Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

The Effect of Maggot Flour (Hermetia illucens) Supplementation on Protein Consumption, Energy Consumption, and Protein Efficiency Ratio in Balenggek Crowing Chickens

A.Kurnianto, S. A. Akbar, dan Rica Mega Sari.
Program Studi Peternakan Fakultas Pertanian Universitas Mahaputra Muhammad Yamin, Solok
Coresponden email : saa@gmail.com

ABSTRACT
This study aimed to determine the effect of maggot flour inclusion in rations on protein consumption, energy consumption, and the protein efficiency ratio of Balenggek Crowing Chickens. The research utilized an experimental method with a Completely Randomized Design comprising 4 treatments and 4 replications. The treatments were as follows: P0 (0% maggot flour), P1 (3% maggot flour), P2 (6% maggot flour), and P3 (9% maggot flour). The results showed that protein consumption ranged from 8.33 to 8.95 g/head/week, energy consumption ranged from 1391.9 to 1446.7 kcal/head/week, and the protein efficiency ratio ranged from 4.23% to 4.53%. It can be concluded that maggot flour supplementation up to a level of 9% had a significant effect ($p < 0.05$) on protein consumption but did not significantly affect ($p > 0.05$) energy consumption or the protein efficiency ratio of Balenggek Crowing Chickens.
Keywords: Balenggek Crowing Chickens, maggot flour (Hermetia illucens), protein consumption, energy consumption, protein efficiency ratio

INTRODUCTION

Local chickens are a significant commodity in Indonesia, representing a vital genetic resource that must be preserved. These chickens have unique characteristics and are well-adapted to their native environments. They are categorized into distinct groups, including kampung, pelung, kedu, and Balenggek crowing chickens.

The Balenggek crowing chicken is a valuable part of West Sumatra's genetic heritage and has been officially recognized as a distinct breed within Indonesia's livestock population. Native to West Sumatra, these chickens have primarily developed in Payung Sekaki District, Solok Regency. Known for their melodious, tiered crowing sounds, Balenggek crowing chickens are classified as "singing chickens," a unique trait that sets them apart—designated as the mascot of Solok Regency, the Balenggek crowing chicken holds cultural and economic significance. Its unique characteristics and the attention it receives underline its importance as a local livestock resource that requires ongoing conservation and development efforts

.

Gultom (2014) stated that high protein consumption positively influences protein deposition in meat and ensures sufficient amino acids in the body, allowing normal

Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

cellular metabolism. Factors influencing protein consumption include ration intake, body weight, environmental temperature, humidity, and the age of the chicken. Protein consumption is closely related to feed intake; therefore, good feed intake is indicative of adequate protein consumption. Wahju, (1997) stat that One method to evaluate protein quality is by measuring its biological value, which can be assessed through the protein efficiency ratio (PER). Factors affecting the protein efficiency ratio include weight gain, protein consumption, age, and environmental temperature.

Maggots are a type of larvae derived from black soldier flies. When the eggs of black soldier flies hatch into larvae, they become maggots. Not many people know that maggots are used by farmers to feed birds, chickens, fish, and catfish, replacing commercial pellets. Maggots are an alternative source of protein, containing a high protein level of about 40–50% (Muslim, et al 2019). This data serves as a primary consideration for utilizing maggots as a protein source in animal feed.

According to a survey conducted in West Sumatra, the selling price of maggots is approximately IDR 10,000 per kilogram. Various sources have reported the nutrient content of maggots derived from black soldier flies (*Hermetia illucens*), which includes: Energy 5,282 kcal GE/kg, Crude Protein 42.1%, Crude Fat 26%, Calcium 7.56%, and Phosphorus 0.9% (Newton et al., 1977; Arango Gutierrez et al., 2004; St-Hillaire et al., 2007; and Makkar et al., 2014).

The *Hermetia illucens* maggot is a potential organism that can be utilized as an organic waste decomposition agent and as a supplementary feed for chickens. The growth of maggots is highly dependent on the growth medium; for instance, *H. illucens* prefers media with a distinctive aroma, but not all media are suitable for egg-laying by *H. illucens* flies (Tomberlin et al., 2009).

Maggots, which contain 42% crude protein (CP), or the larvae of black soldier flies (*Hermetia illucens*), serve as an alternative feed that meets the requirements as a protein source. According to Murtidjo (2001), feed materials containing more than 19% crude protein are classified as protein-rich feed sources.

