Jurnal Sain Peternakan Indonesia
Available at https://ejournal.unib.ac.id/index.php/jspi/index
DOI: https://doi.org/10.31186/jspi.id.17.1.44-50
P-ISSN 1978-3000
E-ISSN 2528-7109
Volume 17 Issue 1 January-March 2022

Effect of Including Fermented Feather Meal as Substitution of Concentrate in the Basal Diet with Different Levels on the Performance of Landrace Crossbred Pigs

N. S. Dalle, S. Sembiring, and E. J. L. Lazarus

Graduate School of Animal Husbandry, University of Nusa Cendana
Jl. Adisucipto Penfui, Kupang NTT 85001
Corresponding author: ivandalle23@gmail.com

ABSTRACT

The study aimed to evaluate the effect of adding fermented feather mael (FFM) on pigs' performance, intake, and digestibility. There were 16 landrace crossbred pigs of 2-3 months old with 6-19 kg (average 13.59 kg; CV= 29.59%) initial body weights used in the study. Trial method using complete block design 4 treatments with 4 replicates procedure was applied in the study. The 4 treatment feeds were formulated as: R0: basal diet with 100% concentrate without TBAT (control); R1: basal diet with 90% concentrate + 10% FFM; R2: basal diet with 80% concentrate + 20% FFM; and R3: basal diet with 70% concentrate + 30% FFM. Variables evaluated were feed intake, daily weight gain and feed conversion (performance) landrace crossbred pigs. Statistical analysis shows no significant (P>0.05) on feed intake, daily weight gain and feed conversion. The conclusion were that including FFM into basal diet gave relative the same results in the feed intake, daily weight gain and feed conversion.

Key words: Fermented feather mael, performance, landrace crossbred pig

INTRODUTION

Pig breeding is one of the hereditary cultures of the population of East Nusa Tenggara (NTT), so NTT occupies the province with the largest pig population in Indonesia. This is due to the socio-cultural conditions of the NTT community which are predominantly non-Muslim, the NTT pig market is very good, and from a sociocultural point of view, pigs are always used in any traditional or religious celebration (Wea, 2009). The people at NTT generally use agricultural waste, kitchen waste, food waste and market waste as local rations, but these rations are of poor quality if not processed first. To improve the quality of the low rations, farmers use concentrate as a source of protein for pigs. However, the concentrate usually added has a high price, so not all growers can use it. Therefore, there must be local ration ingredients that have almost the same nutritional value to replace the function of the concentrate in the ration.

One of the ingredients that can be used as a concentrate substitute is chicken feather meal, which is high in protein so it can be used as a source of protein in the ration. Chicken feather waste that is not used and disposed of in the vicinity of the market harms the environment. Feather meal has great potential because, according to (Huda and Aji, 2016), feathers of up to ± 6% of its live weight (cut weight ± 1.5 kg) are obtained from the slaughter results of each bird. According to the Central Statistics Agency (BPS), NTT produced 27,160 broilers in the Kupang Regency in 2019. Based on the chicken production in Kupang Regency and the assumption that the weight of the chicken feathers reaches ± 6% of the live body weight, the number of feathers in Kupang Regency can reach ± 1,629 kg in 2019.

According to Seo et al. (2009) Chicken feather meal is obtained by drying and grinding chicken feathers after heating them under high pressure. Chicken feather meal has the potential to be used as animal feed as its protein content reaches 80-90%, exceeding the crude protein content of soybean meal (42.5%) and fish meal (66.5%) (Adiati et al., 2003). The nutritional value of chicken feather meal is 81% protein, 1.2% fat, 86% dry matter and 1.3% ash (Zerdani et al., 2004), also chicken feather meal contains 0.19% calcium minerals, phosphorus 0.04%, 0, 15% potassium and 0.15% sodium (Kim and Patterson, 2000). However, the protein in chicken feathers is difficult to digest because it is classified as a keratin protein (Joshi et al., 2007).

