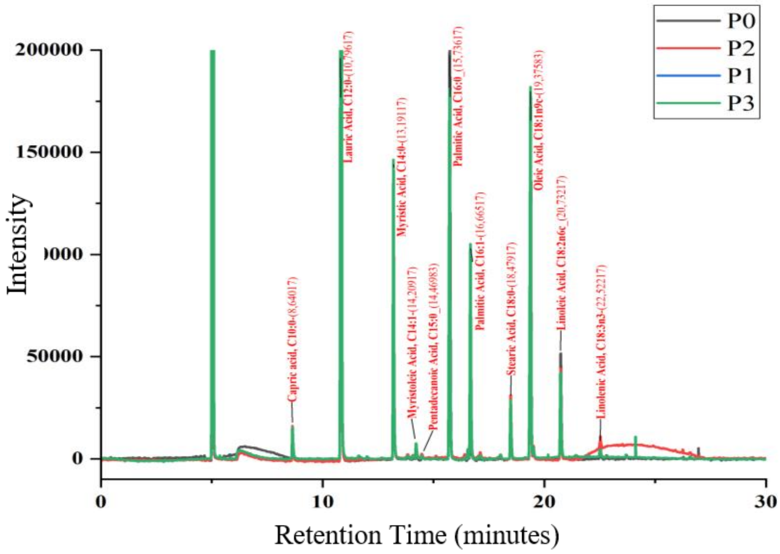


Table 3. Fatty acid content in maggot flour variations

No	Formula	Concentration (%)			
		P0	P1	P2	P3
1	Capric acid, C10:0	0,95	0,92	1,09	0,91
2	Lauric acid, C12:0	41,87	39,27	41,82	43,01
3	Myristic acid, C14:0	7,16	6,88	7,74	7,04
4	Myristoleic acid, C14:1	0,23	0,41	0,34	0,42
5	Pentadecanoic acid, C15:0	0,18	0,09	0,18	0,08
6	Palmitic acid, C16:0	8,00	6,89	6,29	6,44
7	Palmitoleic acid, C16:1	2,39	5,07	3,64	5,63
8	Stearic acid, C18:0	1,20	1,35	1,36	1,15
9	Oleic acid, C18:1n9c	5,97	5,97	5,26	5,66
10	Linoleic acid, C18:2n6c	3,27	2,60	2,87	2,45
11	Linolenic acid, C18:3n3	0,45	0,25	0,37	0,23
	Total AL (%)	71,68	69,70	70,97	73,02

content of lauric acid can function as an antioxidant (Sulistiyani *et al*. 2023). At P0 fatty acids palmitic acid, C16:0 higher than palmitic acid, C16:0 in P3. This shows that fatty acids with variations in feed from cow blood waste and date pulp can produce high levels of fatty acids. Maggots have a high content if given feed that has high nutrients as well. Linoleic acid or omega-6 was the highest in the P0 treatment at 3.27% and linolenic acid or omega-3 was the highest in the P0 treatment at 0,45%. The highest total fatty acids in P3 are 73.02%, P0 is 71.68%, P2 is 70.97% and finally in P1 is 69.70%.

According to Majid *et al.* (2023), the content of fatty acids that are dominated is lauric acid (12.126%) and oleic acid (7.249%) in household organic waste. According to Widianingrum *et al.* (2021) The highest essential fatty acid in maggot flour is lauric acid at 13.39%. Lauric acid can function as an immunomodulator and antimicrobial (Widianingrum *et al*. 2021).

Fatty acids based on chemical structure are divided into 3, namely the first saturated fatty acid (SFA), the second *monounsaturated fatty acid (*MUFA), the third polyunsaturated fatty acid (PUFA) and (Kusmiati 2018). SFA is a type of fatty acid that does not have double bonds on its carbon atoms, examples are palmitic acid and stearic acid, fatty acids are stable and do not oxidize easily. MUFA is a type of fatty acid with a double bond on the carbon chain, for example, oleic acid which functions to increase good cholesterol (HDL) in the body. PUFAs are fatty acids with more than one double bond in the carbon atomic chain, for example linoleic acid or omega-6 and linolenic acid or omega-3 which function for cell membrane formation, inflammation regulation, blood pressure regulation and blood clotting. Omega-3s support healthy brain and heart function.

