Research Article

Effect of Type and Dosage of Pellet Binders of Miana Plant (*Plectranthus scutellarioides* [L.]. R.Br) on Crude Fiber Digestibility, Nitrogen Retention, and Energy Metabolism in Broiler Chicken

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Abstract | This study aimed to determine the effect of the type and dosage of pellet binder Miana plant (*Plectranthus scutellarioides* [L]R.Br) on crude fiber digestibility, nitrogen retention, and energy metabolism in broiler chicken. The study used 30 broiler male chickens with an average body weight of 1.5 kg at five weeks of age. This study used an experimental method with a completely randomized design (CRD) of a 3x3 factorial pattern which was repeated three times. Factor A (type of pellet binder): A1 (brown seaweed), A2 (taro tuber), and A3 (tapioca flour), then factor B (dosage of pellet binder): B1 (1.5; 3.3; and 4.5%). Crude fiber digestibility, nitrogen retention, and energy metabolism were measured. The results showed no interaction (p>0.05) between the type of pellet binder and dosage of pellet binder on the digestibility of crude fiber, nitrogen retention, and energy metabolism of Miana plant pellets on broiler chicken. The type of pellet binder had a non-significant (p>0.05) effect on crude fiber digestibility, nitrogen retention, and energy metabolism of Miana plant pellets on broilers. However, the dosage of pellet binder had a highly significant impact (p<0.01) on crude fiber digestibility, nitrogen retention, and energy metabolism of Miana plant pellets on broilers. In conclusion, there was no interaction between the type and dosage of pellet binder on crude fiber digestibility, nitrogen retention, and energy metabolism of Miana plant pellets on broiler chicken. The best dosage of Miana plant pellet binder for all types of binder was found at 3.0%, with crude fiber digestibility of 45%, nitrogen retention of 59.92%, and metabolic energy of 1871.21 Kcal/kg.

Keywords | Binder type, Binder dosage, Broiler chicken, Pellet, Miana plant

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INTRODUCTION

The livestock industry in Indonesia is growing; this development demands good quality feed, available at any time at a reasonable price, and does not compete with human needs. There are several forms of serving diet for poultry, namely flour, crumbles, and pellets. Miana plants (*Plectranthus scutellarioides* [L.].R.Br) in the form of flour can be included as a mixture of broiler diets up to 12.5% (Mahata et al., 2021). However, based on observations in the field, the provision of Miana plant flour on the broiler was spilled from the feeding place when consumed by broiler chicken, leading to their inability to optimally utilize the content of phytochemicals, such as alkaloids, flavonoids, saponins, tannins, and anthocyanins (Auliawan and

Cahyono, 2014; Puspita et al., 2018). In addition, Miana plants also contain 84.5% moisture content, 15.5% dry matter, 14.96% crude protein, 21.09% crude fiber, 10.18% crude fat, 13.6% ash, 1.357, 39 kcal/kg metabolic energy, and 206.40 ppm anthocyanins (Mahata et al., 2021). Efforts to utilize phytochemicals due to the large spillage of flour in food containers when consumed by broilers can be overcome by changing the form of feed ingredients from flour to pellet. Feed pellets were reported to positively affect the broiler chicken's growth performance, feed consumption, and feed conversion (Abdollahi et al., 2013; Abdollahi et al., 2018). Manufacturing feed ingredients in the form of pellets requires a binder. Animal feed factories commonly use expensive synthetic binders such as bentonite, lignosulfonates (Retnani et al., 2010), and Carboxyl Methyl Cellulose (CMC). Some materials potentially used as pellets binder are brown seaweed (Sargassum binderi), taro tubers (Colocasia esculenta), and tapioca flour (*Manihot utilissima*. Pohl).

