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Pellet Quality with the Addition of Kepok Banana Peel Silage in Grower Crossbred Native Chickens Diet

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ABSTRACT

Kepok banana peel is one food processing waste that can be used as poultry feedstuff. The content of fiber and tannins in banana peels limits its utilization, and the fermentation process can improve the nutritional quality of banana peels. Crossbred native chickens feed usually available in three forms mash, granules, and pellets. The nutrient content of the feed ingredients used in the manufacture of pellets will affect the quality of the pellets produced. This study aimed to examine the use of banana peel silage on pellets' physical and nutritional quality for crossbred native chickens in the grower phase. This experiment used a completely randomized design with four treatments and five replications. The four treatments were (P0) diet without banana peel silage, (P1) diet with 10% banana peel silage, (P2) diet with 20% banana peel silage, (P3) diet with 30% banana peel silage. Data were analyzed by analysis of variance and continued with Duncan's New Multiple Range Test. The results showed that the level of banana peel silage had a very significant effect ($P<0.01$) on the pellet durability, pellet density, moisture content, crude fiber, and crude fat pellet. It was concluded that kepok banana peel silage up to 30% in the crossbred native chicken feed positively impacted pellet durability, density, moisture content, fat content, crude protein content, and reduced crude fiber content.

Key words: kepok banana peel silage, physical quality, pellets, crossbred native chicken

INTRODUCTION

Abdollahi and Ravindran (2013) stated feed is the greatest cost item in poultry production, representing 60–70% of the total production cost, with the cost of ingredients accounting for a significant portion of feed cost. The utilization of conventional feed ingredients in poultry feed, such as corn and soybean meal, has many obstacles, such as competition with food necessity and insufficient domestic availability. Importing that feedstuff from other countries might be a resolution to the issue. However, it raised soaring prices for poultry feed—using unconventional materials such as agricultural waste or food industry waste. One of the potential food processing waste as substitute feedstuff is banana peel.

Kepok banana peel can be used up to 7.5% in broiler chicken feed (Koni et al., 2013). Banana peel contains nutrients such as crude protein 3.63-18.01%, crude fat 2.52-5.17%, calcium 0.36-7.18%, phosphorus 0.10-2.06% and crude fiber. 18.01-37.36.7% (Koni, 2013; Fitroh et al., 2018); gross energy 3727 kcal/kg (Diarra, 2018) and 4.87% tannins (Hudiansyah et al., 2015). High crude fiber and tannins are the limitations for banana peels as poultry feed ingredients. Therefore, the processing of banana peel can be conducted by fermentation.

Fermentation can decrease crude fiber (Mandey et al., 2015; Chrysostomus et al., 2020) and reduce tannins (Mandey et al., 2015; Koni and Foenay, 2020a). Processing kepok banana peels by anaerobic fermentation as in producing silage using tapioca can reduce the crude fiber content up to 43.13%, with crude fiber content before and after fermentation being 18.71% to 10.64% (Chrysostomus et al., 2020). According to Koni and Foenay (2020a), the ensilase process decreases tannin levels from 28.77 to 59.96%. In contrast, Chrysostomus et al. (2020) reported that banana peel silage increased phosphorus content up to 81.48% and 155.56% in calcium.

Chicken feed usually comes in three forms: mash, crumble, and pellets. Pellets are a form of feed that has been mechanically compacted and are the most widely used in the poultry feed industry(Abdollahi et al., 2013). Giving feed to poultry in pellet form enhances production economics by increasing the feed intake and thus growth performance and feed efficiency (Briggs et al., 1999). Pellet also form easier handling of feed and reduces spilled feed (Akhadiarto, 2010).

Retnani et al. (2010) stated that the starch content of raw materials also affects the quality of pellets. Therefore, a study has been conducted to measure the quality of native chicken feed pellets for the grower phase using kepok banana peel silage.

MATERIALS AND METHODS

Research Material

This study used materials such as kepok banana peels, which were obtained from banana processing waste (making fried bananas) around Kupang area, tapioca flour as a soluble carbohydrate, digital scale with a capacity of 150 kg, which is used to weigh feedstuffs, digital scale with a capacity of 3000 g which is used to weigh small amounts of feed ingredients. disc mill type A-Y3E-13252-233 with a sieve size of 1.5 mm for grinding grain form feedstuffs. Pellet machine used is simple without steam and cooler (Pelletizer Model 260B), pellet durability tester (6Z820C) to test the friction resistance of pellets. Feed ingredients such as kepok banana peel silage, maize, rice bran, meat bone meal, soybean meal, vegetable oil, dicalcium phosphate, DL-methionine, L-lysine, salt (NaCl), and vitamins and minerals premix. The nutrient content of the diet is presented in Table 1.