According to Rizal (2006), protein consumption significantly affects live weight gain. This is because live weight gain results from the synthesis of body proteins derived from the dietary protein consumed. The higher the protein content in the ration, the greater the protein intake. However, if the protein content is relatively the same, protein intake will also remain similar (Winedar et al., 2004).

Piliang and Al Haj (1991) stated that the protein efficiency ratio (PER) is defined as the weight gain (in grams) per amount of protein consumed (in grams).

Energy is the calorie or fuel (heat) essential for all metabolic processes and bodily functions in livestock. The energy from the ration utilized by the chicken's body comes from the digestion (breakdown) of starch (carbohydrates), fats, and proteins in the ration.

Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

Carbohydrates and proteins each provide 4 calories per gram, while fats provide 9 calories per gram (Scott et al., 1982; Iskandar and Zainuddin, 1984).

The success of poultry farming is highly dependent on feed availability. Based on research conducted by Musawwir et al. (2020), the inclusion of black soldier fly (BSF) maggot flour in broiler chicken feed up to 100% can increase weight gain. Adenji (2007) reported that maggot flour can replace up to 100% of groundnut cake (22% of the ration as fed) without any negative effects on the performance of 25-day-old broilers. Akpodiete and Inoni (2000) stated that maggot flour can replace 75% of fishmeal protein, with 15% maggot flour (6.75% in the ration) during the starter and finisher phases, resulting in better weight gain and similar carcass production (Teguia et al., 2002).

This study aims to determine the effect of using maggot flour in the ration on protein consumption, energy consumption, and protein efficiency ratio in Balenggek crowing chickens up to 9 weeks of age. The research hypothesis is that including 9% maggot flour (*Hermetia illucens*) in the ration can improve protein consumption, energy consumption, and the protein efficiency ratio in Balenggek crowing chickens up to 9 weeks of age.

MATERIALS AND METHODS

This study was conducted over 8 weeks, from October 20 to December 15, 2022, at the AKB livestock farming facility of the Animal Science Study Program, Faculty of Agriculture, located in Halaban Housing, Phase II, Block J No. 1, Kubung District, Solok Regency.

.

The study used 64 one-week-old Balenggek crowing chickens, obtained from a hatching process conducted independently using 140 eggs sourced from Tigo Lurah District, Solok Regency

Materials and Tools

The type of cage used in this study was a bamboo box cage with dimensions of 50 cm x 40 cm x 80 cm (length x width x height) per unit. The tools used in this study included: lamps, feeders and drinkers, a 3 kg digital scale, writing utensils, newspaper, water hoses, plastic, dry straw, and an oven. The material used was maggot flour, which was processed independently. The maggots were purchased from the Poultry Shop Intan PS in Solok City

.

Research Methodology

The research method used in this study was an experimental method with a Completely Randomized Design (CRD), consisting of 4

Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

treatments and 4 replications for each treatment. Each replication consisted of 4 Balenggek crowing chickens as the experimental unit. If the calculated F-value indicates significant results ($p < 0.05$), further analysis will be conducted using the Duncan's New Multiple Range Test (DNMRT).

The four treatments used in this study were:
P0 = 0% maggot flour supplementation
P1 = 3% maggot flour supplementation
P2 = 6% maggot flour supplementation
P3 = 9% maggot flour supplementation

Research Procedure

Cage Preparation

The cages used were battery cages, each consisting of separate units. Each unit was equipped with a feeder and drinker, and the cages were illuminated and heated with a 40-watt incandescent bulb. Before use, the cages were cleaned and sterilized using disinfectant. The equipment, such as the feeders and drinkers, was also sanitized to ensure they were free from disease-causing pathogens. Next, the feed and drinking water were prepared, and the lights were turned on to serve as heating for approximately 2 hours before the chickens arrived.

Maggot Flour Preparation

The maggots used in this study were obtained from Solok City. The process of making maggot flour is quite simple. The steps for preparing maggot flour are as follows:

1. The sack containing the maggots is first removed and placed into a bucket.
2. Hot water is then poured over the maggots to immobilize them.
3. Afterward, the maggots are left to air-dry until there is no remaining water dripping from them.
4. The maggots are then sun-dried for about 2 days until they are fully dry.
5. Once dry, the maggots are ground using a blender until they form a powder.