Alginate active compounds in brown seaweed act as adhesives (Saade and Siti, 2009). Brown seaweed Sargassum binderi contains 40.51% alginate (Dewi, 2020). Pellet binder for manufacturing fish feed pellets using brown seaweed can be used up to 3.7% to produce good quality pellets (Sutrisno, 2016). Taro tubers (*Colocasia esculenta*) are a type of tuber with binder power. The high amylopectin in taro tubers makes them fluffier and sticky (Aurum and Elisabeth, 2015). The starch content in taro tubers was reported to be 75.19%, consisting of 7.51% amylose and 67.68% amylopectin (Kaushal et al., 2011). Taro tuber flour can be used up to 4% as a binder for chicken pellet rations (Liu et al., 2020). The other binder is tapioca flour, derived from the extraction of cassava tubers (*Manihot utilissima.* Pohl) which has been washed and dried (Wikantiasi, 2001; Fathia, 2016). Tapioca flour contains 83% amylopectin and 17% amylose (Winarno, 2004). The use of 5% tapioca flour in manufacturing duck feed in the form of pellets shows the physical properties of the ratio with good quality (Syamsu, 2007). The addition of the type and dosage of pellet binder will determine the quality of the pellets produced and the digestibility of the feed substances contained in the pellet-shaped ration, mainly due to the presence of different adhesive components alginate in brown seaweed. Digestibility is also influenced by the rate at which feed travels through the digestive tract, the physical form of feed ingredients, and the composition of nutrients in feed ingredients (Sukaryana et al., 2011). Furthermore, using the right dosage of pellet binder will produce pellets with different hardness levels, which will determine the quality and digestibility of the pellets. Parsons et al. (2006) reported pellet rations with a harder texture due to the concentration of adhesive used, causing a higher nitrogen retention value of pellet rations compared to the retention value of pellet rations with soft texture, only by adding water to broilers (Parsons et al., 2006). The quality of the pellets is also influenced by the fiber that serves as the pellet framework (Balagopan et al., 1988). Noersidiq (2015) reported that the increasing consumption of crude fiber would increase the excretion of crude fiber, thereby reducing the digestibility of crude fiber. In addition, Wulandari et al. (2013) also stated that the metabolic energy value of a feed ingredient is also related to the crude fiber content of the feed ingredient. Furthermore, they also stated that the metabolic energy value of a feed ingredient is also related to the crude fiber content of the feed ingredient. Nevertheless, there has been no report on the production of broiler chicken feed made from Miana (*Plectranthus scutellarioides* [L.] R.Br) in a pellet form using different types of pellet binders (brown seaweed, taro tubers, and tapioca flour) with varying doses for broiler chicken feed and its effect on crude fiber digestibility, nitrogen retention, and energy metabolism. Therefore, this study was carried out to determine the effect of the type and dosage of pellet binder made of Miana plant (*Plectranthus scutellarioides* [L]R.Br) on crude fiber digestibility, nitrogen retention, and energy metabolism in broiler chicken.

MATERIALS AND METHODS

Ethical approval

This study has been approved by the animal ethics committee of Universitas Andalas, Padang, Indonesia, with registration number: 29/UN.16.2/KEP FK/2023.

Research material

This study used an experimental method with a completely randomized design (CRD) with a 3x3 factorial pattern and three replications. Factor A (type of pellet binder) was composed of A1 (brown seaweed), A2 (taro tuber), and A3 (tapioca flour), while factor B (dosage of pellet binder) was composed of B1 (1.5; 3.3; and 4.5%). This study used 30 male broiler chickens with a body weight of 1.5 kg, at five weeks of age. Miana plants (*Plectranthus scutellarioides* [L.] R. Br.) consisted of leaves and stems (30 cm left from the ground), seaweed (*Sargassum binderi*), taro tubers (*Colocasia esculenta* (L.) Schott), tapioca flour (*Manihot utilissima.* Pohl), selenium, H_2SO_4, distilled water, NaOH, methyl red, acetone, and methyl orange.

The Miana plant flour sample preparation

The Miana plant flour was prepared by chopping the Miana leaves into a size of 2-3 cm. Then, the sliced leaves were dried in the sun for 3-5 days and were ground using a Hummer mill HMR-50 grinder machine.

Pellet binder preparation

The pellet binders used in this experiment were brown sea

Table 1: Nutrient content, energy metabolism, and chemical composition, of the 9 feeds tested in this study

