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The Effect of Tofu and Fermented Coconut Dregs on Body Weight Gain and Cocoon Production of African Worms *(Eudrilus eugeniae)*

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Abstract: Earthworms are currently in great demand for industrial and pharmaceutical needs, so it is necessary to increase the productivity of worms by breeders. This study aims to determine the effect of giving tofu pulp and coconut pulp on body weight gain and cocoon production of *Eudrilus eugeniae* worms. The object of this research is *Eudrilus eugeniae* which has been clit. This study was divided into two groups, namely control and treatment with six replications each so that there were 24th experimental units. In the control and treatment groups, the researchers included 10th *Eudrilus eugeniae* worms in each treatment in the form of a combination of tofu pulp and coconut pulp. Parameters observed were worm biomass and several cocoons. The data on the weight gain of the worms were analyzed using One Way Anova and then continued with the Duncan Multiple Test (DMRT) with significantly different results. Furthermore, data on the number of worm cocoons were analyzed using the Kruskal Wallis test. The results showed that the provision of tofu and coconut pulp had a significant effect on body weight gain and the production of *Eudrilus eugeniae cocoons.* There is an effect of giving tofu dregs and fermented coconut pulp on the increase in body mass of *Eudrilus eugeniae* worms as a conclusion.

Keywords: *Eudrilus eugeniae*, tofu pulp, cocoon production

Introduction

African worm (*Eudrilus eugeniae*) is an animal that has many benefits for humans. The cultivation of worms has not been carried out by many breeders in Indonesia, even though worms have great potential as livestock and have a very high selling value (Sahribulan *et al*., 2019).

People generally recognize earthworms and find them in rice fields or plantations that have moist soil. Eudrilus eugeniae is a worm originating from Africa that has been bred in various parts of the world, one of which is Indonesia. African worms are one type of earthworm that can function as decomposers of organic matter (decomposers) so that they can decompose organic compounds into simpler elements needed by other living things (Saraswati *et al*., 2009). Several factors that affect the growth and development of earthworms include media temperature, type of feed, pH, light, and oxygen availability (Palungkun, 2010).

Feed and media are the things that most influence the growth and development of Eudrilus euginiae worms. Earthworms feed and maintenance media are a collection of fermented organic materials that can be utilized by earthworms to grow and reproduce optimally. The live media can also be a source of food for earthworms (Yusuf, 2019).

Organic matter used for maintenance in earthworm cultivation can be found in a variety of media. One of them is rice bran media. Rice bran contains fat, sodium, potassium, carbohydrates, protein, vitamins, and minerals. Worms can naturally live in animal manure and moist rice bran (Arwanto, 2017). Other organic materials that can be used for the cultivation of

earthworms are tofu pulp and coconut pulp. Dregs are waste from the manufacture of a product that is usually not used. Tofu dregs contain protein, fat, water which can be used for animal feed (Purkan, 2017). Coconut pulp itself is usually not used when the coconut milk has been taken, even though coconut pulp still contains fibre, vitamins, fat, carbohydrates, and high protein levels so it is very useful as animal feed (Hidayati, 2011).

Earthworm cultivation often encounters obstacles in determining suitable media and feed. If the media and feed are not by their physiological needs, the earthworms will try to get out of the media tub. The character of this type of media and feed can affect the growth and productivity of worms. Research that has been carried out by Apriani (2016) uses the media of sawdust coconut stems and manila grass which can be used as a medium for the growth and reproduction of earthworms. Then Rahmawati (2016) used the media of sawdust from palm tree trunks and manila grass waste as a medium for breeding earthworms. Media from coconut tree sawdust, manila grass, and palm tree trunk sawdust are difficult to obtain. The innovation of this research uses a combination of media materials consisting of soil, rice bran, and chicken manure. The three compositions are predicted to not meet the nutritional needs for growth and the development of worms so that tofu and coconut pulp are needed as feed.