Ration

The feed ingredients used to formulate the rations in this study consisted of fine rice bran, corn, CP124 concentrate, maggot flour, and the addition of a premix. The ration was formulated according to the nutritional requirements of local chickens, using iso-energy and iso-protein methods. The composition of the feed ingredients and the formulation of the experimental rations, along with their nutritional content, are presented in Tables 3, 4, and 5.

Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

Table 3. Content of feed ingredients in research rations

No	Bahan Pakan	PK (%)	ME[d] (kkal/kg)	Metionin (%)[b]	Lisin (%)[b]	Ca (%)[b]	P (%)[b]
1	Corn[a]	8,50	3300	0,18	0,20	0,02	0,20
2	Rice bran[a]	12,0	2400	0,27	0,71	0,12	0,21
3	CP124c concentrate	32,0	2700	0,45	1,2	10,90	0,67
4	Coconut meal[b]	18,60	1410	1,79	5,07	0,10	0,60
5	Maggot flour[a]	32,33	4,498	0,66	2,71	0,39	0,15
6	Coconut oil[b]	0	8600	0	0	0	0

Note:
a. Results of laboratory analysis of Politani Payakumbuh (2022)
b. Sinurat (1999)
c. Charoen Pokphand (2013)
d. Calculated based on the formula: ME = $\frac{(\epsilon \text{ PK x } 4{,}4)+(\text{LK x } 8{,}7)+(\text{BETN x } 4)}{100} \text{ x } 1000$

Tabel 4. The Formula and Susunan Ransum dan Kandungan Nutrisi Ransum

The Content of Rations	P0	P1	P2	P3
Rice bran	38	40	37	35
Coconut meal	20	20	20	20
Corn	25	22	19	16
CP124 concentrate	14	14	17	19
Maggot flour	0	3	6	9
Coconut oil	2	0	0	0
Premix	1	1	1	1
	100	100	100	100

Tabel 5. Nutritional Content of Rations

ME (Kkal/Kg)	2778,40	2726,34	2723,58	2739,72
Crude Protein (%)	16,23	16,41	16,73	16,94
Calcium (%)	2,77	2,67	2,57	2,47
Phosfor (%)	0,44	0.44	0.44	0.45
Methionin (%)	1.28	1.24	1.20	1.16
Lisin (%)	1.39	1.39	1.05	0.87

Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

Management Process

After the cages are prepared, the chickens are placed inside the cages according to the treatment groups, with 4 chickens per unit, and are allowed to acclimate to the environment for about 1 hour. After that, drinking water and feed are provided. During the first week of management, the Balenggek crowing chickens were given commercial ration 311.

The experimental feeding treatment was carried out when the chickens reached 7 days old (second week). The feed was provided twice a day, in the morning and in the evening. The feed was mixed weekly according to the predetermined ration formulation for each treatment to prevent the feed from spoiling.

Measured Variables

The parameters measured in this study were:

1. Protein Consumption

   Protein consumption was calculated weekly using the formula from Tillman et al. (1991) as follows:

   Protein consumption (g) = feed consumption (g) × crude protein content of the ration (%)

2. Protein Efficiency Ratio (PER)

   The protein efficiency ratio is the average weight gain divided by the average protein consumption, calculated weekly. PER is computed using the formula (Tillman et al., 1991):

   PER = (Weight gain (g)) / (Protein consumption (g)) × 100%

3. Energy Consumption

   Energy consumption was calculated by multiplying feed consumption by the metabolic energy content of the feed (Setiawan et al., 2017).

   Energy consumption (g) = feed consumption (g) × energy content of feed (Kcal/Kg)

RESULTS AND DISCUSSION

The Effect of Maggot Flour Supplementation on Protein Consumption in Balenggek Crowing Chickens until 9 Weeks of Age

The results of the study showed the average protein consumption of Balenggek crowing chickens given maggot flour in the ration, as presented in Table 6.

