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EFFECT OF DIFFERENT PELLET BINDERS ON PALM KERNEL MEAL ON GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY IN BROILER CHICKEN

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Abstract

Feed plays a paramount role in supporting growth, metabolism, and production performance. Their high price encourages the utilization of inexpensive and alternative feed ingredients. PKM (Palm Kernel Meal), one such feed ingredient, is produced by palm oil industries. However, its limited application is due to its high crude fiber content, which requires processing technologies such as pelletization with binder addition. Based on this background, this experiment was conducted to evaluate the effects of various types of natural and commercial binders on the performance and nutrient digestibility of 15% PKM-based pellets in broilers. The study was conducted for 5 weeks using 175 DOC broiler chickens of the CP 707 strain, arranged in a completely randomized design with 7 treatments and 5 replications. Observed variables are feed consumption, body weight gain, feed conversion ratio, crude protein digestibility, and metabolizable energy digestibility. The results showed that the use of PKM pellets with a binder significantly affected the growth and digestion of the broiler chickens. The best results were obtained when starch was used as a binder in pellet treatment. On this basis, starch is recommended as a binder for the preparation of 15% PKM pellets, which would contribute towards sustainable efficiency in the use of feed.

Keywords: Broiler, palm kernel meal, pellet binder

INTRODUCTION

Using leftover materials from farming and food production as different things to feed animals has been a focus. The use of agro-industrial by-products as alternative sources of feed ingredients has recently received immense attention in the livestock sector (Choct, 2015). Among the agro-industrial by-products with immense potential is palm kernel meal, a by-product of the palm oil processing sector. Although this product is known to be rich in protein, its high crude fiber content generally reduces digestibility and feed efficiency when used in poultry formulations (Sundu and Dingle, 2006).

Pelletization is one procedure that may enhance the use of PKM. This process may increase feed density, reduce the discriminability of feed ingestion in poultry, and improve feed system efficiency (Thomas et al., 1998). The quality of pellets will be greatly affected by the usage of binders. Useful binders also play a role in maintaining pellets strong, intact, and attractive to poultry (Retnani et al., 2011). Natural binders like starch, glutinous rice flour, and durian seed flour may serve as good alternatives for binders, as they are available and cheaper, with extra nutrients as well.

Previous observations indicated that animal feed made from agricultural waste, when processed with relevant technology, could enhance the productivity of broiler chickens (Sundu and Dingle, 2006). Nevertheless, related investigations regarding the impact of different natural binding materials on the physical properties of pellets as well as the performance of poultry are not extensive yet, especially since the relevant literature stresses the material properties of feed without

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referring to its biological aspects, such as consumption speed, weight increase, or overall digestion (Zimonja & Svihus, 2009).

This study aims to help achieve sustainable poultry production by optimizing resource use. Through PKM and the use of natural binding agents sourced locally, it is hoped to create effective, affordable, environmentally friendly poultry feed.

MATERIALS AND METHODS

Animals and Housing

The research was conducted at the Research Cage, Faculty of Animal Husbandry and Fisheries, Universitas Tadulako, namely in Sibalaya Village, Sigi Regency, Central Sulawesi. The research was conducted over a period of 5 weeks, from 1st of May until 13th of June 2021. A total of 175 unsexed day-old chicks of the CP 707 breed were taken from PT Charoen Pokphand Indonesia, Salatiga, Indonesia. All experimental procedures involving living animals were approved by the Institutional Animal Care and Use Committee (IACUC) of Universitas Tadulako.

In addition, the cages or pens used for the experiment comprised 35 individual cages measuring 90 cm x 90 cm x 60 cm (L x W x H). Five chickens per pen were maintained, and each experimental unit comprised five birds. The feeder was made of plastic, and the feeding system varied depending on the group, while the drinking water source was maintained using a manual drinker appropriate for the broilers.