Based on the explanation above, this study aims to determine the effect of giving tofu pulp and fermented coconut pulp as feed with different amounts of composition on body weight gain and earthworm (*Eudrilus eugeniae*) cocoon production.

Materials and Methods

This type of research uses a completely randomized design. Observations on the addition of body mass and the amount of worm cocoon production were carried out after three weeks of observation. Worms were obtained from local breeders in the Garung, Wonosobo regency. This study was divided into two groups, namely the treatment group and the control group with six replications each so that there were 24 experimental units with a total of 240 worms used.

The tools used include plastic container, research table, documentation camera, measuring cup, stationery, stirring shovel, winnowing, thermometer, ph meter, a digital scale with an accuracy of 0.1 – 0.001 gram, sprayer, soil meter. While the materials needed in this study were: tofu pulp, coconut pulp, soil, rice bran, chicken manure, sugar, water, EM4, African worm (*Eudrilus eugeniae)*.

Control and treatment groups, 10 Eudrilus eugeniae worms were used in each treatment in the form of a combination of tofu pulp and coconut pulp as follows: a mixture of soil, rice bran, and chicken manure 100% (A), a mixture of soil, rice bran, and manure. chicken 50% + coconut pulp 50% (B), a mixture of soil, rice bran, and chicken manure 50% + tofu waste 50% (C), a mixture of soil, rice bran, and chicken manure 33.3% + tofu pulp 33 ,3% + coconut pulp 33,3% (D).

Implementation Procedure

The procedure for experimenting included preparation for drying and fermenting feed using EM4. Furthermore, the selection of Eudrilus eugeniae worm seeds as many as 240 adults who have matured (the clitellum is visible) and each individual weighs 0.8 g – 1.5 g. Earthworm cultivation will be carried out by inserting 10 adult worms into a plastic container containing growth media. Furthermore, maintenance will be carried out by spraying water once a day using a sprayer and being protected from pest attacks. Checking the number of worms, measuring humidity, temperature, and pH of the growing media were carried out every day to adjust the needs of the worms so that the worms would not come out of the treatment tub. The research parameters observed were the increase in body mass and the amount of cocoon production of *Eudrilus eugeniae worms.*

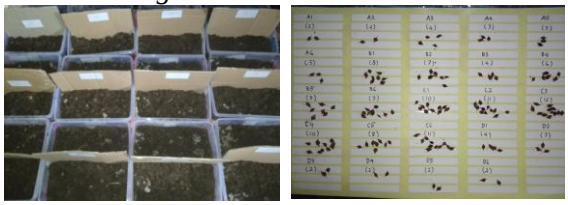

Figure 1. Growing media and cocoons *Eudrilus eugeinae*

Data were collected at the beginning before treatment and at the end of the study to determine the effect of feed on body weight and worm cocoon production. The increase in body mass of African worms was obtained from the initial body mass before treatment minus the final body mass after treatment. The production of worm cocoons was seen from the number of worms produced in each treatment unit. Counting the number of cocoons was carried out on day 21 after treatment with the hand sorting method.

Data Analysis Technique

The analysis used on the worm mass data, namely the normality test and homogeneity test, if the data is normally distributed and homogeneous (parametric data) then proceed with One Way ANOVA analysis to determine whether there is an effect of differences in the composition of media and feed on the growth of worms. If there is an effect, then the Duncan Multiple Range Test is carried out at a 5% level. Furthermore, data on the number of worm cocoons were analyzed using the Kruskal Wallis test.