Table 6. Average Protein Consumption of Balenggek Crowing Chickens Given Maggot Flour (g/Chicken/Week) during the Study

Perlakuan	Konsumsi protein
P0 (0 %)	8,33^{b}
P1 (3 %)	8,38^{b}
P2 (6 %)	8,60^{ab}
P3 (9 %)	8,95^{a}
SE	0,1313

Note: Superscripts in the same column indicate significant differences (P<0.05)

From Table 6, it can be observed that the average protein consumption ranged from 8.33 g/chicken/week to 8.95 g/chicken/week, with the highest consumption observed in P3 (9% maggot flour in the ration) and the lowest in P0 (no maggot flour supplementation). In Table 6, it is clear that the average protein consumption of Balenggek crowing chickens supplemented with maggot flour

showed a significant difference (P<0.05). This could be due to the supplementation of maggot flour up to the 9% level in the ration, which can increase protein consumption in the Balenggek crowing chickens. Protein consumption is also influenced by feed consumption. In this study, the feed consumption for the treatment with 9% maggot flour supplementation was numerically higher compared to the other treatments (52.80 g/chicken/day). This is consistent with the opinion of Tampubolon and Bintang (2012), who stated that protein intake is influenced by feed consumption. Wahju (1997) added that higher feed consumption is generally followed by greater protein consumption.

The follow-up test using DNMRT revealed that protein consumption in the P3 treatment (9% maggot flour) was higher than in the P2 (6% maggot flour), P1 (3% maggot flour), and P0 (0% maggot flour) treatments. This could be due to the higher protein content of the ration and feed consumption in the P3 treatment. The protein content of the ration in P3 was 16.94%, with an average feed consumption of 52.80 g/chicken/day (Appendix 2). This is in line with the statement of Parakkasi (1990), who noted that poultry will consume protein in proportion to the quantity of feed consumed.

The supplementation of 9% maggot flour (P3) was able to increase protein consumption in Balenggek crowing chickens to 8.95 g/chicken/day. This could be because the protein in maggot flour is effectively utilized by the Balenggek crowing chickens. This is in accordance with Fitasari et al. (2016), who stated that protein consumption is related to the protein content of the feed ingredients.

The Effect of Maggot Flour Supplementation on Energy Consumption in Balenggek Crowing Chickens until 9 Weeks of Age

From the results of the study, the average energy consumption of the Balenggek crowing chickens given maggot flour in the ration is shown in Table 7 below:

Table 7. Average Energy Consumption of Balenggek Crowing Chickens Given Maggot Flour (Kcal

Perlakuan	Konsumsi Energi
P0 (0 %)	1425,4
P1 (3 %)	1391,9
P2 (6 %)	1400,6
P3 (9 %)	1446,7
SE	21,727

Keterangan : Perlakuan menunjukan pengaruh berbeda tidak nyata (P>0,05)
ME/g/Chicken/Week) during the Study

From Table 7 above, it can be seen that the average energy consumption ranged from 1291.9 Kcal ME/g/chicken/week to 1446.7 Kcal ME/g/chicken/week. The highest energy consumption was observed in P3 with 9% maggot flour supplementation, and the lowest was in P1 with 3% maggot flour supplementation.

In Table 7, it is evident that the average energy consumption of Balenggek crowing chickens given maggot flour supplementation shows no significant difference (P>0.05). This may be due to the energy content of the rations in each treatment being almost the same (Table 5), which was already in line with the chickens' nutritional requirements. As a result, the feed consumption in each treatment is also similar.

Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

This aligns with North's (1992) statement that higher energy in the feed leads to lower feed consumption. When the energy content of the rations is the same, the feed consumption and energy consumption will also be the same, as energy consumption is calculated based on the feed consumption and energy content of the ration.

Energy consumption in this study ranged from 1291.9 Kcal ME/g/chicken/week to 1446.7 Kcal ME/g/chicken/week, or 184.56 Kcal ME/chicken/day to 206.67 Kcal ME/chicken/day. The results obtained in this study were higher than the findings of Candrawati (1999), who stated that the energy requirement for basal metabolism in native chickens is 103.96 Kcal ME/W0.75/day, while Asnawi (1997) found 127.75 Kcal ME/W0.75/day.