Feed Materials (%)	AIB1	AIB2	A1B3	A2B1	A2B2	A2B3	A3B1	A3B2	A3B3
Miana flour (*Plectranthus scutellarioides* [L.] R.Br)	98.5	97.00	95.5	98.5	97.00	95.5	98.5	97.00	95.5
Seaweed (*Sargassum binderi*)	1.5	3.00	4.5	-	-	-	-	-	-
Taro tubers (*Colocasia esculenta* (L.) Schott)	-	-	-	1.5	3.00	4.5	-	-	-
Tapioca flour (*Manihot utilissima*. Pohl)	-	-	-	-	-	-	1.5	3.00	4.5
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Crude protein	14.83	14.70	14.57	14.82	14.46	14.53	14.74	14.52	14.30
Crude fat	10.04	9.90	9.76	10.03	9.88	9.74	10.03	9.88	9.72
Crude fiber	20.89	20.69	20.49	20.82	20.55	20.28	20.80	20.52	20.23
Calcium	0.35	0.35	0.34	0.35	0.35	0.34	0.35	0.35	0.34
Available phosphor	0.26	0.25	0.25	0.26	0.25	0.25	0.26	0.25	0.25
Energy metabolism (Kcal/kg)	1337.03	1316.67	1296.31	1337.03	1316.67	1296.31	1337.03	1316.67	1296.31
Carbohydrate	0	0	0	1.25	2.50	3.75	1.33	2.66	3.99
Starch	0.85	1.70	2.56	1.13	2.26	3.38	1.34	2.67	4.01
Neutral Detergent Fiber (NDF)	0.30	0.60	0.91	0.00	0.00	0.00	0.00	0.00	0.00
Acid Detergen Fiber (ADF)	0.23	0.46	0.68	0.00	0.00	0.00	0.00	0.00	0.00
Cellulosa	0.08	0.15	0.23	0.00	0.00	0.00	0.00	0.00	0.00
Hemicellulosa	0.07	0.15	0.22	0.08	0.16	0.23	0.21	0.21	0.32
Lignin	0.15	0.29	0.44	0.00	0.00	0.00	0.00	0.00	0.00
Amylosa	0.09	0.19	0.28	1.02	2.03	3.05	0.51	0.51	0.77
Amylopectin	0.76	1.52	2.27	1.02	2.03	3.05	2.49	2.49	3.74
Anthocyanin (ppm)	203.30	200.21	197.11	203.30	200.21	197.11	203.30	200.21	197.11
Alginate	0.61	0.61	1.82	0.00	0.00	0.00	0.00	0.00	0.00
Ash	12.41	12.41	12.03	12.46	12.32	12.17	12.22	12.22	12.03

Note: A1B1: Seaweed (*Sargassum binderi*), 1.5% dosage
A1B2: Seaweed (*Sargassum binderi*), 3% dosage
A1B3: Seaweed (*Sargassum binderi*), 4.5% dosage
A2B1: Taro tubers (*Colocasia esculenta* (L.) Schott), 1.5% dosage
A2B2: Taro tubers (*Colocasia esculenta* (L.) Schott), 3% dosage
A2B3: Taro tubers (*Colocasia esculenta* (L.) Schott), 45% dosage
A3B1: Tapioca flour (*Manihot utilissima*. Pohl), 1.5% dosage
A3B2: Tapioca flour (*Manihot utilissima*. Pohl), 3% dosage
A3B3: Tapioca flour (*Manihot utilissima*. Pohl), 4.5% dosage

weed flour, taro tuber flour, and tapioca flour. The brown seaweed *Sargassum binderi* flour was first cleaned from the sea salt by soaking in flowing water for 15 hours. Secondly, the brown seaweed was dried and ground into flour. The taro tubers (*Colocasia esculenta* (L.) Schott) were peeled, cleaned with water, and cut into small pieces. Then the sliced tubers were dried in the sun and ground into flour with a moisture content of 14%. Furthermore, tapioca (*Manihot utilissima*. Pohl) flour was purchased from local minimarkets. Each type of pellet binder was weighed with dosage according to the treatment (1.5, 3, and 4.5%) of 500 g of Miana plant flour as pellet diets, namely 7.5, 15, and 22.5 g (Table 1). Furthermore, each type of pellet binder was mixed with 500 ml water and heated at 100°C while stirring until it formed a gel and allowed to stand up to the temperature of 70°C. Furthermore, each type of pellet binder forming a gel was mixed with 500 g Miana plant flour until well mixed. Then the pellet manufacturing process was carried out.

Pellet preparation from Miana plant flour

Miana plant flour mixed with each type of pellet binder was printed using a Thcheng PZ30 brand pellet machine. The pellet dimension was 0.5 cm with a diameter and length of 1 cm. The resulting pellets were dried in the sun for 3 hours and in the oven at 60°C for 24 hours. Then the resulting pellet was tested for physical quality.

The measurements

Water content: The moisture content of the pellets was measured using an oven at 105°C for 6-8 hours (AOAC, 1990).