Results and Discussion

Increase in Body Mass of Worm *Eudrilus eugeniae*

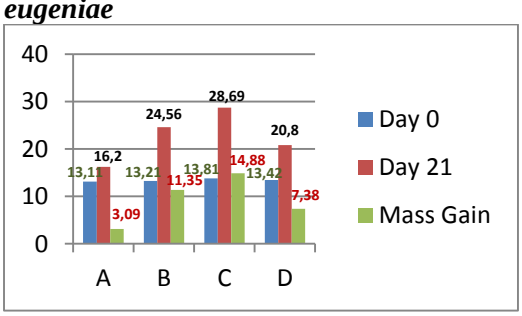

Figure 2. Graph of Average Weight Gain of Body Mass of Worm *Eudrilus eugeniae*

Based on Figure 2, the highest average increase in body mass of Eudrilus eugeniae worms from the six replicates was in combination C (treatment 2) of 14.88 grams. Meanwhile, the lowest average weight gain of Eudrilus eugeniae worms occurred in group A or control at 3.09 grams.

Worm Cocoon Production *Eudrillus eugeniae*

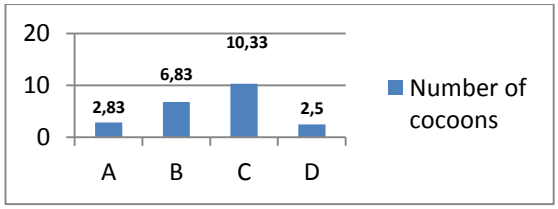

Figure 3. Graph of Average Cocoon Production of Worm *Eudrillus eugeniae*

Based on Figure 3, the highest average cocoon production from the six replicates in all groups were worms in growing media C (a mixture of soil, fermented rice bran, and chicken manure 50% + 50% tofu dregs) with an average of 10, 33 grains and the lowest average cocoon production was growth medium D (a mixture of soil, fermented rice bran, and chicken manure 33.3% + 33.3% tofu pulp + 33.3% coconut pulp) with an average of 2,5 items.

The Effect of Combination of Tofu Dregs and Coconut Fruit Dregs on the Increase in Body Weight of African Worms (*Eudrilus eugeniae*)

Based on the analysis of the weight gain of African worms using the one-way Anova test, the following results were obtained.

Table 1. Results of One Way ANOVA Test for *Eudrilus eugeniae* Mass Weight Gain

ANOVA

Body Weight Gain

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	465,757	3	155,252	658,815	,000
Within Groups	4,713	20	,236		
Total	470,471	23			

The table above shows the significant effect of feeding tofu and coconut pulp on the increase in body mass of Eudrilus eugeniae worms ($P < 0.05$), this is indicated by a significance value of 0.000. This value is smaller than 0.05, which means that different feeding and combinations of feeds have a significant effect on the growth of worms with body mass indicators. The difference in

mean between treatment groups was further tested by the Duncan Multiple Range Test with a level of 5%. Based on data analysis, the results are shown in Table 2.

Table 2. Results of the DMRT Follow-up Test on the Increase in Body Mass of Worms *Eudrilus eugeniae*

Body Weight Gain
Duncan[a]

		Subset for alpha = 0.05			
Group	N	1	2	3	4
A	6	3,0883			
D	6		7,3767		
B	6			11,3567	
C	6				14,8833
Sig.		1,000	1,000	1,000	1,000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 6,000.

Based on the results of the DMRT follow-up test with a level of 5%, it was found that each group, both A (control), D (treatment 3), B (treatment 1), and C (treatment 2), had a significant effect on the increase in body mass of the Eudrilus eugeniae worm. Each treatment group in this study had a very significant difference. This difference occurs because the provision of different types and combinations of feed affects the number of nutrients in the growing media so that the increase in body mass differs between groups, both A, B, C, and D.

Media is a habitat for worms that must be regulated and determined in such away (Palungkun, 2010). Worm rearing media is the main component as a food source for worms so that apart from being a place to live, worms can obtain the source of nutrition needed to increase the body mass of worms. So in this study, a mixture of soil, fermented rice bran, and chicken manure was used as a growing medium.

