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ECO-FRIENDLY FEED MIGRATION: QUALITY OF LOCAL BROILER FINISHER PELLETS WITH NATURAL ADHESIVES

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Abstract

The use of synthetic binders in pelletized feed is considered expensive, prompting the search for more economical and readily available alternatives from abundant natural sources in Indonesia. Sago flour, tapioca flour, and molasses are identified as natural ingredients rich in starch and energy. This study aims to evaluate the quality of pelletized feed using different binders based on their physical properties and nutritional values. A Completely Randomized Design (CRD) with four treatments were employed: PO: Commercial finisher broiler pellets, P1: Broiler finisher ration + 2% tapioca flour, P2: Broiler finisher ration+ 2% molasses, and P3: Broiler finisher ration+ 2% sago flour, each with 10 replications. Observed variables included proximate analysis to assess crude protein content and pellet metabolism energy, as well as physical quality tests such as bulk density, breaking force, density, and stack density. Physical quality test data were analyzed using Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT). The addition of binders P1 (2% tapioca flour) and P3 (2% sago flour) did not differ in physical properties such as the hulk density, breaking force, density, and stack density of the pellets (P<0.05). Meanwhile, P2 (2% molasses) shows significant differences in density and stack density (P<0.05), but not in bulk density and breaking force. In conclusion, the use of 2% tapioca flour as a binder proves to be the optimal treatment for achieving the best physical quality and nutritional value, as observed in bulk density, breaking force, density, and stack density of the pellets.

Keywords: Broiler chickens, binders, physical quality.

MIGRASI PAKAN RAMAH LINGKUNGAN: KUALITAS PELET LOKAL AYAM BROILER FINISHER DENGAN PEREKAT ALAMI

Abstrak

Penggunaan bahan perekat sintetis pada pelet pakan dianggap mahal, sehingga mendorong pencarian bahan alternatif yang lebih ekonomis dan mudah didapat dari sumber alami yang melimpah di Indonesia. Tepung sagu, tepung tapioka, dan molases diidentifikasi sebagai bahan alami yang kaya akan pati dan energi. Penelitian ini bertujuan untuk mengevaluasi kualitas pelet pakan dengan menggunakan bahan perekat berbeda berdasarkan sifat fisik dan nilai nutrisinya. Rancangan Acak Lengkap (RAL) digunakan dengan 4 perlakuan, yaitu PO: Pelet ayam pedaging finisher komersial, P1: Ransum ayam pedaging finisher + tepung tapioka 2%, P2: Ransum ayam pedaging finisher + molases 2%, dan P3: Ransum ayam pedaging finisher + tepung sagu 2%, dengan masing-masing 10 ulangan. Variabel yang diamati mencakup analisis proksimat untuk menilai kandungan protein kasar dan energi metabolisme pelet, serta uji kualitas fisik berupa berat jenis, daya ambang, kerapatan, dan kerapatan tumpukan. Data uji kualitas fisik dianalisis menggunakan ANOVA (Sidik ragam) dan uji DMRT. Penambahan bahan perekat PI (tepung tapioka 2%) dan P3 (tepung sagu 2%) tidak menunjukkan perbedaan signifikan terhadap sifat fisik berat jenis, daya ambang, kerapatan, dan kerapatan tumpukan pelet (P<0,05). Sementara P2 (molases 2%) menunjukkan perbedaan signifikan terhadap kerapatan dan kerapatan tumpukan (P<0,05), namun tidak pada berat jenis dan daya ambang. Kesimpulannya, penggunaan bahan perekat tapioka 2% menjadi perlakuan terbaik untuk mencapai kualitas fisik dan nilai nutrisi yang optimal, dilihat dari berat jenis, daya ambang, kerapatan, kerapatan tumpukan pelet.

Kata kunci: ayam broiler, binder, kualitas fisik.

INTRODUCTION

The demand for animal protein in Indonesia is very high, in line with the increase in population and public awareness of the importance of animal protein to fulfill nutritional needs. Data from the Central Bureau of Statistics (2024) shows that broiler chicken meat consumption in Indonesia continues to increase, reaching 7.63% per year, with the average national chicken meat consumption at 7.04 kg/capita/year. Success factors in chicken farming need to be considered to fulfill these needs. One of the success factors in chicken farming is the fulfillment of feed needs. Feed is one of the main factors in achieving optimal broiler productivity. Therefore, the quality and quantity of feed need to be considered. Feed costs are the largest cost component with 60-70% of all poultry production costs (Anggitasari et al., 2016).