Nitrogen retention and crude fiber digestibility: Nitrogen and Crude Fiber (CF) of excreta from each bird was analyzed using a proximate analysis (AOAC, 1990). The nitrogen retention was calculated using the method proposed by Sibbald (1985), and the CF digestibility was calculated using the method proposed by Mujahid et al. (2003) with few modifications, as follows:

Energy metabolism: The measurement of energy metabolism was calculated using the method proposed by Sibbald (1985).

Note:
Gef = Gross energy of feed ingredients (Kcal/kg)
X = Ration consumed (g/day)
Y = Amount of excreta issued (g/day)
Ye = Gross energy excreta (Kcal/kg)

Statistical analysis

All data were analyzed using an analysis of variance (ANOVA), and differences among treatments were further analyzed using an analysis of Duncan's multiple range test (Steel and Torrie, 1991).

RESULTS AND DISCUSSION

The nutritional content of each type and dosage of the binders, especially crude fiber, is not much different, so the digestibility of each type is not much different, and so is the binder dosage (Table 2). The size of the pellets in this study was also the same for each type and dosage of the binders, i.e., 1 cm long and 0.5 cm in diameter. Using a too close dosage is also likely to result in the absence of interaction between the type and dosage of adhesive. This confirms the results of the study done by Sukaryana et al. (2011) who found that digestibility is influenced by the rate at which food travels through the digestive tract, its physical form, the size of feed ingredients, and the composition of feed substances from the ingredients. Furthermore, Abdollahi et al. (2013) state that increasing the size from 3, 5, and 7 mm will increase the hardness of the pellets from 13.8 to 42.8 N. This condition affects the increase in the weight of the gizzard, its retention, and its volume, thereby increasing the nutrient digestibility because it takes more time to secrete hydrochloric acid and pepsin and increase intestinal reflux, which functions to re-expose digesta to pepsin.

The difference in crude fiber digestibility between treatments on binder at the dosages of 1.5, 3.0, and 4.5% is caused by the increased consumption of crude fiber in pellets of the Miana plant (*Plectranthus scutellarioides* [L.].R.Br.). This finding supports Rahmawati (2018), who found a negative relationship between the digestibility of feed ingredients and the crude fiber content of the feed ingredients. Earlier, Noersidiq (2015), who examined pineapple peel flour fermented with yogurt, found that the increasing consumption of crude fiber led to greater excretion of crude fiber, thereby reducing the digestibility of crude fiber. The cellulose content of the binder of brown seaweed is 5.01% (Dewi, 2020), taro tubers 1.95% (Ruminant laboratory 2021), and tapioca flour 4.67% (Zhang et al., 2013) and 14.72% (Maheswari et al., 2020). Cellulose is part of the fiber fraction in the Acid Detergent Fiber (ADF) group, which consists of cellulose and lignin. It is undigestible by broilers, so increasing the binder dosage of each different type of pellet binder increases the cellulose content in plant pellets. Miana (*Plectranthus scutellarioides* [L.].R. Br.) decreased crude fiber digestibility. This is in line with the opinion of Melati and Mas (2016), who argues that ADF determines the digestibility of some feed raw materials from forage. The higher the ADF level, the lower the quality and digestibility of raw materials forage feed. Wahju (2004) also believes that poultry does not have cellulase enzymes that can break down the crude fiber component in the form of cellulose. In this study, the digestibility value of crude fiber in different types and dosage of binders is close to the digestibility of crude fiber diets in the form of pellets with different binders (tapioca, gambir liquid waste, bentonite, and cassava) in native chickens, i.e., 40.48 - 42.52 % (Alhafizh, 2020).

The results of the statistical analysis show no interaction ($p>0.05$) between the type and dosage of binder on the nitrogen retention of Miana plant pellets (Table 2). However, the pellet binder dosage has a highly significant effect ($p<0.01$) on the nitrogen retention of Miana (*Plectranthus scutellarioides* [L.].R.Br.) pellets in broilers. Increasing the dosage of binder will increase the amount of protein in Miana plant pellets, so that protein consumption in Miana plant pellets increases, it becomes more digestible, and retained in the digestive tract. Another factor that increases the value of nitrogen retention in this study is the addition of binder dosage, resulting in pellets of Miana (Plectranthus scutellarioides [L.].R.Br.) with different hardness levels. The pellet hardness level of Miana (*Plectranthus scutellarioides* [L.].R.Br.) at a dosage of 1.5% is 95.33%, 96.30% at the dosage of 3.0%, and 97. 11% at the dosage of 4.5% (Lubis, 2021). The higher the binder dosage, the more complex the pellets will be and the higher the nitrogen retention value. Parsons et al. (2006) stated that pellets with a hard texture (addition of binder) had a better nitrogen