Land that is used for all groups in this study is humus soil with a dark layer, has a high absorption of water, formed from rotting plants, categorized as very fertile and loose soil (Rahmaniah *et al*., 2021). So that the worms do not come out of the growing medium, it is necessary to mix fermented rice bran and chicken manure as a source of nutrition for worms. Fermented rice bran has a nutritional content of 10.93% crude protein, 15.07% crude fibre, and 3275.37 kcal/kg gross energy content (Wibawa *et al*., 2015) while chicken manure contains 12% protein, 0.30% fat, 29% carbohydrates, and 57.55% ash (Suminto & Hutabarat, 2014).

Apart from media, Supplementary feeding is the main thing that must be considered. according to Sugiantoro (2012), one worm can consume two to three times its body mass on organic matter in just 24 hours. In this study, the treatment of feeding tofu dregs and/or fermented coconut pulp was carried out to survive for 21 days and to avoid the decay process that interfered with the growth and development of worms. Tofu pulp contains 23.67% crude protein, 26.92% carbohydrates, 20.26% crude fiber, 2.72% crude fat, 3.69% ash, 11.19% water content, 1.10% Ca, P 0.89%, and its metabolized energy is 2.830 kcal/kg (Witariadi *et al*., 2016) Meanwhile, coconut pulp contains 18% carbohydrates, 79% fat, and 3% protein with 354 calories per 100 grams (Subagio, 2011).

If comparing data on the increase in body mass of worms from the six replications in all groups, the average results showed that the highest mass increase of *Eudrilus eugeniae* worms was obtained by media containing a lot of tofu waste as feed. This is because the combination of media and feed with the highest nutrition is owned by growing media C (treatment 2), namely with a combination of media in the form of a mixture of soil, fermented rice bran, and 50% chicken manure + 50% tofu dregs feed. Tofu dregs in this treatment contained the most protein compared to fermented rice bran, chicken manure, and coconut pulp. Thus, the worms get an adequate source of protein as a growth substance (Yulisman *et al*., 2012). This is following research conducted by Brata *et al* (2017) which stated that giving tofu dregs as a feed mixture affected the growth of earthworms.

According to Yunitasari *et al* (2016), In addition, to feeding, factors that also affect the growth of worms are humidity, temperature, and pH. The environmental conditions in this study did not come from external factors, but came from the composition of the media and feed in each treatment group. The provision of feed and media with different compositions resulted in different environmental conditions. The results of the average humidity, temperature, and pH calculated from the six replications on growth media A (control), B (treatment 1), C (treatment 2), and D (treatment 3) can be seen in Figures 4, 5, and 6 followings.