Experimental Design

In this study, a Completely Randomized Design (CRD) with seven treatments and five replications per treatment was used. Five broilers comprised each replication. These treatments were designated as follows:

T0 = Control diet (without PKM);
T1 = Diet containing 15% PKM, unpelleted;
T2 = Diet containing 15% PKM, pelleted without binder;
T3 = Diet containing 15% PKM, pelleted with glutinous rice flour binder;
T4 = Diet containing 15% PKM, pelleted with durian seed flour binder;
T5 = Diet containing 15% PKM, pelleted with tapioca flour binder; and
T6 = Diet containing 15% PKM, pelleted with commercial binder (Lignobond).

Table 1 presents the nutrient content of the feed ingredients incorporated in the dietary treatments, including crude protein, metabolizable energy, amino acids, and mineral composition.

Observation Variables

Variables observed in the study included feed consumption, weight gain, feed conversion ratio, crude protein digestibility, and metabolizable energy. The feed consumption (g) is measured by the difference in weight of the feed prior to its distribution and the weight of the leftover feed. This feed measurement is conducted weekly and is cumulative; that is, feed consumption from the beginning of the study to the end. The body weight gain (g) obtained by subtracting the body weight of the chicken at the end of the research period from the body weight of the chicken at the beginning of the research period. The feed conversion ratio (FCR) was estimated using the following formula:

$$\text{Feed Conversion} = \frac{\text{Feed consumption (g)}}{\text{Body weight gain (g)}}$$

The nutrient digestibility variables included crude protein (CP) digestibility and metabolizable energy, was calculated using:

$$\text{Crude Protein} = \frac{\text{CP intake} - \text{Corrected CP in Excreta}}{\text{CP intake}} x\ 100$$

$$\text{Metabolizable Energy} = \frac{\text{Gross Energy Intake} - \text{Gross Energy Excreted}}{\text{Feed consumption}}$$

Data Analysis

The data obtained were then analyzed using analysis of variance based on the Completely Randomized Design (CRD) model (Steel and Torrie, 1991), with the following mathematical model:

$$Yij = \mu + \alpha_i + \varepsilon_{ij}$$

Where Y_{ij} is the response observed; i is the treatment (1,2,3,4,5), j is the replication (1,2,3.4); μ is the overall mean; α_I is the effect of the i-th treatment, and ε_{ij} is the experimental error associated with the i-th treatment and j-th replication. If the ANOVA results indicated significant treatment effects, further analysis was conducted using the Honestly Significant Difference (HSD) test.

RESULTS AND DISCUSSION

Table 3 shows the average results of the experiment on feed consumption, weight gain, feed efficiency, protein digestibility, and metabolizable energy digestibility of the broilers affected by the different pellet binding materials used in palm kernel meal.

Table 1. Nutrient content of feed ingredient

Feed Ingredients	Nutrient Content						
	Crude Protein (%)	Metabolizable Energy (Kcal/Kg)	Methionine (%)	Lysine (%)	Arginine (%)	Cysteine (%)	Calcium (%)
Palm kernel meal[1]	13.7	2,260	0.20	-	1.90	0.20	0.70
Corn[2]	8.60	3,350	0.20	0.30	0.30	0.20	-
Fish meal[2]	60.1	2,580	1.60	4.00	4.00	0.70	6.10
Rice bran[2]	12.0	2,980	0.30	0.60	1.00	0.30	0.10
Soybean meal[2]	44.0	2,230	0.60	2.70	3.10	0.70	0.30
$CaCO_3$[2]	-	-	-	-	-	-	40.0
Palm oil[2]	-	9,001	-	-	-	-	-
DCP[2]	-	-	-	-	-	-	23.3
Salt[2]	-	-	-	-	-	-	-
Premix[2]	-	-	-	-	-	-	-
Lysine[2]	76.0	-	-	76.0	-	-	-
Methionine[2]	98.0	-	98.0	-	-	-	-

Note: [1]NRC (1984), [2]NRC (1994).