Keratin is a product made from hardened epidermal tissue of the body such as nails, hair and feathers and consists of fibrin, which is rich in cysteine and cystine (Rachmawati and Samidjan, 2019). In the digestive tract of pigs, keratin cannot be broken down into digestible protein and therefore cannot be used by farm animals. To be used as ration material, chicken feathers must be processed by breaking the cystine bond in the feathers (Adiati et al., 2003). Therefore, the quality of chicken feathers can be improved by processing them into flour and then fermenting them.

The fermentation process can be used as a biological attempt to reduce or eliminate nutritionally harmful substances in certain ration materials through microorganisms. According to (Sembiring et al., 2017) the fermentative processing of feed ingredients has been shown to increase the crude protein content and the energy of the feed. Fermentation with baker's yeast and ribbon yeast is expected to break the disulfide bridges found in chicken feathers, since baker's yeast is a unicellular protein that contains proteases that can break down protein and contains complete amino acids (Ahmad, 2005). Tape yeast is the starting material for the production of sticky rice tape or tapioca tape, according to Dewi and Aziz (2011) Tape yeast consists of bacteria (Acetobacter, Pediococcus and Bacillus sp.), Yeast (*Saccharomycopsis fibuligera, Saccharomycopsis malanga, Pichia burtonii, Saccharida utilomyces*) and molds (Aspergillus, *Amylomyces rouxii*, Mucor sp. and Rhizopus) and *Saccharomyces cerevisiae* ensure good aroma and taste and contain complete amino acids, galactosidase (oligosaccharide decomposer), proteases (proteinase (decomposer) carbohydrate decomposer) and phytase (Ly, 2016). In addition, microorganisms that break down keratin, including the bacterial species *Bacillus* sp. (Tiwary, 2012) contained in yeast tape. During the fermentation process, the production of proteases and some naturally occurring keratinofolic microorganisms present in baker's yeast and band yeast, such as the bacteria *Bacillus steptomyces* and the fungi Rhyzopus and Aspergillus, can be catalyzed and broken down by breaking the disulfide bonds into keratin and converting them into simpler ones and more easily digestible compounds (Grazziotin et al., 2006). Before fermentation, cooking and grinding chicken feathers is also carried out according to Mirnawati (2006), which says that karatin can be reduced by the heating process.

Research by Arunlertaree and Moolthongnoi (2008) has shown that chicken feather meal fermented with bread yeast and band yeast as a substitute for fish meal in tilapia rations increases crude protein and increases the efficiency of using feather meal as a substitute for fish meal in fish rations. Fermented feather meal can be used as a substitute for fish meal in a ratio of 25 to 50% for rations with 28.48 to 30.38% protein. Bidura (2010) also reported that using fermented chicken feather meal 5% in the ration can lower fat and cholesterol levels in broilers as young as 6 weeks old.

MATERIALS AND METHODS

This study was carried out in Sonraen, South Amarasi, Kupang Regency and lasted for 10 weeks, consisting of 2 weeks of adaptation and 8 weeks of data collection. The farm animals used were landrace crosses in the initial phase of 2-3 months with 16 crossbed pigs. The ration materials used were rice bran, corn flour, concentrate, mineral-10 and coconut oil. The ingredients and nutritional value of the ration are shown in Table 1, while the composition and nutritional value of the basic ration are shown in Table 2.

Table 1. Diet materials and nutritional content of the basic rations

Rations material	Nutrition Content							
	Dry Matter (%)	Dry Organic (%)	Crude Protein (%)	EM (Kkal/kg)	Crude Fiber (%)	Crude Fat (%)	CHO (%)	BETN (%)
Cornmeal [a)]	85.31	83.74	7.68	2,951.34	2.46	1.42	74.64	72.17
Rice Bran [a)]	91.03	78.49	8.91	2,478.89	18.96	9.85	59.73	53.66
Consentrat [b)]	88	80	38	2,700	8	3	71.50	67.50
Mineral-10 [c]	-	-	-	-	-	-	-	-
Coconut oil [b)]	-	-	-	8,600	-	90	-	-
FFM [a)]	85.85	96.26	89.22	3,622.53	1.17	5.49	1.53	0.37

Descriptions:

a) The results of the laboratory chemical analysis of the rations of the Faculty of Animal Husbandry Undana (2021);

b) Based on the information on the ration label.

c) Mineral content of Ca = 43%, P = 10%, Fe 4.40%, Mg = 3.30%, Mn = 0.40%, Zn = 0.50%, Cu = 0.05%.