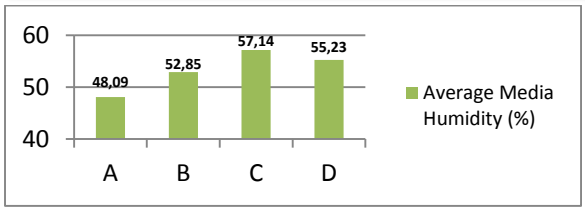

Figure 4. Graph of Average Humidity of Growing Media

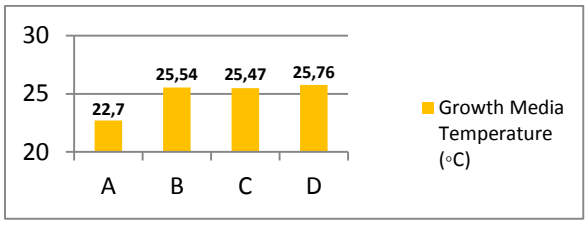

Figure 5. Graph of Average Growing Media Temperature

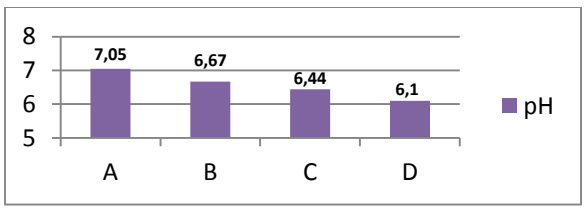

Figure 6. Graph of Average pH of Growing Media

The highest increase in body mass of worms was in growth medium C (treatment 2). Data from day 1 to day 21 ranged from 50% to 60%. This is under the opinion of Rukmana (1999), which states that the ideal humidity for worm growth is 42 to 60%. In terms of temperature measurements, the C growing medium (treatment 2) from day 1 to day 21 ranged from 25°C to 26.9°C. This is by the opinion of Brata *et al*., (2017) Brata *et al*., (2017) which states that the optimum temperature for the growth of worms is 21°C to 29°C. Meanwhile, the pH of the growing medium C (treatment 2) ranged from 6.3 to 6.6. according to Hanafiah *et al*. (2005), the best earthworm growth is in a place that has a pH of around 6 to 7.2. However, worms can still survive at pH 4 if the media has organic sources that can meet the needs of worms.

The increase in body mass of worms in growth medium B (treatment 1) with a media composition of soil mixture, fermented rice bran, and 50% chicken manure + 50% fermented coconut pulp was 13.21 grams, which means it is second after growing media C (treatment). 2). This condition arises because the nutrient content in growing media C (treatment 2) is more than the nutrient content available in growing media B (treatment 1). The nutritional content has a significant effect on the growth of worms. When viewed from the environmental conditions in media B (treatment 1), the following results were obtained: the temperature of the media ranged from 24.1°C to 27.2°C, the pH of the media ranged from 6.5 to 6.9, and the humidity of the media ranged from 50% to 55%. This means that, both in terms of temperature, pH, and humidity, the growth medium B (treatment 1) was good.

Media growing D (treatment 3) with the composition of growing media mixed with soil, fermented rice bran, and 33.3% chicken manure + 33.3% tofu pulp + 33.3% coconut pulp got third place after C growing media (treatment 2) and B (treatment 1) in terms of increasing the body mass of the *Eudrilus eugeniae* worm which was 7.38 grams. If viewed from the availability of nutrients, growth media D (treatment 3) should contain nutrients, especially protein, which is better than growth media B (treatment 1), but this condition may occur due to the aeration factor of media B (mixed soil media, fermented rice bran, and 50% chicken manure) which is more friable so that the availability of O2 is more optimal than the D growing media which uses a mixture of soil, fermented rice, and chicken manure 33, 3% with the addition of tofu and coconut pulp, a total of 66.6%. From the environmental condition data, media D was also by the habitat of worms with the following data obtained: media temperature ranged from 26.4°C to 27.2°C, media pH ranged from 6 to 6.2, and media humidity was 50 to 60%.

Based on the results of the study, the lowest body mass gain of *Eudrilus eugeniae* worms was found in the control group. In growth medium A (control) the results of environmental conditions were obtained by measuring every day from day 1 to day 21 as follows: growing media temperature ranged from 22.1°C to 26.1°C, media pH ranged from 7 to 7.2, and the humidity of the media by 40% to 60%. When viewed from environmental conditions, the growth medium A (control) was appropriate, but the nutritional content was not optimal so that the lowest increase in body mass of worms was obtained when compared to groups B (treatment 1), C (treatment 2), and D (treatment 3).

The Effect of Combination of Tofu Dregs and Coconut Fruit Dregs on the Production of Worm Cocoons *Eudrilus eugeniae*

Based on table 3, the results of the data

analysis show a significance value of 0.000232. This significant value is smaller than 0.05 so that feeding with different types and combinations affects the number of cocoons produced by worms.

Table 3. Kruskall Wallis Test Results Number of Worm Cocoons *Eudrilus eugeniae*

Test Statisics [a,b]

	Number of Worm Cocoons
Chi-Square	19,342
df	3
Asymp. Sig.	0,000232

a. Kruskal Wallis Test
b. Grouping Variable: Group

Adult worms that have clitellum will exchange spermatozoid, after copulation occurs the next process is the formation of the cocoon sheath. Each egg cell that has received sperm from the posterior of the body will move towards the mouth where the worm will spit out the cocoon and its sheath containing the egg. Each cocoon contains from 1 to 13 eggs. The development of eggs in the cocoon occurs after 14 to 21 days which will then hatch into juveniles (Rukmana, 1999).