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Table 2: The average crude fiber digestibility, nitrogen retention, and energy metabolism of Miana plant pellet

Variables	Pellet binders type	Pellet binder dosage (%)			Mean
		B1	B2	B3	
Crude fiber digestibility (%)	A1	48.62	45.00	41.34	44.99
	A2	48.98	45.45	41.42	45.28
	A3	48.02	44.54	40.36	44.31
	Mean	48.54[a]	45.00[b]	41.04[c]	44.86
Nitrogen retention (%)	A1	55.17	60.03	62.99	59.40
	A2	56.01	60.15	63.54	59.90
	A3	54.73	59.57	62.88	59.06
	Mean	55.30[c]	59.92[b]	63.14[a]	59.45
Energy metabolism (Kcal/kg)	A1	1882.53	1870.41	1851.89	1868.28
	A2	1883.78	1873.66	1854.17	1870.53
	A3	1880.18	1869.57	1850.18	1866.64
	Mean	1882.16[a]	1871.21[b]	1852.08[c]	1868.48

Note: A1 = Pellet binder of brown seaweed *Sargassum binderi*; A2 = Pellet binder of taro tuber (*Colocasia esculenta* (L.) Schott); and A3 = Pellet binder of tapioca flour (*Manihot utilissima*). Pellet binder dosage (B1 = 1.5%; B2 = 3%; and B3 = 4.5%).
Different lowercase superscripts in columns and rows showed a highly significant effect ($P < 0.01$).

retention value than pellets with a soft texture (addition of water). In addition, Xu et al. (2015) reported that coarsely ground corn increased gizzard weight and retention time in broiler gizzards. It was further explained that this increase was due to a lower digesta pH, peptic digestibility, and increased enzyme-substrate interactions due to a more excellent retention time. The coarser the food, the longer it will be in the gizzard (Rizal, 2006). Gizzard's pH ranges from 1.5-2, but under the influence of buffering from food, its pH rises to approximately 3.5-5 (Wahju, 2004). The acidic conditions caused by HCl and produced by the proventriculus mucosal cells help activate pepsinogen into pepsin in the protein digestion process, and the results of this breakdown are in the form of peptides which will undergo further hydrolysis in the small intestine (Rizal, 2006). The binder dosage of the pellet in this study increases the nitrogen retention value but decreases the digestibility of the crude fiber. As the crude fiber content consumed by broilers is still within the digestible tolerance limit, it does not interfere with nitrogen retention results. Furthermore, this study found that increasing the dosage causes an increase of the crude fiber and protein content in the Miana plant pellets. Thus, increasing the dosage results in more digested protein in the digestive tract. Moreover, increasing the dosage also causes an increase in the hardness of the resulting Miana plant pellets, thus prolonging the digestion process in the gizzard. This confirms the study done by Gonzales et al. (2008) who found that pellets with a hard texture would take a long time to be digested in the gizzard so that nutrient digestibility will increase with the amount of hydrochloric acid produced to activate pepsinogen into pepsin.

The statistical analysis results show no interaction ($p>0.05$) between the type and the binder dosage on the energy metabolism of Miana plant pellets (Table 2). However, the pellet binder dosage has a highly significant effect ($p<0.01$) on the energy metabolism of Miana (Plectranthus scutellarioides [L.]. R. Br.) pellets in broilers. The increasing dosage of pellet binder in this study decreases the metabolic energy content of the pellets of Miana (*Plectranthus scutellarioides* [L.].R. Br.). This is related to the increase in the crude fiber content of the Miana plant pellets (Plectranthus scutellarioides [L.].R.Br.), which also increased with increasing the dosage of the pellet binder. The high crude fiber in feed ingredients will disrupt the efficiency of the use of other food substances so that the absorption of nutrients by the small intestine is reduced and causes a reduced contribution of these nutrients to the energy metabolism of Miana plant pellets (*Plectranthus scutellarioides* [L.]. R.Br.). Tillman et al. (1998) argue that too high crude fiber content in the feed makes the digestion of nutrients take longer and requires much energy, thereby reducing metabolic energy. The amount of undigested crude fiber will affect the absorption of other nutrients because undigested crude fiber will carry some of the digested nutrients out with the excreta. One of the factors that affect the value of metabolic energy, in addition to the gross energy content in the ration, is the content of polysaccharides (cellulose). and hemicellulose) which are included in the fiber fraction (Wulandari et al., 2013). Furthermore, Elvina (2008) states that if polysaccharides in crude fiber cannot be digested, it will reduce energy availability in the ration. In contrast, if polysaccharides in crude fiber can be digested, it will increase energy availability and metabolic