Research Procedure

The research procedure consisted of three major parts: silage making, formulation, pellet processing, and measurement of pellet quality.

Ensilage of Kepok Banana Peels

The procedure for making silage refers to Koni and Foenay (2020b). Banana peels are collected from banana processing (fried bananas) around the Kupang City area. The banana peel used is the ripe banana marked peel yellow color. The selected banana peels are washed using clean water to remove the dirt. After washing, the banana peels were drained for ± 60 minutes to reduce the water. Then, the banana peels were cut ± 3 cm, then mixed with 10% tapioca flour of the weight of the banana peel and mixed until homogenous. Once mixed homogeneously, put into a bucket with a capacity of 20 kg. Banana peels were put in a bucket while compacting. The surface of the bucket was covered with plastic, then covered with a bucket lid until tight, and on the outside, the cover was given tire lid. They were fermented for 21 days. After 21 days, the bucket was opened, then the banana peel silage is sun-dried for 2-3 days. After drying, the kepok banana peel silage was mashed using a disk mill with a 1.5 mm sieve. Kepok banana peel silage flour was mixed with other feed ingredients according to the formulation presented in Table 2.

Diet Treatment Preparation

Diets are formulated from kepok banana peel silage, maize, rice bran, meat and bone meal, soybean meal, vegetable oil, dicalcium phosphate, DL-methionine, L-lysine, salt (NaCl), vitamin and mineral premix. The nutrient content of feedstuffs is presented in Table 1.

Table 1. Nutrient content of feed ingredients

Ingredient	ME (kcal/kg)	Crude Protein (%)	Amino acid (%)		Crude fat (%)	Crude fiber (%)	Ca (%)	P (%)
			Lysine	Methionine				
Corn[1]	3,350.00	8.50	0.26	0.18	3.80	2.20	0.02	0.08
Rice bran [2]	2,227.90	11.06	0.01	0.00	8.87	15.05	0.53	0.29
Soybean meal [2]	3,216.17	44.00	0.62	0.34	1.34	4.41	0.29	0.09
Meat and bone meal [1]	2,150.00	50.40	2.61	0.69	10.00	0.36	10.30	5.10
Vitamin and mineral premix [3]			0.30	0.30			0.06	0.30
DL-methionine,		58		99				
L-lysine HCl		95.6	88					
Kepok banana peel silage[4]	3010	7.08			9.38	7.81	0.18	1.02

[1]NRC (1994), [2] Koni *et al*., (2017), [3] Top Mix Production Medion, Bandung: Every 10 kg contain 12.000.000 IU vitamin A, 2.000.000 IU vitamin D3, 8.000 IU vitamin E, vitamin K3 2.000 mg, vitamin B1 2000 mg, vitamin B2 5.000 mg, vitamin B12 12.000.000 µg, vitamin C 25.000 mg, Calcium-D-panthotenate 6000 mg, choline chloride 10.000 mg, niacin 40.000 mg, methionine 30.000 mg, lysine 30.000 mg, mangan 120.000 mg, Fe 20.000 mg, iodine 200 mg, zink 100.000 mg, cobalt 200 mg, copper 4.000 mg, santoquin (antioxidant) 10.000 mg. [4] (Koni and Foenay, 2020a)

Diet formulated according to BSNI (2013) native chickens grower recommendation (Table 2). The experimental feedstuffs were weighed according to the formulation and mixed until homogeneous. The small quantities of feedstuffs such as amino acids, salt, and vitamins mineral premix are premixed. The vegetable oil is added at the end to mix evenly. After homogenous, the diets are printed in the pellet form using a pellet machine. Pellets were sun-dried for a day to dry.