The cocoons produce finely woven fibrils. In Eudrilus eugeniae, the cocoons are brown, in contrast to earthworms in general, which are round and yellowish-green. The cocoon shape of this African worm is unique because it is bulging in the middle and pointed at the corners. The mother worm will place the cocoons on the soil surface if the habitat has high humidity, whereas if the growing media is dry, the cocoons will be placed in the deepest place so that juvenile development in the cocoons is not disturbed and protected (Brata, 2003).

Parameter The cocoon production used in this study was the number of cocoons produced by worms after 21 days observations to ensure the worms have copulated. Determination of 21 days is considered appropriate because each worm can produce one cocoon within 7-14 days after copulation, and juveniles will come out of the cocoon after two to three weeks if the habitat is suitable. The cocoons were recorded after 21 days of observation to avoid a reduction in the number of cocoons due to the decay process after the juveniles leave the cocoons (Putra *et al*., 2018). The number of cocoons in each treatment unit can be seen in Figure 7.

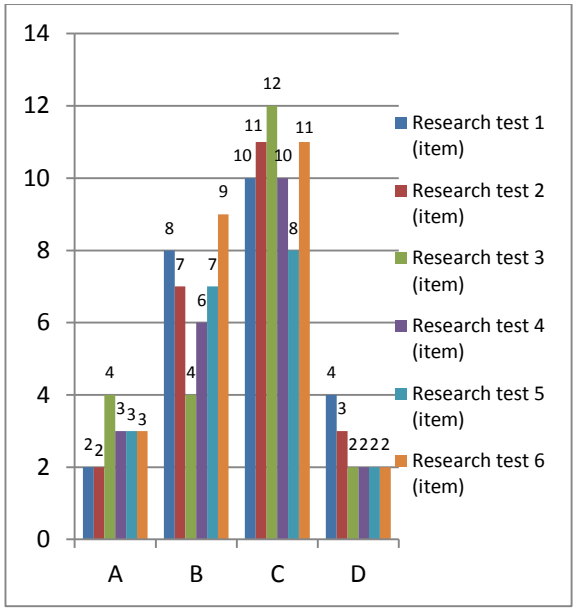

Figure 7. Graph of the number of cocoons of *Eudrilus eugeniae*

Based on Figure 7, it is known that the highest amount of cocoon production was worms in growing media C (treatment 2) with a mixed media composition of the soil, fermented rice bran, and chicken manure by 50% + 50% fermented tofu dregs. This is because the nutrient content in C growing media is the highest and most complete compared to other growing media, besides that C growing media also has good environmental conditions. Meanwhile, the lowest cocoon production was obtained by growing media D (treatment 3) with a mixture of soil, fermented rice bran, 33.3% chicken manure + 33.3% fermented tofu dregs + 33.3% tofu dregs. This was because the aeration in the D growing medium was the worst among the others, although in terms of nutrient content it was better than the control group. This is explained by Apriani (2016) which stated that the environmental conditions of the growing media greatly affected the production of earthworm cocoons.

Giving tofu dregs and coconut pulp also indirectly changes the environmental conditions of the media where the worms grow. Excessive feeding was also not good for the reproduction of worms. This can be seen in growing media D (treatment 3) which uses 66.6% of feed (33.3% tofu pulp + 33.3% coconut pulp) and a mixture of soil media, fermented rice bran, and 33.3% chicken

manure. . Although feed can be used as a growing medium for worms, loose soil media has a significant positive effect on the reproduction of *Eudrilus eugeniae* worms.