4.3. The Effect of Maggot Flour Supplementation on the Protein Efficiency Ratio of Balenggek Crowing Chickens Until 9 Weeks of Age

The results of the study showed the average protein efficiency ratio of the rations for Balenggek crowing chickens supplemented with maggot flour, which can be seen in Table 8 below:

Perlakuan	rasio Efesiensi protein
P0 (0 %)	4,24
P1 (3 %)	4,31
P2 (6 %)	4,53
P3 (9 %)	4,36
SE	0,1898

Note: The treatments showed no significant difference (P>0.05)

From Table 8 above, it can be seen that the average Protein Efficiency Ratio ranges from 4.24% to 4.53%. The highest energy consumption was found in P2 with 6% maggot flour, and the lowest in P0 with no maggot flour added.

In Table 8, it can be observed that the average protein efficiency ratio for Balenggek crowing chickens given the addition of maggot flour shows no significant difference (P>0.05). This means that the addition of maggot flour up to 9% in the ration had the same effect as the ration without maggot flour (0%) or the ration with the addition of commercial concentrates. Protein Efficiency Ratio (REP) showing no significant difference (P>0.05) is related to the results of protein consumption and body weight gain (P>0.05). Nuraini (2009) stated that the amount of feed consumed determines the amount of body weight gain produced. Furthermore, Mahfudz et al. (2010) mentioned that the protein efficiency ratio (REP) is influenced by two factors: body weight gain (BWG) and protein consumption. The nearly identical protein balance resulted in no significant difference in REP values, which is due to the high protein content consumed in the feed. According to Wahju (1997), REP is used to test the effectiveness of protein in the feed, and the effectiveness of protein used in the feed is low if the REP value decreases signif cantly. Previous studies have mentioned that REP and REE are influenced by the protein and energy content in the feed (Kaman, 2008; Ratriyanto, Indreswaari, and Sunan, 2014). According to Mahfudz (1997), REP indicates the use of protein for growth, which is obtained from the comparison of body weight gain to protein consumption. Therefore, the consumed protein is a factor in the protein efficiency ratio.

The difference in protein consumption is caused by the slightly different feed compositions. The similar consumption levels led to nearly identical body weight gains, and the body weight remaining similar at the end of the study led to no differences in the protein efficiency ratio. This aligns with the statement from Iqbal et al. (2012), who stated that protein consumption influences body weight gain, as the weight gain is derived from the synthesis of body protein from the consumed protein.

CONCLUSION

Based on the results of this study, it can be concluded that the addition of maggot meal up to 9% in the feed significantly (P<0.05) increases protein consumption. However, the addition of maggot meal does not have a significant effect (P>0.05) on the protein efficiency ratio (REP) and energy consumption in Ayam Kokok Balenggek

References

Akpodiete, O. J. ; Inoni, O. E., 2000. Economics of production of broiler chickens fed maggot meal as replacement for fish meal. Nigerian J. Anim. Prod., 27: 59-63

Anggorodi, R. 1995. Nutrisi Aneka Ternak Unggas. PT. Gramedia Pustaka Utama. Jakarta

Arango Gutierrez, G. P., R.A. Vergara Ruiz, H. Mejia Velez. 2004. Compositional, microbiological and protein digestibility analysis of larval meal of Hermetia illucens Diptera:Stratiomyidae)

Asnawi. 1997. Kinerja Pertumbuhan dan Fisiologi Ayam kampung dan Hasil Persilangannya dengan Ayam Ras Tipe Pedaging. Tesis. Program Pascasarjana IPB.Bogor.

Candrawati, D.P.M.A. 1999. Pendugaan Kebutuhan Energi dan Protein Ayam Kampung Umur 0-8 Minggu. Tesis.Institut Pertanian Bogor.

Fitasari, E., K. Reo, dan N. Niswi. 2016. Penggunaan kadar protein berbeda pada ayam kampung terhadap penampilan produksi dan kecernaan protein. Jurnal Ilmu-Ilmu Peternakan 26 (2): 73–83.

Gultom, S.M., Supratman, R.D.H., Abun., 2014. Pengaruh Imbangan Energy dan Protein Ransum Terhadap Bobot Karkas Dan Bobot Lemak Abdominal Ayam Broiler Umur 3-5 Minggu.E-Journal Mahasiswa dan Pascasarjana Universitas Padjajaran Bandung. Vol.1 (1).