Table 2. Composition and nutritional content of research rations

Diet materials	Treatment Diet (%)			
	R0	R1	R2	R3
Cornmeal	40	40	40	40
Rice Bran	31	31	31	31
Consentrate	28	25.2	22.4	19.6
Mineral-10	0.5	0.5	0.5	0.5
Coconut oil)	0.5	0.5	0.5	0.5
FFM	-	2.8	5.6	8.4
Total	100	100	100	100
Nutritional content of treatment rations	R0	R1	R2	R3
Dry matter	86.99	86.93	86.87	86.81
Dry organic	80.23	80.69	81.14	81.60
Gross energy (Kkal/kg)	2,186.45	2,206.83	2,227.21	2,247.60
ME (Kkal/kg)(**)	2,771.17	2,797.00	2,822.83	2,848.66
Crude protein (%)	16.48	17.91	19.34	20.78
Crude fiber (%)	4.96	5.03	5.10	5.17
Crude fat (%)	9.11	8.91	8.72	8.53
CHO (%)	68.39	66.43	64.48	62.52
BETN (%)	60.41	58.53	56.65	54.77

Descriptions: Nutritional content is calculated based on Table 3 and the composition of the ration mixture.

Cages and Equipment

The cages used were single cages with 16 plots, with the floor and walls made of wooden boards and each plot being 1 m long x 0.5 m wide x 1 m high and equipped with separate ration and drinking water containers. The tools used in this study consisted of an SF-400 electric scale with 10,000 grams for weighing feed and weighing feces, a hanging scale from Dacin Logam with a capacity of 100 kg cattle per week, buckets, sacks, water hoses, Broomstick and a camera.

Research Method

The research design used was a randomized block design consisting of 4 treatments and each treatment was repeated 4 times, making 16 experimental units.

The treatment of the research ration was:

R_0: Basic ration with 100% concentrate without fermented chicken feather meal (control)

R_1: Basic ration with 90% concentrate + 10% fermented chicken feather meal

R_2: Basic ration with 80% concentrate + 20% fermented chicken feather meal

R_3: Basic ration with 70% concentrate + 30% fermented chicken feather meal

Preparing Fermented Chicken Feather Meal

Chicken feathers were collected from the Oesao Market, Kupang Regency, and then washed and cleaned to remove adhering dirt. After washing, the feathers are steamed; according to Mirnawati (2006), the heating process can reduce the keratin content in chicken feathers. Steamed chicken feathers are dried in the sun to dry for easier grinding. The chicken feathers are then ground into flour and then fermented with bread yeast and band yeast according to Arunlertaree and Moolthongnoi (2008) fermentation with cake yeast and band yeast. The fermentation consists of 6 stages, namely:

1) Chicken feather meal is weighed up to 1000 g;
2) Then the chicken feather meal is added to the container;
3) Baker's yeast and band yeast are weighed up to 50 g and 100 g, respectively, and then dissolved in 300 ml of water;
4) The solution is placed in a container containing chicken feather meal, mixed into the container, and stirred until all ingredients are mixed;
5) The container is tightly closed with plastic so that it is not exposed to the sun;
6) The container with the dough is kept in a place not exposed to sunlight, and then left for 48 hours.

Mixing the Ration

Each ration material used is weighed according to its composition (corn, rice bran, concentrate and chicken feather meal). The ration materials were mixed from the lowest composition to the highest composition so that the rations were mixed evenly according to the treatment (R0 to R3). In addition, the mixture of each ration for each treatment that is marked with the treatment is filled in a sack.