Conclusion

Based on research objectives and results, it can be concluded that there is an effect of giving tofu dregs and fermented coconut pulp on the increase in body mass of Eudrilus eugeniae worms. The best growing media in this study was unit C (treatment 2) with a combination of soil mixture media, fermented rice bran, and 50% chicken manure + 50% fermented tofu dregs. In addition, there was an effect of giving tofu dregs and fermented coconut pulp on the cocoon production of Eudrilus eugeniae worms.

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References

Apriani, L. (2016). *Pengaruh Kombinasi Media Serbuk Gergaji Batang Pohon Kelapa (Cocos nucifera, L.) dan Rumput Manila (Zoysia matrella) terhadap Pertumbuhan dan Produksi Kokon Cacing Tanah (Eudrilus eugeniae)*. Skripsi. Yogyakarta: Universitas Negeri Yogyakarta. http://eprints.uny.ac.id/id/eprint/49437

Arwanto, L. (2017). Pertumbuhan Populasi Cacing Renik (*Panagrellus redivivus*) Pada Media Yang Berbeda Growth Of Panagrellus redivivus. *JURNAL MINA SAINS*, *1*(1), 34–39. https://doi.org/10.30997/jms.v1i1.16

Brata, B. (2003). *Pertumbuhan, Perkembangbiakan dan Kualitas Beberapa Spesies Cacing Tanah Pada Kondisi Lingkungan yang Berbeda*. Disertasi. Program Pasca Sarjana. Bogor: Institut Pertanian Bogor.

Brata, B., Juliansyah, A., & Zain, B. (2017). Pengaruh Pemberian Ampas Tahu sebagai Campuran Pakan terhadap Pertumbuhan Cacing Tanah Pheretima sp. *Jurnal Sain Peternakan Indonesia*, *12*(3), 277–289. https://doi.org/10.31186/jspi.id.12.3.277-289

Hanafiah, K. A., Napoleon, N., & Ghofar. (2005). *Biologi Tanah*. Jakarta: Raja Grafindo Persada. ISBN: 979-3654-40-6

Hidayati, S. G. (2011). Pengolahan Ampas Kelapa Dengan Mikroba Lokal Sebagai Bahan Pakan Ternak Unggas Alternatif di Sumatera Barat. *Jurnal Embrio*, *1*(4), 26–36.http://ojs.unitas-pdg.ac.id/index.php/embrio/article/view/125>

Palungkun, R. (2010). *Usaha Ternak Cacing Tanah Lumbricus rubellus*. Jakarta: Penebar Swadaya. ISBN: 9789790024335

Purkan, P. (2017). Lactobacillus bulgaricus Sebagai Probiotik Guna Peningkatan Kualitas Ampas Tahu Untuk Pakan Cacing Tanah. *Jurnal Kimia Riset*, *2*(1), 1. https://doi.org/10.20473/jkr.v2i1.3688

Putra, S. E., Johan, I., & Hasby, M. (2018). Pengaruh Pencampuran Kotoran Ternak Sebagai Media Kultur Terhadap Pertambahan Populasi Cacing Tanah (Lumbricus rubellus). *Dinamika Pertanian*, *XXXIV* (April), 75–80. https://doi.org/10.25299/dp.2018.vol34(1).4086

Rahmaniah, R., Zulfida, I., & Oesman R. (2021). Karakteristik Status Kesuburan Tanah Pada Lahan Pekarangan dan Lahan Usahan Tani di Kecamatan Rantau Selatan. *Journal Liaison Academia and Society*, *1*(1), 9–18. http://j-las.lemkomindo.org/index.php/J-LAS/issue/view/J-LAS/showToc

Rahmawati, F. (2016). *Pengaruh Kombinasi Media Serbuk Gergaji Batang Pohon Aren (Arenga pinnata, Merr) dan Limbah Rumput Manila (Zoysia martella) terhadap Pertumbuhan dan Produksi Kokon Cacing Afrika (Eudrilus eugineae)*. Universitas NegeriYogyakarta. http://eprints.uny.ac.id/id/eprint/48897