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energy. On the other hand, increasing the dose of Miana plant pellet adhesive will increase nitrogen retention, but this increase in nitrogen retention has not shown an increase in the energy metabolism of Miana plant pellets (Plectranthus scutellarioides [L.].R.Br.). The energy needed comes from carbohydrates, fats, and proteins contained in feed ingredients (Wahju, 2004). Gross energy contribution from carbohydrates is 4.15 cal/g, protein is 4.1 cal/g, and fat is 9.4 cal/g feed (carbohydrates: protein: fat = 4: 4: 9), but the energy in feed ingredients consumed is not entirely used by the body (Leeson and Summers, 2001).

CONCLUSION

This study concluded that there was no interaction between the type and dosage of binder on crude fiber digestibility, nitrogen retention, and energy metabolism of Miana plant pellets in broilers. The best binder dosage of Miana plant pellet for all types of binder is at 3.0%.

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CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest concerning the work presented in this paper.

NOVELTY STATEMENT

There has been no report on the production of broiler chicken feed made from Miana (Plectranthus scutellarioides [L.] R.Br) in a pellet form using different types of pel- let binders (brown seaweed, taro tubers, and tapioca flour) with varying doses for broiler chicken feed and its effect on crude fiber digestibility, nitrogen retention, and energy metabolism.

AUTHORS' CONTRIBUTIONS

Maria Endo Mahata participated in all stages of the research, namely the research design, the conduct of the experiment, sample analysis, data analysis, writing, and editing of articles. Oriyanti Br Situngkir_participated in conducting the investigation and was responsible for data analysis. Yan Heryandi, Takayuki Ohnuma, and Yose Rizal participated in the research and editing of the article. All authors participated in writing the article and checking the statistical analysis, and finally approved the last version of the article for publishing.

REFERENCES

Abdollahi MR, Ravindran V, Svihus, B (2013). Pelleting of broiler diets: An overview with emphasis on pellet quality and nutritional value. Anim. Feed Sci. Technol., 179 (1-4): 1-23. https://dx.doi.org/10.1016/j. anifeedsci.2012.10.011

Abdollahi MR, Zaefarian F, Ravindran V (2018). Feed intake response of broilers: Impact of feed processing. Anim. Feed Sci. Technol., 237 (2018): 154–165. https://doi.org/10.1016/j.anifeedsci.2018.01.013

Alhafizh. (2020). Penggunaan jenis perekat ransum pelet berbasis ampas kelapa terhadap retensi nitrogen, kecernaan serat kasar, dan energi metabolisme pada ayam kampung. Skripsi. Fakultas Peternakan Universitas Andalas, Padang.

AOAC (1990). Association of Official Analytical Chemists. Official Method of Analysis, 15th edition. Washington DC. pp 69-88.

Auliawan R, Cahyono B (2014). Efek hidrolisis ekstrak daun Iler (*Coleus scutellarioides*) terhadap aktivitas inhibisi enzim α-glukosidase. J. Sains dan Matematika, 22(1): 15-19. https://ejournal.undip.ac.id/index.php/sm/article/view/8052

Aurum FS dan Elisabeth DAA (2015). Formulasi tepung komposit keladi dan ubi jalar sebagai bahan baku mi kering pengganti sebagian terigu. Jurnal Pengkajian dan Pengembangan Teknologi Pertanian, 18 (3): 237-249. https://media.neliti.com/media/publications/139840-ID-formulasi-tepung-komposit-keladi-dan-ubi.pdf

Balagopalan C, Padmaja G, Nanda SK, and Moorthy SN (1988). Cassava in food, Feedand Industry. IRC Press, Florida.

Dewi YL (2020). Pengolahan rumput laut *Sargassum binderi* dan pengaruh penggunaannya dalam ransum terhadap performa dan kualitas telur ayam. Disertasi. Fakultas Peternakan Universitas Andala, Padang.