Table 2. Feed consumption

Feed ingredients	Nutrient content		
	P0	P1-P2	P3-P6*
Palm kernel meal*	-	15.0	15.0
Corn	59.0	43.9	43.9
Fish meal	6.70	5.90	5.90
Rice bran	5.00	5.90	5.90
Soybean meal	20.0	19.9	19.9
$CaCO_3$	3.00	3.00	3.00
Palm oil	2.40	4.00	4.00
DCP	2.60	1.60	1.60
Salt	0.30	0.20	0.20
Premix	0.30	0.30	0.30
Lysine	0.35	0.15	0.15
Methionine	0.35	0.15	0.15
Total	100	100	100
Nutrient content			
Crude protein (%)	19.1	19.1	19.1
Metabolizable energy (Kcal/Kg)	2960,4	2941,5	2941,5
Crude fiber (%)	0.70	0.50	0.50
Methionine (%)	1.30	1.10	1.10
Lysine (%)	1.10	1.40	1.40
Arginine (%)	0.30	0.30	0.30
Cysteine (%)	2.30	2.10	2.10
Calcium (%)	0.60	0.50	0.50

Note: Nutrient content is calculated based on Table 1. *PKM 13.01% + 1.9% Different Types of Binders.

Table 3. Average Feed Consumption, Body Weight Gain, Feed Conversion Ratio, Protein, Digestibility, and Metabolizable Energy during the Study

Treatment	Parameter				
	Feed Consumtion*	**Body Weight Gain***	**Feed Conversion***	**Protein Digestibility****	**Metabolizable Energy****
P0	3,542.3±29.9[ab]	2,097.0±68.5[a]	1.69±0.07[bc]	72.0±1.86[ab]	2778,6±110.7[ab]
P1	3,571.7±89.8[ab]	2,128.0±49.3[ab]	1.68±0.05[abc]	72.6±0.85[ab]	2709,3±34.3[a]
P2	3,627.6±38.9[b]	2,125.4±11.8[ab]	1.71±0.02[c]	74.3±1.20[ab]	2779,8±46.3[ab]
P3	3,576.2±37.8[ab]	2,127.1±41.5[ab]	1.68±0.02[abc]	74.4±1.41[ab]	2776,3±53.9[ab]
P4	3,551.6±43.4[ab]	2,150.1±30.7[ab]	1.65±0.03[abc]	70.4±1.46[a]	2774,0±54.7[ab]
P5	3,506.6±60.8[a]	2,195.9±47.5[b]	1.60±0.04[a]	75.9±0.82[b]	2913,0±43.0[b]
P6	3,511.3±15.3[a]	2,182.2±60.2[b]	1.61±0.04[ab]	74.1±3.08[ab]	2826,1±113.0[ab]

Note : P0: P0: Control; P1: PKM 15% without Pellets; P2: PKM 15% without Binder in Pellets; P3: PKM 15% in Pellets with Glutinous Rice Binder; P4: PKM 15% in Pellets with Durian Rice Binder; P5: PKM 15% + Pellets with Starch Binder P6: PKM 15% + Pellets with Lignobond Binder
* significant effect (P<0.05), ** very significant effect (P<0.01)
Different alphabets indicate significant differences between treatments.

Feed Consumption

Analysis of variance revealed that feed consumption was significantly (P<0.05) influenced by treatments, with values ranging from 3506,6±60.79 to 3627,6±38.89 g. Treatment P2 (15% PKM without binder addition during pelleting) had the heaviest feed consumption and significantly differed from treatments P5 and P6, while treatments P5 and P6 had the lowest feed consumption. Treatments P0, P1, P3, and P4 were in the intermediate group and did not differ significantly from each other, suggesting that overall feed consumption is mainly affected by the combination of PKM use and addition during the binder process.