Table 2. Experimental diets for grower birds

Feed ingredients	P0	P1	P2	P3
	%			
Kepok banana peel silage	0.00	10.00	20.00	30.00
Corn	58.00	54.00	50.00	46.00
Rice bran	21.00	15.00	9.00	3.00
Meat and bone meal	4.60	4.60	4.60	4.60
Soybean meal	11.00	11.00	11.00	11.00
Vegetable oil	2.00	2.00	2.00	2.00
Vitamins and minerals Premix	0.25	0.25	0.25	0.25
DL-metheonine	0.30	0.30	0.30	0.30
L-lysine HCl	0.60	0.60	0.60	0.60
Dicalcium phospat	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100

P0: diet without banana peel silage; P1: diet with 10% banana peel silage; P2: diet with 20% banana peel silage, P3: diet with 30% banana peel silage.

Pellet Quality Measurement

The four pelleted diets were analyzed for moisture, crude fiber, protein content, and extract eter according to AOAC (2005). Pellet durability is measured by the post tumbling method (Loar and Corzo, 2011) A total 500 g sample size was put into the pellet durability test machine. The sample was rotated for ten minutes, and the rotation was speed of 50 revolutions per minute. The pellets were sifted through a 3 mm sieve, to separate the whole pellets and the crushed pellets. Pellet durability was calculated as the ratio of the pellet after the test and the weight of the whole pellet at the start.

$$\text{Pellet durability (\%) formula} = \frac{\text{Weight after tumbling}}{\text{Weight before tumbling}} \times 100$$

Pellet density was measured by weighing 25 grams of sample then put into a 100 ml measuring cup with an initial volume of 40 ml filled with distilled water. Then observe the volume changes that occur. Pellet density is calculated based on the ratio of changes in the volume of distilled water after adding pellets to distilled water before adding pellets

Research Design and Parameters

The study uses a complete randomized design with four treatments and five replication.. The four treatments were diet without banana peel silage (P0); diet with 10% banana peel silage (P1); diet with 20% banana peel silage (P2), a diet with 30% banana peel silage (P3).

The post tumbling method measured the research parameter, namely pellet durability (Loar and Corzo, 2011). Pellet density (g/cm3) is the ratio between the material's weight and volume (Retnani et al., 2011). The moisture content, crude protein, crude fiber, and crude fat were analyzed according to AOAC (2005).

Data Analysis

Data were analyzed according to one-way ANOVA. Differences among means were determined with Duncan's Multiple Range Test with a 5% significance level (Gasperz, 2006).

RESULT AND DISCUSSION

The effect of banana peels silage utilization in crossbred native chickens diet on pellet durability, pellet density, moisture content, crude protein, crude fiber and crude fat of pellet is shown in Table 3.

Table 3. The effect of banana peels silage utilization on physical quality and nutrient content of grower phase crossbred native chicken diet pellet

Parameter	Treatments				*p* value
	P0	P1	P2	P3	
Pellet durability (%)	72.69 ± 0.74[c]	84.35 ± 0.72 [b]	90.35 ± 0.44 [a]	90.95 ± 038 [a]	0.001
Pellet density (g/cm^3).	1.04 ± 0.16 [b]	1.06 ± 0.09 [b]	1.28 ± 0.04 [a]	1.39 ± 0.19 [a]	0.008
Moisture (%)	6.46 ± 0.01 [d]	6.67 ± 0.04[c]	6.77 ± 0.05[b]	6.87 ± 0.03[a]	0.001
Crude protein (%)	15.48 ± 0.03[a]	15.39 ± 0.01[b]	15.04 ± 0.04[c]	15.01 ± 0.02[c]	0.001
Crude fiber (%)	11.10 ± 0.07[a]	10.59 ± 0.04[b]	7.35 ± 0.05 [c]	5.04 ± 0.05 [d]	0.001
Crude fat (%)	8. 52 ± 0.06 [d]	9.21 ± 0.16 [c]	9.55 ± 0.16 [b]	10.24 ± 0.15[a]	0.001

P0: diet without banana peel silage; P1: diet with 10% banana peel silage; P2: diet with 20% banana peel silage, P3: diet with 30% banana peel silage. Average ± S.D. standard deviasi, [a, b, c, d] different superskrip in the same row shows significant differences (P<0,05)

Pellet Durability

Measurement of pellet durability is very important for adjusting treatment during storage and distribution of feed (Krisnan and Ginting, 2009). The inclusion of banana peel silage in native local chicken diet increased the friction durability. The fiber content in diet containing banana peel silage was significantly lower (P<0.05) and resulted in producing pellets more sturdy and not crushed easily. The fiber content in the diets affects the durability of the pellets, if the crude fiber is high, the durability of the pellets will be lower (Loar and Corzo, 2011). In addition, banana peels also contain starch, which is 76.12% (Rochi and Nuriyasa, 2020), thus strengthening the produced pellets. Thomas and van der Poel (1996) stated that the starch content of the constituent materials can affect the physical quality of the pellets produced. The durability of pellets containing banana peel silage ranged from 83.35 to 90.5% and according to the durability of chicken pellets, with a minimum durability index of 80% (Dozier et al., 2010).