Randomization Process for Research Pigs

Before the randomization process, the pigs were first weighed to obtain the initial body weight and then the cage was numbered (numbers 1-16). Then the coefficient of variation between the initial body weight was calculated. The group determination was based on the coefficient of variation of body weight. The first treatment randomization was performed in each group. Suppose there is a difference in initial total/mean weight between treatment groups. In that case, adjustments will be made by limited randomization of treatment for farm animals in the group until all treatment groups have an equal/balanced total/mean body weight.

Table 3. Weight (kg) of a pigs research the beginning of randomization

The Grup	Treatment				Total	Averange
	R0	R1	R2	R3		
I	9 (3)	7.50 (2)	6 (1)	10 (4)	80.5	8.12
II	12.50 (7)	12 (6)	12.5 (8)	11 (5)	112	12
III	17 (12)	16 (10)	17 (11)	14 (9)	137	16
IV	17.50 (13)	18.50 (15)	18 (14)	19 (16)	290.5	18.25
Total	56	54	53,5	54		
Averange	14	13.50	13.37	13.50		

Description: The number in brackets (1-16) is the sequence number of livestock based on the initial weight of the weighted pigs

Ration Sampling Method for Analysis

The basic ingredients of the ration in the form of corn and rice bran and fermented chicken feather meal were taken every 100 g for each ingredient and then analyzed in more dehead in the animal feed chemistry laboratory of the Undana Faculty of Animal Husbandry. In the meantime, concentrate mineral and edible oil have nutritional value that can be seen on the package or the label on the package. After the nutritional value of each feed ingredient was known, the nutritional value of the treatment ration was calculated based on the composition of each treatment.

Procedure for Ration and Dispensing Drinking Water

The rations to the animals were previously weighed according to the daily requirement, namely 5% based on the weekly bodyweight of the animals, and the rations were administered twice a day, namely in the morning (7:00 a.m. WITA) and in the afternoon (4:00 p.m. WITA). In the meantime, drinking water is made available to the livestock ad libitum (unlimited). The cages are cleaned and the animals are bathed once a day, namely in the morning (06:00 WITA).

Research Variable

Diet Intake

The intake diet results from the number of rations administered minus the remaining rations for one day of administration.

Weight Gain

Weight Gain results from the final body weight minus the initial weight divided by the duration of the maintenance period using the formula:

$$\text{Weight Gain} = \frac{\text{Final Weight (kg)} - \text{Initial Weight(kg)}}{\text{Maintenance Time (days)}}$$

Ration Conversion

The ration conversion was obtained from the amount of ration consumed divided by the increase in body weight of the cattle.

$$RC = \sum \frac{\text{Amount of Feed Consumed}}{\text{Weight Gain}}$$

Data Analysis

The data collected then analyzed using analysis of variance (ANOVA). If there is a significant effect, this is continued with Duncan's multiple distance test according to Gaspersz (1991) instructions.

RESULTS AND DISCUSSIONS

Effect of treatment on research animal performance

Diet Intake

The results of the diversity fingerprint analysis showed that the treatment had an unreal effect (P>0.05) on intake diet. Based on the research done, the averages of R1-R3 treatment has increased nearly equivalent to treatment R0 that is control ration. This means that the replacement of concentrate with fermented chicken feather flour in rations can be done at a level above 30%, that it can be equivalent to R0 or control rations.

The highest average ration consumptions were R0 Treatment (1,672 g/h/d) followed by R3 (1,614 g/h/d), R2 (1,611 g/h/d), R1 (1,529 g/h/d), The highest average ration consumption was R0 Treatment (1,672 g/h/d) followed by R3 (1,614 g/h/d), R2 (1,611 g/h/d), R1 (1,529 g/h/d), The highest average ration consumption was R0 Treatment (1,672 g/h/d) followed by R3 (1,614 g/h/d), R2 (1,611 g/h/d), R1 (1,529 g/h/d) The highest average ration consumptions were R0 Treatment (1,672 g/h/d) followed by R3 (1,614 g/h/d), R2 (1,611 g/h/d), R1 (1,529 g/h/d). The R0 has the highest average consumption because livestock prefer control rations over treatment rations. Was followed by the R3, treatment R2 and R1 according to the level the use of tbat in rations. This is in line with the opinion of Uta et al. (2017), which states that the ration material fermented using saccharomyces cereviciae results. Based on rataan in table 8, fondness cattle is higher for R3 than R2 and R1.