These findings agree with Berliana et al. (2022), who found that supplementing the broiler diet with multi-enzymes did not significantly affect (P>0.05) feed consumption, which ranged from 2429,8 to 2547,3 g. In contrast, supplementation with 0-20% palm kernel meal in the diet significantly (P<0.05) affected feed consumption, with broilers consuming 3861,2 – 3988,3 g of feed. The supplementation of 0-20% palm kernel meal with enzymes into the diet was found by the same study to significantly affect (P<0.05) feed consumption, with broilers consuming 3861.2 – 3988,3 g of feed. According to Adhitama (2020), palm kernel meal substituted with untreated corn significantly increased the consumption of the feed (3242,3 g/bird), compared with the use of enzyme-treated palm kernel meal (3097,9 g/bird).

Among the treatments, it was observed that treatment P2 had higher feed consumption compared to P5 and P6. On the other hand, the remaining treatments did not show significant results. The higher feed consumption observed in treatment P2 suggests that adding 15% PKM without binder to the pelleted feed affected palatability and feed consumption. According to Adrizal et al. (2018), palm kernel meal contains a relatively higher amount of crude fiber. This can affect the texture of the feeds. In broiler chickens, a higher amount of crude fiber can result in lower feed consumption. However, with less-dense feed, the chickens can eat higher.

Higher feed consumption in treatment P2 (15% PKM without binder in pellets) compared to other treatments may be influenced by a softer pellet texture due to the absence of binder, so that feed is easier for chickens to consume. Generally, binders such as glutinous rice flour, durian seed flour, starch, and lignobond are added to increase pellet physical strength; however, they may increase pellet hardness and reduce feed palatability. Amerah et al. (2007) showed that feed hardness is a major factor affecting feed consumption in poultry, with softer or more easily crushed feed increasing intake.

On the other hand, treatments P3 to P6 used binders with a rather lower feed consumption that tended to converge, especially in the lowest consumption groups in P5 and P6. This means that the use of binders made pellets uniform and relatively hard, thus not encouraging increased feed consumption. According to Amerah et al. (2007), the addition of binders increases physical durability, but does not improve palatability when the pellet texture becomes too hard. Relatively similar feed consumption in the treatments of P3 to P6 reflects the effect of physical homogenization of the pellets resulting from binder use.

Body Weight Gain

Analysis of variance indicated that the treatments significantly affected body weight gain in broilers ($P<0.05$), with mean values ranging from 2097,2±68.5 to 2195,9±47.5 g. Post-hoc test indicated that the treatments P5 and P6 significantly increased body weight gain compared to the P0 control, while P1, P2, P3, and P4 did not differ significantly from P0 or P5 and P6. These findings show that the response to the body weight gain treatments is selective.

Previous studies reported that multienzyme supplementation to the ration did not have a significant effect ($P>0.05$) on body weight gain, consistent with relatively similar feed consumption (Sundu and Dingel, 2006). These results showed that supplementing broiler rations containing up to 30% palm kernel meal with enzymes can yield relatively equal chicken performance compared to the control. The average value, however, showed a trend of increasing body weight gain in some treatments, which is believed to be related to the optimization of digestion and nutrient absorption. According to Berliana et al. (2015), increased body weight gain can result from improved protein intake and utilization. This was clearly justified by Iqbal et al. (2012), who argued that protein consumption significantly determines body growth, as the process of body tissue synthesis largely depends upon protein synthesis.

The highest weight gain were P5 (15% PKM with starch binder) and P6 (15% PKM with lignobond binder), which were significantly different from the control P0. This suggests that combining palm kernel meal with the pelleting method and using different binders increased the ability to properly utilize these nutrients, thereby having an overall positive effect on the growth performance of the chicken. Weight gain in P5 and P6 suggests that the strength and energy content of the pellets have been important factors contributing to growth.

In treatment P1 (15% PKM not pelletized), although weight gain was significantly higher than in the control, there were no statistically significant differences. This shows that the PKM treatment, not pelletized, is not yet effective. Palm kernel meal is also naturally rich in protein and crude fiber. However, without proper processing, the feed will be unequally distributed, affecting its nutrient availability. Alimon (2004) explained that PKM, a crude fiber-based ingredient, needs further processing to enhance its nutrient utilization.