CONCLUSION

The conclusion of this study is that maggot can decompose waste from date pulp and cow blood and maggot has a high protein and fat content so that it can be used as a raw material for feed.

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REFERENCES

Amandanisa, A. & Suryadarma, P. (2020). Kajian nutrisi dan budi daya maggot *(Hermentia illuciens* L.) sebagai alternatif pakan ikan di RT 02 Desa Purwasari, Kecamatan Dramaga, Kabupaten Bogor. *Jurnal Pusat Inovasi Masyarakat*. **2(5)**: 796-804.

Andika, W.D.M., Suardana, K.A.A. & Wahyudi, I. W. (2023). Kadar protein dan kadar air pada maggot (*Hermetia illucens*) dalam berbagai fase pertumbuhan. jurnal widya biologi. **14(01)**: 20-26.

Anggraini, D.P. (2022). Pemanfaatan limbah organik rumah tangga sebagai media hidup magot dan aplikasi magot sebagai pakan ternak. Skripsi. Fakultas Matematika dan Ilmu Pengetahuan Alam. Institut Pertanian Bogor. Bogor.

Association of Official Analytical Chemists. (2012). Official methods of analysis of AOAC International (20th ed.). AOAC International.

Badan Pusat Statistik. (2022). *Jumlah ternak yang dipotong di rumah potong hewan dan di luar rumah potong hewan yang dilaporkan menurut jenis ternak* (BPS No. 05210-1401-2014). Badan Pusat Statistik.

Badan Standardisasi Nasional. (2013). Standar Nasional Indonesia (SNI) 7783.1:2013 tentang pakan ayam ras pedaging (broiler). Badan Standardisasi Nasional.

Cicilia, A.P. & Susila, N. (2018). Potensi ampas tahu terhadap produksi maggot (*Hermetia illucens*) sebagai sumber protein pakan ikan. *Anterior Jurnal*. **18(1)**: 40-47.

Devi, S., Aslamsyah, S. & Karim, M. Y. (2023). Pengaruh pemberian multi asam amino terlarut terhadap percepatan metamorfosis benih udang vaname (*Litopenaeus vannamei* Boone, 1931). *Journal of Aquaculture Research & Development*. **1(1)**: 23-30.

Farida, T., Suhartono, S. & Kartika, I. R. (2023). Pengaruh variasi komposisi susu skim terhadap kadar asam amino pada yogurt sari jagung manis (*Zea mays* L. saccharata). *JRSKT-Jurnal Riset Sains dan Kimia Terapan*. **9(1)**: 33-44.

Sulistiyani, S., Firdaus, M.F., Sigiro, R.H., Nawangsih, A.A., Purwanto, U.M.S. & Andrianto, D. (2023). Potensi ekstrak maggot lalat tentara hitam *Hermetia illucens* (Linnaeus) dalam regulasi mekanisme antioksidan selular dan antiradang: Kajian in silico: *Jurnal Entomologi Indonesia*. **20(3)**: 223-239.

Fitro, R., Sudrajat, D. & Dihansih, E. (2015). The performance of broiler chickens fed commercial ration containing date press cake meal as a substitute for corn. *Jurnal Peternakan Nusantara.* **1(1)**: 1–8

Giffari, F.R., Susanto, A., Putra, R.E. & Permana, A. D. (2021). Periode hidup dan potensi reproduksi lalat tentara hitam (*Hermetia illucens*) Linnaeus (Diptera: Stratyomyidae) pada substrat kulit pisang. *Agrikultura*. **32(2)**: 158-167.