Pelleted feed is considered to be one type of feed that has high quality and effectiveness, especially because broilers instinctively prefer it (Pandiangan, 2018). The pellet feed manufacturing process involves mechanical pumping of the complete feed, providing advantages such as better pile density and even composition without segregation (Nurhayatin & Puspitasari, 2017 Rahmana, 2016). However, the weakness of pelleted feed lies in its physical properties that are easily brittle, but the use of adhesives is considered a solution to maintain the strength and cohesiveness of the pellet structure (Jaelani, 2020).

The use of synthetic adhesives such as bentonite and lignosulphonate at levels of 2.5% and 1.25% respectively are commonly used in large industries. However, these materials are relatively expensive and their adverse effects are not fully known, therefore, a more economical and easily found alternative is needed using abundantly accessible, natural ingredients in Indonesia. Sago starch, tapioca starch and molasses are among the natural ingredient options, as they have sufficient starch and protein content. The objective of this study was to examine the nutritional value and physical properties of broiler pellets using local feed ingredients and natural adhesives sources.

MATERIALS AND METHODS

This research was conducted in three laboratories. Pellet making and energy content testing were conducted at the Feed Technology Laboratory of Jember State Polytechnic. The process of testing the physical quality of pellets, such as specific gravity, threshold power, density, and pile density, was carried out at the Livestock Technology Laboratory, Faculty of Agriculture, University of Jember. Crude protein analysis was conducted at the Animal Nutrition and Feed Division Laboratory of the Batu Animal Husbandry Training Centre. The implementation method includes several stages, namely:

a. Ration Preparation

The feed ingredients used in this experiment consisted of yellow corn, rice bran, SBM, MBM, Azolla, DL-Met, L-Lysin, Calcium Phosphate, Premix, and NaCl. All feed ingredients were obtained from poultry shops in Bondowoso and Jember districts and through online shops. Control feed ingredients used commercial concentrates (Japfa, Indonesia).

This study used a completely randomized design (CRD) consisting of four treatments and 10 replicates, resulting in 40 experimental units. Consisting of 4 treatments and 10 replicate samples so that 40 experimental units were obtained. The arrangement of the research treatment is as follows:

P0: Commercial broiler finisher pellets
P1: Finisher broiler ration + 2% tapioca flour
P2: Finisher broiler ration + 2% molasses
P3: Finisher broiler ration + 2% sago starch

b. Ration Formulation

The feed ration for finisher phase broilers was prepared in accordance with the standard needs of finisher phase broilers based on SNI 8173.3:2015 (Table 1).

c. Pelletizing

All ingredients, including control feed, were grounded using a mash mill (FFC 15, China) and were mixed according to the formula in fresh weight, according to the treatment. A total of 10 kg of ingredients were mixed using a mixer (Redfox R-CM 180, Indonesia) for 30 minutes. The homogenised rations were then put into the respective containers according to the treatment. The addition of adhesive material was homogenised manually on a tarpaulin using the quartering method (Jaelani, 2020). The material was spread into four parts then a quarter of the part was mixed with the adhesive material and then put back together with the other parts until homogeneous. After that, the feed was substituted into the feed raw material intake hole or hopper on the pellet farm feed pellet machine (Mahkota, Indonesia). The pellet moulding process was carried out in the pelleting chamber which was pressed by a roller and then cut by a cutting machine. The resulting pellets were 4 mm in diameter and 1 cm long. After that, the pellets that had been produced went through a cooling process to reduce the temperature by providing airflow at room temperature (Jaelani, 2020). The pellets were then tested for physical quality and nutrient content.

d. Physical Quality Test of Pellets

1. Specific gravity

   Specific gravity testing was conducted by putting water into the container to the maximum. Then, the pellets were added and the volume of added distilled water were calculated (Achmad, 2016).