Durability pellet in the treatment with 20 and 30% inclusion of banana peel silage were higher (P<0.05) than in treatment without and with 10% banana peels silage inclusion. It might be due to decreased fiber content in diet with 20 and 30% inclusion of banana peel silage. Muramatsu et al. (2015) stated that pellet durability was affected by fiber, starch, and fat content. Water-insoluble fiber can affect the pellet quality since the hardiness characteristic (rigidity and elasticity) causes the fiber to be unable to form proper binding between particles; therefore, large fiber addition in ration results in fragmentation and lead to the decreasing of physical quality of pellet. Ilmiawan et al. (2015) stated that low crude fiber content in pollard resulted in increasing pellet hardness.

Pellet Density

Pellet density is ratio between weight and volume change of materials. Pellet density have an important role in various processing, handling and storage processes (Rahmana et al., 2016). Analysis of variance showed that the banana peel silage inclusion had significant effect (P<0.01) on the pellet density. Increasing inclusion of banana peel silage in diets, increased the value of pellet density obtained. This is due to differences in dry matter of feed ingredients were used, which is low dry matter content in banana peel silage causes high moisture content. High moisture content in banana peel silage were due to metabolic processes of microorganisms that produce H_2O and then released on banana peels as substrate in the fermentation process. This finding was in line with Olagunju and Ifesan (2013) opinion that the metabolic activity of microorganisms produces H2O (water), which leads to increased water content in the substrate and decreased dry matter content.

The treatment using 20 and 30% banana peel silage had higher (P<0.05) than other treatments. This is because the water content in 20 and 30% banana peel silage is higher than treatments without and 10% of the inclusion. Lower dry matter content will produce pellets with low pellet density. Rahmana et al. (2016) stated that the higher the water content, the higher pellet density of pellets. Pellet density value obtained in this study was 1.19 g cm-3 on average, which were lower than pellet density of broiler chicken feed using 5% kepok banana peel, which was 1.38 g cm^{-3} (Harahap et al., 2020)

Moisture Content

Analysis of variance showed that the inclusion of kepok banana peel silage had significant effect (P<0.01) on the moisture content in crossbred native chicken pellet ration. This is likely caused by the microorganism metabolic activity that produces water molecules during the fermentation process of banana peels

that enhance the water content of fermented substrate. The finding was inline with Oluwamiyi dan Bazambo (2016) which states that the metabolic activity of microorganisms causes the increasing water content in fermented materials during the fermentation process.

Duncan's multiple range test results showed that 20 and 30% of banana peel silage had higher water content ($P<0.05$) than other treatments. This is due to water content differences in banana peel silage, rice bran, and corn used as ingredients in this study. Retnani et al. (2011) stated that the difference in the water content of the pellets was due to differences in the nutrient content of the feed ingredients, the temperature and humidity of the surrounding environment during the measurement process which allowed water absorption from the air. The moisture content of the pellets in this study was 6.46-6.87%. This finding was still following the Indonesian National Standard (SNI.7783.1-3:.2013), with the maximum water content value in native chicken feed being 14% (BSNI, 2013). The moisture content of the pellets in this study was lower than pellets using 5% kepok banana peel which was 7.23% as reported (Harahap et al., 2020).

Crude Protein of Pellet

Analysis of variance showed that inclusion of kepok banana peel silage had a very significant effect ($P<0.01$) on the crude protein content of native chicken pellets. It can be seen that the highest crude protein content was found in the treatment without kepok banana peel silage. The higher crude protein content in the treatment without banana peel silage should lead to higher pellet durability than the banana peel silage treatment. This is might be due to the high crude protein content was followed by high crude fiber content, and the difference in crude fiber content was higher than the difference in crude protein content when compared to the treatment using kepok banana peel silage. Briggs et al. (1999) stated that high protein content in feed will produce pellet with better physical quality.