Elvina D (2008). Nilai energi metabolis ransum ayam broiler ayam broiler berbasis pollard yang ditambahkan enzim xilanase dan diproses dengan mesin pelleter. Fakultas Peternakan Institut pertanian Bogor, Bogor. https://adoc.pub/nilai-energi-metabolis-ransum-ayam-broiler-berbasis-pollard-.html

Fathia N (2016). Uji sifat dan mekanik pakan ikan buatan dengan perekat tepung tapioka. Universitas Lampung, Bandar Lampung. https://adoc.pub/uji-sifat-fisik-dan-mekanik-pakan-ikan-buatan-dengan-perekat.html

Gonzales-Alvarado J, Jimenez-Moreno ME, Lazaro R, Mateos GG (2008). Effect of fiber source and heat processing of the cereal on the development and pH of the gastrointestinal tract of broilers fed diets basedon corn or rice. Poult. Sci., 87

(9): 1779- 1795. https://doi.org/10.3382/ps.2008-00070

Kaushal P, Kumar V dan Sharma HK (2011). Comparative study of physicochemical, functional, antinutritional and pasting properties of taro (*Coocasiaesculenta*), rice (*Oryzasativa*) flour, pigeonpea (*Cajanuscajan*) flour and their blends. Food Sci. Technol. 48: 59-68. https://doi.org/10.1016/j.lwt.2012.02.028

Leeson S and Summers JD (2001). Nutrition of the chicken. 4th Edition. University of Books. Guelph.

Liu AS, Foenay TAY, dan Koni TNI (2020). Evaluasi penggunaan tepung keladi terhadap kualitas fisik dan kandungan nutrien pelet pakan ayam. J. Ilmu dan Teknol. Peternakan Tropis, 7(2):158-165. http://dx.doi.org/10.33772/jitro.v7i2.10940

Lubis HS (2021). Pengaruh jenis dan dosis perekat terhadap kualitas fisik tanaman Miana merah (*Plectranthus scutellarioides* [L.] R.Br.) berbentuk pelet sebagai bahan pakan unggas. Skripsi. Fakultas Peternakan Universitas Andalas, Padang.

Mahata ME, Putri DO, Arif, Ohnuma T, Rizal Y. (2021). The performance of broiler chickens fed on miana plant flour (*Plectranthus scutellarioides*, L.) R. Br. J. World Poult. Res., 11(3): 332-337. https://dx.doi.org/10.36380/jwpr.2021.39

Maheswari DU, Balakrishna V, Valli C (2020). Substrate specific enzyme mixture for tapioca flour. Int. J. Curr. Microbiol. Appl. Sci., 9 (11): 2995- 3001. https://doi.org/10.20546/ijcmas.2020.911.362

Melati dan Mas T (2016). Pengaruh enzim selulase *Bacillus subtilis* terhadap penurunan serat kasar kulit ubi kayu untuk bahan baku pakan ikan. Artikel Widyariset, 1 (1): 57-66. http://dx.doi.org/10.14203/widyariset.2.1.2016.57-66

Mujahid A, Asif M, Haq I, Abdullah M, Gilani AH (2003). Nutrient digestibility of broiler feeds containing different levels of variously processed rice bran stored for different periods. Poult. Sci., 82:1438-1443. https://doi.org/10.1093/ps/82.9.1438

Noersidiq A (2015). Pengaruh pemberian tepung kulit nanas yang diberi fermentasi dengan yoghurt terhadap retensi bahan kering, protein kasar, dan kecernaan serat kasar pada ayam broiler fase awal. Skripsi. Fakultas Peternakan Universitas Jambi.

Parsons AS, Buchana NP, Bleaming KP, Wilson ME, Moritz JS (2006). Effect of corn particle size and pellet textur on broiler performance in the growing phase. J. Appl. Poult. Res., 15: 245-255. https://doi.org/10.1093/JAPR/15.2.245

Puspita D, Tjahyono YD, Samalukang Y, Anthon B, Toy BAI, Totod NW (2018). Anthocyanin production from miana leaves (*Plectranthus scutellarioides*) as natural pigment. Jurnal Ilmu dan Teknologi Pangan, 4 (1): 298-303. https://doi.org/10.29303/profood.v4i1.78

Rahmawati (2018). Uji daya cerna serat kasar pada broiler yang diberikan antibiotik dan probiotik. Skripsi. Jurusan Ilmu Peternakan, Fakultas Sains dan Teknologi, Universitas Islam Negeri Alauddin Makassar, Makassar. http://repositori.uin-alauddin.ac.id/12343/

Retnani Y, Hasanah N, Ramyeni, dan Herawan L (2010). Uji sifat fisik ransum ayam broiler bentuk pellet yang ditambahkan binder onggok melalui proses penyemprotan air. Agripet. 10 (1) : 13 – 18. https://doi.org/10.17969/agripet.v10i1.632

Rizal, Yose. (2006). Ilmu Nutrisi Unggas. Andalas University Press, Padang.