   Specific Gravity (g/cm^3)

   $$= \frac{Material\ weight\ (g)}{Change\ in\ volume\ of\ distilled\ water\ (cm3)}$$

2. Pellet threshold power

   Measurement of pellet threshold power was conducted according to the procedures outlined by Farda *et al.* (2020). The procedure included dropping 10 g of material particles from a height of 2 metres from the floor, then using a stopwatch to measure the time taken to reach the ground. A base of aluminum foil was placed where the material fell, to ensure precise tracking of the fall. To minimize the influence of air currents, all wind inlets were closed during the measurement process. Threshold power was calculated by the formula:

   Pellet Threshold Power (m/s)

   $$= \frac{distance\ traveled\ (m)}{time\ required\ (s)}$$

3. Density

   Measurement of pellet density in each treatment was conducted by weighing the weight. Then, the pellets were measured with a caliper to determine the diameter (d) and height (Triyuslianti *et al.*, 2003). Calculations were made using the following formula.

   Density (g/cm^3) = $\frac{w}{\pi r2t}$

   Description:
   Weight of material (w)
   Finger - finger (r)
   Height (t)

4. Bulk Density

   Bulk density is the mass of particles in a unit volume. The bulk density is obtained by putting the pellets into a 1000 ml measuring cup, then the volume is measured to determine the pile density value (Khalil, 2009). According to (Jaelani, 2020), during the measurement, shaking the measuring cup needs to be avoided. The unit of pile density is expressed in gr/ml converted to kg/cm^3. Pile density is calculated by the formula:

   Bulk Density (KT)

   $$= \frac{Material\ weight\ (gr)}{Volume\ of\ occupied\ space\ (cm3)}$$

e. Nutrient Content Test of Pellets

1. Analysis of Crude Protein Content

   The determination of crude protein content was carried out using the Association of Official Analytical Chemists method (AOAC, 2005). The calculation was done with the following formula:

   % crude protein

   $$= \frac{(Vs - Vb) \times M\ (HCl) \times 1 \times 14{,}007}{A \times 10} \times 6{,}25$$

   Description :

Vs	=	ml of HCL used for sample titration
Vb	=	ml of HCl used for blank test
M (HCl)	=	HCl Molarity
1	=	acid factor
14,007	=	molecular weight of N
10	=	conversion from mg/g into units of %
A	=	sample weight
6,25	=	multiplication factor based on the results of the N analysis in getting PK

2. Energy Content Analysis

   Energy content measurements were made using a bomb calorimeter (Parr 6557, USA).

f. Data Analysis

The data collected in this study were analysed using Analysis of variance (ANOVA). If the data results were significant, further analysis were performed using Duncan's Multiple Range Test (DMRT) at a significant level of P > 0.05. Nutrient quality data were presented descriptively quantitative.

RESULTS AND DISCUSSION

Information on the physical quality of the pellets is presented in Table 2 and the nutrient content in Table 3. Based on the physical quality test results (Table 2), the specific gravity and threshold power of the pellets produced did not show significant differences between treatments. Significant differences were observed in the test results of pellet density and stack density. Finisher broiler pellets + 2% tapioca (P1) had a pellet density value (1.33 ± 0.01 g/cm^3) which was not significantly different from commercial pellets (P0: 1.34 ± 0.01 g/cm3) and finisher broiler pellets + 2% sago, (P3: 1.33 ± 0.01 g/cm^3) but significantly different from ration pellets + 2% molasses (P2: 1.36 ± 0.02 g/cm^3). The stack density value of P2 (0.643 ± 0.006 g/cm^3) also showed significant differences with P0 (0.669 ± 0.021 g/cm^3), P1 (0.668 ± 0.026 g/cm^3), and P3 (0.669 ± 0.031 g/cm^3).

Based on the data in Table 3, the crude protein content of chicken finisher pellets + 2% tapioca (P1) is comparable to commercial pellets, at 18.17%. Meanwhile, other treatments showed lower protein levels: chicken finisher pellets + molasses 2% (P2) contained 16.51% and chicken finisher pellets + sago 2% (P3) contained 15.71%. In the energy content data, the P1, P2, and P3 treatments have energy levels of 3178 kcal/kg, 3176 kcal/kg, and 3173 kcal/kg, respectively, which are higher than P0 with 3100 kcal/kg.