Jacoeb, A.M., Suptijah, P. & Kamila, R. (2014). Kandungan asam lemak, kolesterol, dan deskripsi jaringan daging belut segar dan rebus. *Jurnal Pengolahan Hasil Perikanan Indonesia*. **17(2)**: 136-143.

Jayanthi, S., Herika, H. & Rafiqah, R. (2017). Teknik budidaya black soldier fly (*Hermetia illucens*). *Jurnal Jeumpa*. **4(1)**: 58-66.

Kristianto, A.H. & Nadapdap, J.P. (2021). Dinamika sistem ekonomi sirkular berbasis masyarakat metode causal loop diagram kota Bengkayang. *Sebatik*. 25(1): 59-67.

Kusmiati, L. (2018). Profil asam lemak ikan beloso (*Saurida tumbil*). Skripsi. Teknologi Hasil Perairan. Fakultas Perikanan dan Ilmu Kelautan Institut Pertanian Bogor. Bogor.

Laila, D.N., Suharyati, S., Sutrisna, R. & Fathul, F. (2023). Pengaruh suplementasi tepung maggot black soldier fly (BSF) dalam ransum terhadap kandungan Low Density Lipoprorotein (LDL) dan High Density Lipoprorotein (HDL) darah ayam joper betina. *Jurnal Riset dan Inovasi Peternaka*n. **7(2)**: 164-170.

Lestari, D.P., Lumbessy, S.Y. & Setyowati, D.N.A. (2023). Analisis nutrisi dan asam amino tepung maggot. *Jurnal Inovasi Pendidikan dan Sains*. **4(3)**: 196-201.

Mabruroh, M., Praswati, A.N., Sina, H.K. & Pangaribowo, D.M. (2022). Pengolahan sampah organik melalui budidaya maggot Bsf organic waste processing through bsf maggot cultivation. *Jurnal EMPATI (Edukasi Masyarakat, Pengabdian Dan Bakti)*. **3(1)**: 34-37.

Majid, Z.A.N.M., Rahmawati, L., Novianti, D. & Rohmanna, N.A. (2023). Identify the amino acid and fat profiles of Black Soldier Fly larvae using meal feed and food waste. *Jurnal Teknologi Industri Pertanian*. **33(1)**: 41–49.

Marbun, F.G.I., Wiradimadja, R. & Hernaman, I. (2019). Pengaruh lama penyimpanan terhadap sifat fisik dedak padi. *Jurnal Ilmiah Peternakan Terpadu*. **6(3)**: 163–166.

Maslami, V., Noersidiq, A., Fahrullah, F., Purnamasari, D. K., Marlida, Y. & Nur, Y. S. (2023). Effect of glutamate supplementation in broiler chicken feed to the quality of carcass. *Jurnal Biologi Tropis*. **23(2)**: 398-405.

Maulana, N. & Fenita, Y. (2021). Pengaruh media tumbuh yang berbeda terhadap kandungan air, protein dan lemak maggot black soldier fly (*Hermetia illucens*). *Buletin Peternakan Tropis Bul. Pet. Trop*. **2(2)**: 150-157.

Monica, S.L.D. & Sa'diyah, K. (2023). Pengaruh rasio kadar tepung maggot terhadap kualitas pakan ikan lele. *Distilat: Jurnal Teknologi Separasi*. **9(4)**: 381-391.

Monita, L., Sutjahjo, S.H., Amin, A.A. & Fahmi, M.R. (2017). Pengolahan sampah organik perkotaan menggunakan larva Black Soldier Fly (*Hermetia illucens*). *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*. **7(3)**: 227-234.

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.

Neneng, L., Angga, S., Hartanti, R.E.D., Laba, F.Y., Gamaliel, G. & Pratama, D. S. (2023). Pengaruh komposisi bahan organik terhadap pertumbuhan maggot *Hermetia illucens* (Black Soldier Fly): The effect of organic matter composition on the growth of maggot *Hermetia illucens* (Black Soldier Fly). *BiosciED: Journal of Biological Science and Education*. **4(1)**: 11-20.