Crude Fiber of Pellet

Based on the analysis of variance, the inclusion of kepok banana peel silage had significant effect ($P<0.01$) on the crude fiber content of native chicken pellets. The highest crude fiber content was in the treatment without banana peel silage. The feed ingredients contained are high in crude fiber content such as rice bran, corn, and fermented banana peel at 13%, 2.6% 8.1%, respectively. Nutrient levels of feed ingredients affect the physical and nutritional quality of the pellets produced (Briggs et al., 1999). Thomas dan van der Poel (1996) explained that crude fiber affects physical quality of pellets. High crude fiber content decreases pellets' physical quality. The volume in feed contained high crude fiber formed air cavities in the pellets produced, therefore, it can be easily brittle (Ilmiawan et al., 2015; Harahap and Zain, 2021).

Crude Fat of Pellet

Based on the analysis of variance, the inclusion of kepok banana peel silage had significant effect ($P<0.01$) on the crude fat content of native chicken pellets. It can be seen that the highest crude fat content was found in the treatment using 30% kepok banana peel silage. The high level of crude fat is due to the banana peel silage, caused by increasing of fat content contributed by microorganisms that play a role in the fermentation process. Suadnyana et al. (2017) stated that the bacterial body consists of 6-11% fat. The increasing fat content also occurs in fermented banana peels using bran as a soluble carbohydrate (Koni and Foenay, 2020a).

The treatment without kepok banana peel silage had lower ($P<0.05$) fat content than that used kepok banana peel silage. This difference is due to the addition of silage, which is higher in fat content than corn and bran. Microorganisms utilize nutrients in banana peels to form body fat during fermentation resulting in higher fat content in the substrate. Atika et al. (2015) stated that microorganisms in the ensilase form fatty acids and increase the fat content. Fat content was increased in banana peel silage using goat rumen fluid (Sa'o et al., 2021) and fermented banana peels with tape yeast (Koni et al., 2019).

The results of this study differ from the opinion of Muramatsu et al. (2015) which states that high fat content will produce pellets with low durability. Increasing fat content is one factor that causes pellets containing banana peel silage to have higher friction resistance value than pellets without the addition of kepok banana peel silage. Behnke (1989) stated that the pellet quality of 40% was influenced by the nutrient content of the feed ingredients used in the formulation. Zaenuri et al. (2014) stated that the difference in fat content was due to variation quality of raw materials were used, such as type of raw material and the manufacturing process. Briggs et al. (1999) stated that oil or fat content in the feed

ingredients will affect durability of the pellets produced. An increase of protein content necessarily follows the use of high-fat source feed ingredients to avoid negative effect on pellet durability (Abadi et al., 2019)

CONCLUSION

The inclusion of kepok banana peel silage has a positive effect on the physical and nutritional properties of native chicken feed pellets. The addition of kepok banana peel silage up to 30% produced pellets with the highest pellet durability, pellet density, moisture content, crude fat, crude protein content, and the lowest crude fiber.

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REFERENCES

Abadi, M. H. M. G., H. Moravej, M. Shivazad, M. A. K. Torshizi, and W. K. Kim. 2019. Effect of different types and levels of fat addition and pellet binders on physical pellet quality of broiler feeds. Poultry Science. 98: 4745–4754. DOI: http://dx.doi.org/10.3382/ps/pez190

Abdollahi, M. R., and V. Ravindran. 2013. Influence of pellet length on pellet quality and performance of broiler starters. Journal of Applied Poultry Research 22:516–522. DOI: http://dx.doi.org/10.3382/japr.2013-00736

Abdollahi, M. R., V. Ravindran, and B. Svihus. 2013. Pelleting of broiler diets : An overview with emphasis on pellet quality and nutritional value. Animal Feed Science and Technology 179:1–23. DOI: http://dx.doi.org/10.1016/j.anifeedsci.2012.10.011

Akhadiarto, S. 2010. The effect of the utilization of cassava peel waste in processing pellet poultry ration. Jurnal Teknik Lingkungan. 11: 127–138.

AOAC. Association of Official Analytical Chemists. 2005. Official Methods of Analysis of the Association of Official Analytical Chemists. 18th ed. Association of Official Analytical Chemist, Washington, DC.