Table 4. Average treatment of research animal performance

Variable	Treatment				P-Value
	R0±SD	R1±SD	R2±SD	R3±SD	
Diet intake (g/h/d)	1,672±300.42	1,529±249.84	1,611±488.83	1,614 ±277.54	0.78
Daily weight gain (g/h/d)	551.59±13.75	527.78±19.97	529.76±69.91	537.70±79.20	0.63
Diet convertion	3.35±0.78	3.18 ±0.67	3.51 ±0.76	3.17±0.31	0.32

Description: The average value indicates the treatment is not real different (P>0.05).

The ration consumption in this study ranged from 1.53 to 1.72 kg. The ration consumption in this study corresponds to the amount recommended by Sihombing (2006) of 1.5-2.75 kg. The difference in ration consumption was due to all trial rations' relatively similar age, environment, and nutritional content. The results of this study are consistent with Widyantara (2013) that the ability of farm animals to digest food, the adequacy of ration nutrients to meet basic living needs, and the growth of research pigs are relatively equal. The consumption of pig rations is influenced by the type of ration and the individual livestock (Sembiring and Dodu, 2018).

One aspect that determines the high and low quality of the ration is the content of proteins, energy, vitamins, minerals and other ingredients that support growth and biological digestive processes (Saud et al., 2018). The energy content of the ration will generally control the amount of consumption. Although the energy content of the ration influences consumption, the variation in the amount consumed from day to day can also be influenced by the cattle themselves. Factors influencing ration consumption such as size and weight, age, condition of the animals and environmental stresses such as ambient temperature, humidity and sunlight (Poluan et al., 2017).

Daily Body Weight Gain

The analysis results showed that fingerprint variety of treatment had a real impact (P>0.05) on adding another body weight daily. Based on the results of research, weight gain daily cattle is higher for those research treatment r0 or control rations 551.59 g/h/d it was followed in a row by the treatment of R3 with 537.70 g/h/d, 529.76 g/h/d (R2) and 527.78 g/h/d (R1). This means that the use of tbat to 30 % have not been able to replace the role of consentrate in basal rations in an optimum manner. Still, there was a rise in body weight gain treatment based on the addition of the level of FFM as a substitute for concentrates in rations (10 %, 20 % and 30 %). It can be concluded that the use of FFM can equal or exceed the control ration if the addition >30% in place of concentrate in the ration.

The weight gain of livestock research has a relatively similar effect; this agrees with the statement by Sihombing (2006) that when pigs are given rations with relatively equal doses, the animals gain relatively the same response in terms of consumption and weight. According to Heryfianto et al (2015), when determining the growth rate, the extent to which farm animals gain body weight is influenced by the amount of ration consumed and the condition of the ration or the palatability of the ration. In addition, sufficient nutrients and a good quality ration are required to achieve maximum bodyweight.

Ration Conversion

The analysis of variance showed that the treatment had no significant effect (P>0.05) on the ration conversion. This means that the use of fermented chicken feather flour in the ration as a substitute for concentrate up to 30% has no significant effect on the conversion of the research pigs ration.

Based on the results of the study, the conversion of livestock rations ranged from 3.17 to 3.35 with the best treatment being R3 (3.17) followed by R1 (3.18), R0 (3.35) and R2 (3.51). The ration conversion rate in the R2 treatment was the largest due to the smaller average initial grouping in the R2 treatment compared to other groups. Still, the final body weight was relatively the same as the other treatments. It can be concluded that the use of TBAT up to a level of 30% in the ration as a substitute for concentrate can be done because the ration conversion rate is relatively the same as the control ration (R0).