Rukmana, R. (1999). *Budi Daya Cacing Tanah*. Yogyakarta: Kanisius. ISBN: 9796724545

Sahribulan, S., Rauf H, D., & Hasyim, Z. (2019). Efek Ekstrak Kasar Cacing Tanah

Pheretima sp. terhadap Morfologi Sel Bakteri Salmonella enteritidis. *Bionature*, *19*(2),152–162. https://doi.org/10.35580/bionature.v19i2.9733

Saraswati, R., Santosa, E., & Yuniarti, E. (2009). Organisme Perombak Bahan Organik. *Organic and Biofertilizers*, *1*(2), 211–230. http://balittanah.litbang.pertanian.go.id/ind/dokumentasi/lainnya/10organisme%20perombak.pdf

Subagio, A. (2011). Potensi Daging Buah Kelapa Sebagai Bahan Baku Pangan Bernilai. *Jurnal Pangan*, *20*(1), 15–26. https://doi.org/10.33964/jp.v20i1.4

Sugiantoro, A. (2012). *Harta Karun dari Cacing Tanah Budidaya Cacing Tanah untuk Obat Alternatif*. Yogyakarta: DAFA Publishing. ISBN: 9786029946123

Suminto, M., & Hutabarat, J. (2014). Pengaruh Penambahan Kotoran Ayam, Silase Ikan Rucah dan Tepung Tapioka dalam Media Kultur Terhadap Biomassa, Populasi, dan Kandungan Nutrisi Cacing Sutera (Tubifex sp.). *Journal of Aquaculture Management and Technology*, *3*(4), 151–157. https://www.neliti.com/publications/93130/pengaruh-penambahan-kotoran-ayam-silase-ikan-rucah-dan-tepung-tapioka-dalam-medi

Wibawa, A. A. P., Wirawan, I. W., & Partama, I. B. (2015). Peningkatan Nilai Nutrisi Dedak Padi Sebagai Pakan Itik Melalui Biofermentasi dengan Khamir. *Majalah Ilmiah Peternakan*, *18*(1), 11–16. https://media.neliti.com/media/publications/164249-ID-peningkatan-nilai-nutrisi-dedak-padi-seb.pdf

Witariadi, N. M., Wibawa, A. A., & Wirawan, I. W. (2016). Pemanfaatan Ampas Tahu yang Difermentasi dengan Inokulan Probiotik dalam Ramsum Terhadap Performans Broiler. *Majalah Ilmiah Peternakan*, *19*(3), 115–120. https://ojs.unud.ac.id/index.php/mip/article/download/25308/16489

Yulisman, Y., Fitriani, M., & Jubaedah, D. (2012). Peningkatan Pertumbuhan dan Efisiensi Pakan Ikan Gabus (Channa sriata) Melalui Optimasi Kandungan Protein dalam Pakan. *Berkala Perikanan Terubuk*,*40*(2),47–55. http://dx.doi.org/10.31258/terubuk.40.2.47-55

Yunitasari, R., Haji, A. T. S., & Susanawati, L. D. (2016). Pengaruh Pemberian Limbah Organik Kantin Terhadap Pertumbuhan Cacing Tanah (Lumbricus rubellus) dengan Media sampah daun sekitar kampus Universitas Brawijaya. *Jurnal Sumberdaya Alam Dan Lingkungan*, *2*(3), 27–31. https://jsal.ub.ac.id/index.php/jsal/article/view/241

Yusuf, M. (2019). Pengaruh Pemberian Ampas Sagu dan Kotoran Ayam Dengan Presentase yang Berbeda Terhadap Pertambahan Populasi Cacing Tanah (lumbricus Rubellus). *Doctoral Dissertation, Universitas Islam Riau).* http://repository.uir.ac.id/id/eprint/1869