Ruminant laboratory (2021). Results of analysis of the cellulose and lignin content of taro tubers. Faculty of Animal Husbandry, Andalas University, Padang.

Saade E dan Siti A (2009). Uji fisik dan kimiawi pakan buatan untuk udang windu penaeus monodon fab. yang menggunakan berbagai jenis rumput laut sebagai bahan perekat. Torani. J. Ilmu Kelautan dan Perikanan, 19 (2): 107-115.

Sibbald IR, Wolynetz MS (1985). Reletionship between estimates of bioavilable energgy made with adults cockerels and chicks. Effects of feed intake and nitrogen retention. Poult. Sci. 64: 127 -138.

Steel RGD, Torrie H (1995). Prinsip dan prosedur statistika suatu pendekatan biometrik. PT.Gramedia Pustaka Utama. Jakarta.

Sukaryana Y, Atmomarsono U, Yunianto VD, dan Supriyatna E (2011). Peningkatan nilai kecernaan protein kasar dan lemak kasar produk fermentasi campuran bungkil inti sawit dan dedak padi pada broiler. J. Ilmu Teknol. Peternakan 1(3): (167-172). https://media.neliti.com/media/publications/99243-ID-none.pdf

Sutrisno (2016). Pemanfaatan rumput laut coklat sebagai bahan tambahan pembuatan pelet pakan ikan. J. Opsi, 9 (2): 127-131. https://doi.org/10.31315/opsi.v9i2.2326

Syamsu JA (2007). Karakteristik fisik pakan itik bentuk pellet yang diberi bahan perekat berbeda dan lama penyimpanan yang berbeda. J. Ilmu Ternak, 7 (2): 128 – 134. https://doi.org/10.24198/jit.v7i2.2246

Tillman AD, Hartadi H, Reksohadiprodjo S, Prawirokusumo S dan Lebdosoekojo S (1998). Ilmu Makanan Ternak Dasar. Cetakan ke-6. Gadjah Mada University Press, Yogyakarta.

Wahju J (2004). Ilmu nutrisi unggas.Cetakan kelima. Universitas Gajah Mada Press, Yogyakarta.

Wikantiasi A (2001). Uji sifat fisik pakan berbentuk pelet tenggelam dengan proses pengukusan dan tingkat penambahan tepung tapioka sebagai perekat. Skripsi. Jurusan Ilmu Nutrisi Dan Pakan Ternak. Universitas Pertanian Bogor, Bogor. http://repository.ipb.ac.id:8080/handle/123456789/12762

Winarno F. G. (2004). Kimia Pangan dan Gizi. Cetakan ke-XI. PT. Gramedia Pustaka Utama. Jakarta.

Winarno FG (1990). Teknologi Pengolahan Rumput Laut. Pustaka Sinar Harapan,Jakarta.

Wulandari KY, Ismadi VDYB, dan Tristiarti (2013). Kecernaan serat kasar dan energi metabolis pada ayam kedu umur 24 minggu yang diberi ransum dengan berbagai level protein kasar dan serat kasar. Anim. Agricult. J., 2 (1): 9-17. https://ejournal3.undip.ac.id/index.php/aaj/article/view/1834/0

Xu Y, Stark CR, Ferket PR, Williams CM, Pacheco WJ, Brake J (2015). Effect of dietary coarsely ground corn on broiler live performance, gastrointestinal tract development, apparent ileal digestibility of energy and nitrogen, and digesta particle size distribution and retention time. J. Poult. Sci. 94:53–60. https://doi.org/10.3382/ps/peu015

Yose R (2006). Ilmu Nutrisi Unggas. Andalas University Press, Padang.

Zhang J, Fang Z, Deng H, Zhang X, Bao J (2013). Cost analysis of cassava cellulose utilization scenarios for ethanol production on flowsheet simulation platform. J. Bioresour. Technol. 134: 298-306. https://doi.org/10.1016/j.biortech.2013.02.041

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