The value of a ration is not only determined by the value of the ration consumption and the rate of body weight growth is also determined by the ration conversion rate, where the ration conversion describes the number of rations used for growth (Seran et al., 2019). According to Sinaga (2010), the ration conversion value is the ratio between the amount of ration consumed and the increase in body weight by one unit, the lower the conversion rate shows that the pig uses the rations more efficiently. According to Atmomarsono and Muryani (2019), the conversion value of the ration can be achieved by several factors, including the ambient temperature, the speed at which the ration moves through the digestive tract, the physical form, and the consumption of the ration. Sihombing (2006) found that the factors influencing the decline in the conversion of pig rations are rations with an unbalanced diet, poor genetic basis, high disease rate, worms, moldy feed granules, drinking water, and environmental factors conditions and bad management.

CONCLUSION

The use of fermented chicken feather meal up to 30% in the basic ration had a relatively similar effect on the performance of Landrace crossbred pigs.

SUGGESTION

The use of fermented chicken feather meal in the basic ration as a concentrate substitute of up to 30% has a relatively similar effect on the test animals; therefore, it is recommended to use chicken feather meal as a substitute for concentrate in the basic ration.

More research is needed to increase fermented chicken feather meal use in the basic ration by more than 30% to determine the maximum benefit in the basic percentage as a substitute for concentrate.

REFERENCES

Ahmad, R. 2005. Pemanfaatan khamir Saccharomyces cerevisiae untuk ternak. Balai Penelitian Veteriner 15 (1): 49–55.

Arunlertaree, C., and C. Moolthongnoi. 2008. the Use of Fermented Feather Meal for Replacement Fish Meal in the Diet of Oreochromis Niloticus. Environment and Natural Resources Journal 6 (1): 13–24.

Bidura, I. G. N. G., & I. B. G. Partama. 2010. Pengaruh Penggunaan Tepung Bulu Ayam Terfermentasi dalam Ransum terhadap Bobot Potong dan Jumlah Lemak Abdomen Ayam Broiler. Majalah Ilmiah Peternakan 13(3): 98- 102.

Dewi, R. S., and S. Aziz. 2011. Isolasi *Rhizopus oligosporus* pada Beberapa Inokulum Tempe di Kabupaten Banyumas. Molekul, 6(2):93-104. https://doi.org/10.20884/1.jm.2011.6.2.97.

Gaspersz, V. 1991. Metode Perancangan Percobaan. Bandung: CV. Armico.

Grazziotin, A., F. A. Pimentel, E.V. De Jong, and A. Brandelli. 2006. Nutritional improvement of feather protein by treatment with microbial keratinase. Animal Feed Science and Technology 126 (1–2): 135–144.

Heryfianto, F., I. M. S., Aryanta, & T. Dodu. 2015. Pengaruh Penambahan Tepung Kunyit dalam Ransum Basal (the Effect of Curcuma Meal Suplemention on the Basal Diet. Jurnal Nukleus Peternakan 2 (2): 200–207.

Huda, S. & M. P. Aji. 2016. Pembuatan and Karakterisasi Pelet Ikan Dari Bulu Ayam. Prosiding Seminar Nasional Fisika SNF2016 http://snf-unj.ac.id/kumpulan-prosiding/snf2016/.

Joshi, S. G., M M Tejashwini, N. Revati, R. Sridevi and D. Roma. 2007. Isolation, Identification, and Characterization of a feather Degrading Bacterium. International Journal Poultry Science 6 (9) : 689-693.

Kim, W. K., and P. H. Patterson. 2000. Nutritional value of enzyme-or sodium hydroxide-treated feathers from dead hens. Poultry Science 79 (4): 528–534. https://doi.org/10.1093/ps/79.4.528

Ly, J. (2016). Evaluasi Nilai Nutrisi Biji Asam Terfermentasi *Saccharomyces cerevisiae* Sebagai Suplemen Pakan Induk dan Implikasinya Terhadap Kinerja Induk Dan Anak Babi Pra-Sapih. Disertasi. Universitas Brawijawa. Malang.