Nurhayati, L., Wulandari, L.M.C., Bellanov, A., Nurhayati, L., Wulandari, L. M. C., Bellanov, A., Dimas, R. & Novianti, N. (2022). Budidaya Maggot sebagai alternatif pakan ikan dan ternak ayam di Desa Balongbendo Sidoarjo. *SELAPARANG: Jurnal Pengabdian Masyarakat Berkemajuan*. **6(3)**: 1186-1193.

Pangestuti, E.K. & Darmawan, P. (2021). Analysis of ash contents in wheat flour by the gravimetric method: Analisis kadar abu dalam tepung terigu dengan metode gravimetri. *Jurnal Kimia dan Rekayasa*. **2(1)**: 16-21.

Ramadan, R.F., Wizna, W., Marlida, Y., Mirzah, M. & Supratman, H. (2021). Kandungan dan kualitas nutrisi campuran darah sapi dan limbah pertanian yang difermentasikan oleh *Bacillus amyloliquefaciens* sebagai pakan broiler. *Jurnal Peternakan*. **18(1)**: 77-86.

Saputra, I.P.G.A.J., Astawa, I.P.A. & Sudiastra, I.W. (2021). The effect of lysine and methionine amino acid on the percentage of carcass and commercial carcases pieces of broiler age of 32 day. *Jurnal Peternakan Tropika*. **9(3)**: 569—587.

Segara, R.O. (2015). Pemanfaatan media sisa hermetia illucens sebagai media cacing kalung (*Pheretima aspergillum*) yang menggunakan darah. Skripsi. Fakultas Peternakan. Institut Pertanian Bogor.

Sipahutar, Y.H., Daging, I.K., Sudrajat, A., Hadi, W., Masengi, S., Nainggolan, C. & Suharyanto. (2015). *Budidaya perairan*. Pusat Penelitian dan Pengabdian Masyarakat. Jakarta.

zRoseno. (2014). Pemanfaatan darah dari limbah RPH sebagai pakan tinggi protein dalam peningkatan biomassa cacing *Lumbricus rubellus*. Skripsi. Fakultas Peternakan. Institut Pertanian Bogor.

Syarif, R., Malik, A.J., Syahnur, K.N.F., Fitriyani, F., Riana, M.A. & Arifin, I. (2022). Pengenalan konsep ekonomi sirkular melalui webinar "Ekonomi sirkular: solusi masalah persampahan di indonesia". *Celebes Journal of Community Services*. **1(1)**: 28-35.

Umar, C.B.P. (2021). Penyuluhan tentang pentingnya peranan protein dan asam amino bagi tubuh di Desa Negeri Lima. *Jurnal Pengabdian Ilmu Kesehatan*. **1(3)**: 52-56.

Utomo, J.W., Sudjarwo, E., Hamiyanti, A.A. (2014). Pengaruh penambahan tepung darah pada pakan terhadap konsumsi pakan, pertambahan bobot badan, konversi pakan serta umur pertama kali bertelur burung puyuh. *Jurnal Ilmu-Ilmu Peternak*. **24(2)**: 41–48.

Widianingrum, D.C., Krismaputri, M.E. & Purnamasari, L. (2021). Potensi tepung magot black soldier fly (*Hermetia illucens*) sebagai agen antibakteri dan immunomodulator pakan ternak unggas secara in vitro. *Jurnal Sain Veteriner*. **39(2)**: 112-120.

Yuwita, R., Fitria, L. & Jumiati, J. (2022). Teknologi biokonversi sampah organik rumah makan dengan larva black soldier fly (Bsf). *Jurnal Teknologi Lingkungan Lahan Basah*. **10(2)**: 247-253.