Treatment P2 (15% PKM without binder in pellet) had no significantly different value from the other treatments, despite being in pellet form. Without binder addition, the pellet structure becomes less stable and more easily fragmented, especially during consumption. It can decrease feed utilization efficiency even though this pelletization has improved nutrient distribution. According to Thomas et al. (1998), pelletization may improve feed efficiency by reducing selectivity during consumption, but pellet stability can become a more critical factor affecting growth performance. Treatments P3 (PKM with glutinous rice flour binder) and P4 (PKM with durian flour binder) tended to show higher weight gain than treatments P1 and P2, but this difference was not statistically significant. Glutinous rice flour and durian fruit flour, as natural binders, may provide greater stability to pellets and provide additional energy through their carbohydrate components. Besides improving pellet stability, glutinous rice flour forms starch gelatinization, which improves palatability and digestibility, while durian fruit flour is rich in soluble fiber and bioactive compounds and has the potential to support digestive health, as reported by Purwadani et al. (2018). However, these effects were too slight to produce significant differences compared to the other treatments.

Treatment P5 (PKM with starch-flour binder) had the highest body weight. Starch flour, as a binder, helps improve the weight and stability of the pellets, as it contains easily digestible starch that serves as a fast-track source of energy. Amerah et al. (2007) reported that the use of starch-based binders can help to improve the efficiency of nutrient digestion and the overall stability of the pellets. In addition, treatment P6 (PKM with lignobond binder) had the highest body weight gain, which was not significantly different from treatment P5. Lignobond, as a binder for the PKM group, helps promote pellet stability but does not add nutritional value. According to Saleh (2020), the stability of the higher-density pellets helps improve feed consumption, but the effect on nutrient digestion depends significantly on the overall ingredients used.

Feed Conversion Ratio

The analysis of variance showed that the addition of palm kernel meal (PKM) with different binders to the feed significantly and highly affected ($P<0.01$) feed conversion, which ranged from 1.60±0.04 to 1.71±0.02. A lower feed conversion ratio indicates better feed efficiency, as feed consumption can directly contribute to increased body weight. Variations in feed conversion ratio across treatments depended on the physical properties of pellets produced with different binder materials. Starch-based materials, such as glutinous and tapioca flours, can improve pellet composition and increase nutrient digestibility and nutrient utilization efficiency. Meanwhile, in treatments that did not use or add binding materials, which can lead to less ideal physical stability of the pellets, feed conversion values could be high, indicating less efficient pellets.

P0 (control) was significantly different from treatments P1, P3, and P4, but was not significantly different from treatment P5 and tended to be higher than treatment P6. The maximum feed conversion was observed in treatment P2 (1.71±0.02) with 15% PKM and without binder addition to the pellet. It implies that it has lowest feed conversion efficiency. These conditions may occur due to the unstable nature of the untreated pellet such that there is inadequate nutrient release and utilization in the digestive tract (Marodi et al., 2017). Adeola and Cowieson (2011) clarified that over-softening of feed may increase the surface area available for enzymes to act on. However, it may hasten feed passage through the intestinal tract with reduced contact time between nutrients and enzymes and decreased feed conversion efficiency.

The lowest (best) mean feed conversion ratio was observed in treatments P5 (1.60±0.04) and P6 (1.61±0.04). Treatment P5 differed significantly from the control and treatment P2, but it did not differ significantly from other treatments. Treatment P6 did not differ significantly from treatment P5 or from the other treatments. This means that starch and lignobond binders have the potential to increase the utilization of nutrients in the form of pellets. Starch binders, such as starch, form a well-defined pellet structure easily digested in the body, whereas lignobond, a synthetic binder, creates a strong bonding between particles without destroying the availability of nutrients.

Treatments P3 and P4 showed feed conversion values in the medium group and did not differ significantly from the control, and treatments P5 and P6. This means that the use of natural binders, such as glutinous rice flour and durian flour, resulted in better feed conversion than P2 but was less efficient than starch. This difference showed that the binder directly influences hardness and nutrient accessibility. High hardness can impair nutrient efficiency because it takes more energy for chickens to digest, as explained by Zimonja and Svihus (2009), who reported that pellet hardness inversely correlates with feed conversion efficiency in chickens, particularly in young ones.