Mirnawati, M. 2006. Peningkatan Kualitas Limbah Bulu Ayam melalui Fermentasi dengan Efektif Mikroorganisme 4 (EM4). In Jurnal Peternakan Indonesia (Indonesian Journal of Animal Science) 11 (3) : p. 242- 248.

Poluan, W. R., R. Petrus, R . I. Montong, F. Jantje, J. F. Paath, R. Vonny, W. Rawung. 2017. Penggunaan Pakan Babi Fase Grower Sampai Finisher yang Diberi Gula Aren (*Arenga pinnata* Merr) dalam Air Minum. Jurnal Zootek 37 (1) : 50-61.

Rachmawati, D., dan Samidjan, I. 2019. The effects of chicken feather silage substitution for fish meal in the diet on growth of saline tilapia fingerlings (*Oreochromis niloticus*). IOP Conference Series: Earth and Environmental Science, *246*(1). https://doi.org/10.1088/1755-1315/246/1/012015

Saud, R. H., Rawung, V. R. W., Soputan, J. M., and Lapian, M. T. R. 2018. Penampilan Produksi Ternak Babi Grower Sampai Finisher Yang Menggunakan Tepung Limbah Ikan Cakalang Sebagai Pengganti Sebagian Konsentrat Dalam Ransum. Zootec, 39 (1): 23. https://doi.org/10.35792/zot.39.1.2019.22109

Seo, S. H., B. Y. Jung, M. K. Lee, B. H. Lee, and I. K. Paik. 2009. The effect of dietary supplementation of feather meal on the performance and muscular taurine contents in growing-finishing pigs. Asian-Australasian Journal of Animal Sciences 22 (10): 1407–1413. https://doi.org/10.5713/ajas.2009.90125

Seran, Y. F., C. V. Lisnahan, & T. I. Purwantiningsih. 2019. Pengaruh Penambahan Probiotik dalam Pakan terhadap Pertambahan Berat Badan, Konsumsi Pakan dan Konversi Pakan Ayam Broiler. JAS. 4 (2): 21–22. https://doi.org/10.32938/ja.v4i2.647

Sinaga, S & M. Silalah. 2010. Pengaruh Pemberian Berbagai Dosis Curcuminoid pada Ransum Babi Periode Starter terhadap Efisiensi Ransum. Jurnal Penelitian Pertanian Terapan 11 (2): 77-83

Suryani, Y., I. Hernaman, & N. H. Hamidah. 2017. Pengaruh Tingkat Penggunaan EM4 (Effective Microorganisms- 4) pada Fermentasi Limbah Padat dan Serat Kasar. Jurnal Istek. 10 (1): 139–153.

Tiwary, E. 2012. Rapid Conversion of Chicken Feather to Feather Meal Using Dimeric Keratinase from Bacillus licheniformis ER-15. Journal of Bioprocessing & Biotechniques, 02(04), 0–4. https://doi.org/10.4172/2155-9821.1000123.

Uta T P., Dato T O D, Dodu T. 2017. Pengaruh Pemberian Tepung Bonggol Pisang Terfermentasi Dalam Ransum Terhadap Konsumsi Dan Kecernaan Serat Kasar Dan Betn Pada Babi Peranakan Landrace Fase Starter. Jurnal Nukleus Peternakan 4 (2) :155 - 162.

Wea, R. 2009. Performans Produksi dan Reproduksi Ternak Babi Lokal di Kodya Kupang. Partner 16 (1): 21–28. https://doi.org/10.35726/jp.v16i1.51

Widyantara, Widyantara, P. R. A., Wiyana, I. K. A., Sarini, N. P. 2013. Tingkat Penerapan Biosekuriti Pada Peternakan Ayam Pedaging Kemitraan Di Kabupaten Tabanan Dan Gianyar. Jurnal Peternakan Tropika 1 (1): 20–33.

Zerdani, I., M. Faid, & A. Malki. 2004. Feather wastes digestion by new isolated strains Bacillus sp. in Morocco. *A*frican Journal of Biotechnology 3 (1): 67–70. https://doi.org/10.5897/ajb2004.000-2012