Iqbal, F., Atmomarsono, U. dan Muryani, R. 2012. Pengaruh Berbagai Frekuensi Pemberian Pakan dan Pembatasan Pakan terhadap Efisiensi Penggunaan Protein Ayam Broiler. *Animal Agricultural 1 no 2: 4-5.*

Iskandar, S. dan D. Zainuddin. 1984. Energi metabolis, kalori atau joule? Wartazoa 1(4): 55-67

Mahfudz, L.D., K. Hayashi, A.Ohtsuka and Y. Tomita. 1997 . Purification of Unidentified Growth Promoting Factor for Broiler Chicken from Shochu Distillery by-product. The Indonesian Student Association in Japan. Proc.

Vol 03 (01) Tahun 2024, Page 160-169
P- ISSN: 30248442
E-ISSN: 3025-3748
Available online at: http://ojs.ummy.ac.id/index.php/janaps

Annual Meeting and Seminar. Agust 1997. Tokyo.

Makkar, H.P.S., G. Tran, V. Heuzé, and P. Ankers. 2014. State-of-the-art on use of insects as animal feed. Animal Feed Science and Technology, Vol. 197:1-33. Diakses pada tanggal 12 Juni 2015

Murtidjo, B. A. 2001. Pedoman Pakan Ikan. Yogyakarta: Kanisius.

Muslim, Dudung Abdul. 2019. Budidaya Maggot Mengenai Morfologi dan Siklus Hidup BSF (lalat tantara hitam). (https://omkicau.com/2019/01/10/budidaya-maggot-mengenal-morfologi-dan-siklus-hidup-bsf-lalat-tentara-hitam/). Diakses pada [18 Januari 2024]

Newton, G. L., C.V. Booram, R.W. Barker, and O.M. Hale. 1977. Dried Hermetia illucens larvae meal as a supplement for swine. J. Anim. Sci. 44-3: 395-400. Diakses pada tanggal 14 November 2014. NRC, 1994. Nutrien R.

Nuraini. 2009. Penformans broiler dengan ransum mengandung campuran ampas sagu dan ampas tahu yang difermentasi dengan *Neurospora Crassa*. *Media Peternakan 32 No3:3-5.*

Parakkasi, A. 1983. Ilmu Gizi dan Makanan Ternak Monogastrik. Bandung: Angkasa.

Ratriyanto, A., Indreswari, R., & Sunarto. (2014). Effects of protein levels and supplementation of methyl group donor on nutrient digestibility and performance of broiler chickens in the tropics. International Journal of Poultry Science, 13(10) : 575–581.

Rizal, Y. 2006. Ilmu Nutrien Unggas. Andalas University Press. Padang

Scott, M. L., C. Nesheim and R.J. Young. 1982. Nutrition of Chicken, 3nd Ed. M.L. Scott and Associates, Ithaca, Newyork.

Sinurat, A.P. 1999. Penggunaan bahan pakan lokal dalam pembuatan pakan ayam buras..

St-Hilaire, S., K. Cranfill, M.A. McGuire, E.E. Mosley, J.K. Tomberlin, L. Newton, W. Sealey, C. Sheppard, and S. Irving. 2007. Fish offal recycling by the black soldier fly produces a foodstuff high in omega-3 fatty acids. J. World Aquacult. Soc. 38 : 309-313. Diakses pada tanggal 7 Juli 2024

Tampubolon dan P. P Bintang, 2012. Pengaruh imbangan energi dan protein ransum terhadap energi metabolis dan retensi nitrogen ayam broiler. Jurnal Fakultas Peternakan Universitar Padjadjaran, Bandung. Vol. 1 No. 1 Tahun 2012..

Teguia, A., M. Mpoame, J.A. Okourou Mba. 2002. The production performance of broiler. birds as affected by the replacement of fish meal by maggot meal in the starter and finisher diets. Tropicultura

Tomberlin JK, Adler PH, Myers HM. 2009. Development of the Black Soldier Fly (Diptera: Stratiomyidae) in Relation to Temperature. Enviromental Entomol. 38:930-934.

Wahju, J. 1997.Ilmu Nutrisi Ternak. Gajah Mada University Press, Yogyakarta

Winedar, H., Listyawati, S dan Sutarno. 2004. Daya Cerna Protein Pakan, Kandungan Protein Daging, dan Pertambahan Berat Badan Ayam Broiler setelah Pemberian Pakan yang Difermentasi dengan Effective (EM4) Jurnal Bioteknologi. 2(1):14-19.