Atika, T., Liman, and R. Sutrisna. 2015. The effect of additioning cassava flour with different level against to nutrition content of vegetable waste silage. Jurnal Ilmiah Peternakan Terpadu 3:110–115. DOI: htt/doi.org/10.23960/jipt.v3i3.p%25p.

Behnke, K. C. 1989. Factors influencing pellet quality. ournal of Chemical Information and Modeling 53:19–22.

Briggs, J. L., D. E. Maier, B. A. Watkins, and K. C. Behnke. 1999. Effect of ingredients and processing parameters on pellet quality. Poultry Science 78: 1464–1471. DOI: https://doi.org/10.1093/ps/78.10.1464.

BSNI. Badan Standardisasi Nasional. 2013. Pakan ayam buras Bagian 2 : Grower SNI 7783.2.2013. BSN, Jakarta.

Chrysostomus, H. Y., T. N. I. Koni, and T. A. Y. Foenay. 2020. The effect of various additives on crude fiber and mineral content of kepok banana peels silage. Journal of Tropical Animal and Veterinary Science 10: 91–97. DOI: https://doi.org/10.46549/jipvet.v10i2.100

Diarra, S. S. 2018. Peel meals as feed ingredients in poultry diets: Chemical composition, dietary recommendations and prospects. Journal of Animal Physiology and Animal Nutrition 102 (5): 1284-1295. DOI: https://doi.org/10.1111/jpn.12954.

Dozier, W. A., K. C. Behnke, C. K. Gehring, and S. L. Branton. 2010. Effects of feed form on growth performance and processing yields of broiler chickens during a 42-day production period 1. J ournal of Applied Poultry Research 19: 219–226. DOI:http://dx.doi.org/10.3382/japr.2010-00156

Fitroh, B. A., W. Wihandoyo, and S. Supadmo. 2018. The use of banana peel meal (*Musa paradisiaca*) as substitution of corn in the diets on performance and carcass production of hybrid ducks. Bulletin of Animal Science. 42: 222–231. DOI:https://doi.org/10.21059/buletinpeternakan.v42i3.31998.

Gasperz, V. 2006. Teknik analisa dalam penelitian percobaan. Edisi III. Tarsito, Bandung.

Harahap, A. E., and W. N. H. Zain. 2021. Physical quality of pellets with addition of cassava leaf flour level and different

binders. Wahana Peternakan 5:5–14. DOI: https://doi.org/10.21776/ub.jnt.2020.003.02.4.

Harahap, S., A. E. Harahap, and E. Irawati. 2020. Physical of pellet with addition of banana peel flour in a ration different storage times. Jurnal Nutrisi Ternak Tropis 3 (2): 1–80. DOI:https://doi.org/10.21776/ub.jnt.2020.003.02.4.

Hudiansyah, P., D. Sunarti, and B. Sukamto. 2015. Effect of fermented banana peels in the diet on energy availability of broiler. Agromedia 33:1–9. DOI:https://doi.org/10.47728/ag.v33i2.109.

Ilmiawan, T., B. Sulistiyanto, and C. S. Utama. 2015. The effect of fermented-pollard addition to pellet on the crude fiber and the physical quality of pellet. Jurnal Litbang Provinsi Jawa Tengah 13:143–152.

Koni, T. N. I. 2013. Effect of fermented banana peel on broiler carcass. Indonesian Journal of Animal and Veterinery Science 18 (2): 153–57. DOI: https://doi.org/10.14334/jitv.v18i2.315.

Koni, T. N. I., J. Bale-Therik, and P. R. Kale. 2013. Utilizing of fermented banana peels by rhyzopus oligosporus in ration on growth of broiler. Jurnal Veteriner. 14:365–370.

Koni, T. N. I., and T. A. Y. Foenay. 2020a. Decreasing of tannins from banana peel silage with different additives. Indonesian Animal Science Journal 15 (3): 333–38. DOI:https://doi.org/10.31186/jspi.id.15.3.333-338.

Koni, T. N. I., and T. A. Y. Foenay. 2020b. Effect of tapioca level and ensilage length on tannin and mineral content of kepok banana peels silage. Jurnal Ilmu Ternak 20 (2): 87–94. DOI:https://doi.org/10.24198/jit.v20i2.29894.