The major difference between P2 and the remaining treatments may also be impacted by the crude fiber content of palm kernel meal. Palm kernel meal has a relatively high fiber content, and when at optimal levels, it can enhance health. But when this nutrient is combined with inadequate attention during pelleting and inadequate binding, this can impair health efficiency. Choct (2015) clarified that a proper balance among crude fiber content, texture, and pelvic physical properties is vital for achieving optimal health efficiency. The results, therefore, indicate that P5 is more efficient compared to P6, with P2 being less efficient owing to physical properties of the pellets, which are not conducive to optimal nutrient digestion and generation of energy.

Protein Digestibility

Results from the analysis of variance revealed that the inclusion of PKM with different binders during pellet feed production had a highly significant effect on protein digestibility, with P<0.01. Protein digestibility ranged from 72.0±1.86 to 75.9±0.82%. Control, P1, P2, P3, and P6 did not differ significantly, whereas P5 had a higher protein digestibility value than P4. Treatment P4 had the lowest protein digestibility, which was significantly lower than P5, while all other treatments fell between P4 and P5 and did not differ from either P4 or P5. This trend shows a selective impact of specific binder types on protein utilization efficiency, even though the treatments were not all significantly different from one another.

The largest increase in protein digestibility was found for the starch treatment (P5), which is attributed to its strong aromatic compound production during the heating step and its good gelation properties, which favor fast disintegration of the pellets and protein degradation in the intestine (Tillman et al., 1998). The remaining pellets, such as glutinous rice flour pellets (P3), contain high concentrations of amylopectin, which plays a significant role in developing a dense yet easily decomposed pellet structure with high protein digestibility. However, statistically, the protein digestibility of P3 was not significantly different from that of the control treatment or the other treatments in the intermediate group.

Durian seed flour (P4), as a natural binder, had lower protein digestibility scores, and their values were significantly different compared to P5. This can be attributed to its starch characteristics and its higher fiber content, which make it more difficult to degrade in the body. In contrast, lignobond (P6), as a synthetic binder, created very hard pellets. In this study, the protein digestibility scores were not significantly different compared to the other treatments in the intermediate level. By creating too hard pellets, the disintegration time may be extended, resulting in suboptimal protein utilization. Maximal protein digestibility is essential to ensure efficient amino acid supply for growth tissue synthesis and to promote maximal growth with less excess fat (Devries and Phillips, 2015).

The findings on the results of starch as a binder, showing the highest protein digestibility compared to other treatments, especially durian seed flour, are based on the physical and chemical characteristics of starch, which contribute to the effectiveness of digestion. Starch with high starch content has a good binding ability to form pellets with a dense texture but can easily disintegrate. Starch flour also contains starch, which serves as an additional energy-rich component to support the microorganisms in the digestive tract, thereby contributing to increased protein utilization. This supports the statement of Abdollahi et al. (2013) that the use of starch flour as a binder can increase the physical efficacy of pellets and the digestion of protein and metabolic energy.

Other binders like lignobond and durian seeds have relatively higher crude fiber content-lignobond, with about 12-15% crude fiber, and durian seeds, with about 10-14% (Amiza and Noor Aziah, 2012; Borregaard, 2020). As such, it is less than ideal for binding due to its negative implications for protein digestibility. High crude fiber tends to delay digestion and reduce nutrient utilization efficiency. Thus, although these two binders can enhance pellet physical stability, protein digestibility is not as good as that achieved with starch-based binders such as tapioca flour. This is supported by Sutrisno et al. (2013), who stated that any binder capable of optimizing pellet texture and nutrient bioavailability would increase protein digestibility.

Using agricultural and plantations by-products as alternative ingredients or additives is greatly preferred because these methods are cost-effective and efficient business practices. Based on the categories established according to the digestibility of the feed, the protein digestibility level within all treatments on the study falls within the high quality category because the values are above 70% as indicated by the comparison done by Tillman et al. (1998), which stated that generally all feeds are still acceptable to be used.

Metabolizable Energy

Analysis of variance results showed that the inclusion of PKM with different binders in pellet feed production significantly affected metabolic energy digestibility (P<0.01). The metabolic energy digestibility values ranged from 2,709.3±34.3 to 2,913.0±43.0 kcal/kg. P5 had the highest value for metabolic energy digestibility and was significantly different from the other treatments, whereas treatment P1 had the lowest value. Treatments P0, P2, P3, and P4 presented metabolic energy digestibility values that did not differ significantly among themselves, while treatment P6 occupied an intermediate position, being significantly higher than P1 and lower than P5.

The highest digestibility of metabolizable energy was recorded in treatment P5 (15% PKM with starch binder) with 2,913.0±43.0kcal/kg. The findings highlighted that the application of starch as a binder improves the bioavailability of metabolizable energy in the feed. This is because starch has a high starch content that can be easily hydrolyzed to glucose by the amylase enzyme. This makes the starch a readily available source of metabolizable energy for the metabolism of the animals. In addition, the application of starch enables the production of pellets with high, consistent physical strength, resulting in lower losses of undigested feed. This improves the utilization of the metabolizable energy that can come from palm kernel meal, the main ingredient. This confirms the view, according to Massuquetto et al. (2018), that pellets with high physical strength can improve their digestion in the animals' digestive systems. In addition, the view argues that the utilization of metabolizable energy can be improved.

These results agree with the report of Sugiarto and Toana (2018), who stated that the inclusion of 7.5% boiled durian seed flour in feed had a very significant effect (P<0.01) on apparent metabolic energy digestibility, which was approximately 2,700 kcal/kg. Moreover, Sholichatunnisa et al. (2022) reported that supplementation of 10% date seed flour significantly (P<0.05) increased apparent metabolic energy digestibility, ranging from 2,521.7 to 2,896.1 kcal/kg. In this experiment, an increase in apparent metabolic energy digestibility in treatment P5 was also suspected to be influenced by the specific smell of cassava (tapioca) during the pelleting process, thus increasing feed consumption and utilization by livestock.

Treatment P6 also showed higher metabolic energy digestibility than P0, P2, P3, and P4, but remained lower than P5. Lignobond is a synthetic binder that enhances the cohesiveness and physical stability of pellets, thereby supporting feed energy utilization. However, lignobond tends to have a relatively high lignin content, which limits digestion because digestive enzymes cannot easily break it down. This leads to lower energy utilization efficiency compared to starch-based binders.

Control, P2, P3, and P4 showed relatively similar metabolic energy digestibility values and were not significantly different from each other. This suggests that even as the pelletization process and the use of natural binders such as glutinous rice flour and durian seed flour can enhance the physical quality of the pellets, their effect in increasing metabolic energy digestibility is less than optimum compared with the use of starch flour. Durian seed flour is rich in fiber and thus has the potential to increase digesta viscosity in the digestive tract, thereby inhibiting energy absorption. On the other hand, glutinous rice flour, though high in energy content, tends to produce pellets that are less stable upon wetting, affecting thereby energy digestion efficiency.

Treatment P1 (15% PKM without pellets) had the lowest metabolic energy digestibility. This suggests that the pelletization process, which employs binders, makes the feeds less ideal for efficient energy utilization due to the nature of the unpelleted feeds, which lack ideal particles for dispersion.

CONCLUSIONS

Inclusion of 15% PKM in pelleted broiler diets, combined with different binders, significantly affected performance and nutrient digestibility. Among the treatments, starch was identified as the most effective binder, resulting in the highest body weight gain, improved feed conversion ratio, and enhanced crude protein digestibility and metabolizable energy. Therefore, starch can be recommended as a suitable binder in pelleted diets containing 15% PKM to improve broiler performance and nutrient utilization.

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