Koni, T. N. I., T. A. Y. Foenay, and Asrul. 2019. The nutrient value of banana peel fermented by tape yeast as poultry feedstuff. Jurnal Ilmu-Ilmu Peternakan 29 (3): 234–40. DOI: https://doi.org/10.21776/ub.jiip.2019.029.03.05.

Koni, T. N. I., Zuprizal, Rusman, and C. Hanim. 2017. Utilization of *Amorphophallus companulatus* tubers meal on the growth of broilers. In: Seminar Nasional Program Studi Peternakan Fakultas Pertanian Universitas Sebelas Maret. Surakarta, Surakarta. p. 32–36.

Krisnan, R., and S. P. Ginting. 2009. The utilization of solid ex-decanter as a binder for pelleted complete feed: a physical evaluation of pelleted complete feed. In: Seminar Nasional Teknologi Peternakan dan Veteriner. p. 480–486.

Loar, R. E., and A. Corzo. 2011. Effects of feed formulation on feed manufacturing and pellet quality characteristics of poultry diets. World's Poultry Science Journal 67 (1): 19–28. DOI:https://doi.org/10.1017/S004393391100002X.

Mandey, J. S., J. R. Leke, W. B. Kaunang, and Y. H. S. Kowel. 2015. Carcass yield of broiler chickens fed banana (*Musa paradisiaca*) leaves fermented with Trichoderma Viride. Journal of the Indonesian Tropical Animal Agriculture 40: 229–233.

Muramatsu, K., A. Massquetto, F. Dahlke, and A. Maiorka. 2015. Factors that Affect Pellet Quality: A Review. Journal of Agricultural Science and Technology 5 (9): 717–22. DOI: https://doi.org/10.17265/2161-6256/2015.09.002.

National Research Council (N.R.C.). 1994. Nutrient Requirements of Poultry. 9th ed. National Academy Press, Washington, D.C.

Olagunju, A. I. and B. Ifesan. 2013. Changes in nutrient and antinutritional contents of sesame seeds during fermentation. J Journal of Microbiology, Biotechnology and Food Sciences 2 (6): 2407–10.

Oluwamiyi, O., and I. Bazambo. 2016. Nutritional and amino acid analysis of raw, partially fermented and completely fermented locust bean (*Parkia biglobosa*) seeds. frican Journal of Food, Agriculture, Nutrition and Development 16 (2): 10866–83.DOI:https://doi.org/10.18697/ajfand.74.15025.

Rahmana, I., D. A. Mucra, and D. Febrina. 2016. Physical quality on finisher phase broiler chicken pellet with addition of animal feses and different binder. Jurnal Peternakan 13 (1): 33–40.

Retnani, Y., E. D. Putra, and L. Herawati. 2011. The effect of different water spraying level and storage period on endurance of pellet broiler finisher. Agripet. 11:10–14.

Retnani, Y., R. S. Rachman, and H. A. Sukria. 2010. The effect of reduction of maize as starch source on flow rate of pellet in continous production process. Agripet. 10:16–20.

Rochi, R., and I. M. Nuriyasa. 2020. Using banana peels in pellet rations to improve performance of local male rabbits (*Lepus nigricollis*). International Journal of Life Sciences 4 (3): 59–71. DOI: https://doi.org/https://doi.org/10.29332/ijls.v4n3.550.

Sa'o, T. M., T. A. Y. Foenay, and T. N. I. Koni. 2021. Nutritive content of banana peel flour (*Musa paradisiaca*) fermented by goat rumen fluid. Jurnal Ilmu Peternakan Terapan 4 (2): 78–83. DOI: https://doi.org/10.25047/jipt.v4i2.2467.

Suadnyana, I. M., I. G. L. O. Cakra, and I. W. Wirawan. 2017. Physical and chemical quality of rice straw silage made by the addition of bali cattle rumen fluid. Journal of Tropical Animal Science 5 (1): 181–88.

Thomas, M. and A. F. B. van der Poel. 1996. Physical quality of pelleted animal feed 1 . Criteria for pellet quality. Animal Feed Science and Technolgy 61: 89–112.

Zaenuri, R., B. Suharto, and A. T. S. Haji. 2014. The quality of fodder fish pellets from agriculture wastes. Sumberdaya Alam dan Lingkungan 1 (1): 31–36.