Table 1. Finisher Broiler Ration Formulation

Material	Compotition (%)		
	P1	**P2**	**P3**
Yellow corn	60,00	60,00	60,00
Rice bran	5	5	5
SBM	19	19	19
MBM	8,85	8,85	8,85
Azolla	0,15	0,15	0,15
Palm oil	3,50	3,50	3,50
DL-Met	0,25	0,25	0,25
L-Lysin	0,25	0,25	0,25
Calsium Phospat	0,50	0,50	0,50
Premix	0,25	0,25	0,25
NaCl	0,25	0,25	0,25
Tapioca flour	2%	-	-
Molasses	-	2%	-
Sago flour	-	-	2%
Total	100	100	100

Table 2. Physical Test Results of Different Adhesive Material Pellets and Commercial Pellets

Component	Treatment			
	P0	**P1**	**P2**	**P3**
Specific gravity (g/cm^3)	1,57 ± 0,21^{ns}	1,56 ± 0,13^{ns}	1,62 ± 0,12^{ns}	1,62 ± 0,06^{ns}
Threshold power (m/s)	6,18 ± 0,47^{ns}	6,39 ± 0,41^{ns}	6,39 ± 0,54^{ns}	6,26 ± 0,50^{ns}
Density (g/cm^3)	1,34 ± 0,02^{a}	1,33 ± 0,01^{a}	1,36 ± 0,02^{b}	1,35 ± 0,03^{ab}
Bulk Density (g/cm^3)	0,669 ± 0,021^{b}	0,668 ± 0.026^{b}	0,643 ± 0,006^{a}	0,669 ± 0,031^{b}

Note: ns denotes "not significant" indicates that the results were not statistically significant at the chosen level of significance (p > 0.05).
Different superscript letters on the same line indicate significant differences (P < 0.05).

Table 3. Pellet Proximate Test Result

Nutrient Content	Treatment			
	P0	**P1**	**P2**	**P3**
Crude protein (%)	19*	18,17**	16,51**	15,71**
EM (kkal/kg)	3100*	3178**	3176**	3173**

Source: * PT JAPFA COMFEED INDONESIA
** Primary data from research (2024)

Specific gravity plays an important role in the handling, processing, and storage stages of feed, as it determines the accuracy level of the automatic weighing process used in feed mills (Koni *et al.,* 2023). Specific gravity has a close relationship with the ration porosity, which is the ratio between pellet density and specific gravity (Puspitasari, 2018). Ration porosity plays a crucial role in the drying efficiency of ingredients (Isar, 2017). The results of the high specific gravity test compared to the research results of Rahmana et al. (2016), who reported the specific gravity of pellets added with livestock feces and different adhesives ranged from 1.18-1.28g/cm³. This outcome is due to the grinding process conducted prior to the pelleting process, resulting in a very smooth feed pellet. This finding supports the opinion of Jaelani & Dharmawanti (2016) that the type of raw material and particle fineness affect the specific gravity test results of feed pellets.

According to Royani & Herawati (2020), high specific gravity indicates high mass loading capacity in one unit volume. Threshold power is used to evaluate the efficiency of material transportion using suction devices or pneumatic conveyors. Measuring threshold power measurement also aims to achieve more uniform feeding to livestock (Nisak, 2013).

The large value of pellet density can be attributed to the pellet machine that produces pellets with a length and diameter of 1 cm and 4 mm respectively. This is in accordance with Hendra (2012) research that the pellet density value increases due to the larger particle size produced. Another factor that affects the density of pellets is their specific gravity; the higher the specific gravity, the greater the density. In addition, the value of pellet density is also influenced by the volume and mass of particles (Wibowo & Arief, 2020), where an increase in mass and volume will cause an increase in density. In this study, commercial pellets had a density value of 1.34 ± 0.02 g/cm^3. Treatments P1 (1.33 ± 0.02 g/cm^3) and P3 (1.35 ± 0.03 g/cm^3) showed values that were not different from the control (P0), indicating good physical quality. This is because the control treatment is a commercial pellet made according to standards and widely used in Indonesia.

Pile density is a parameter used to determine the volume of space required to store a given weight of feed material (Jaelani & Dharmawati, 2016). The results of the analysis of variance showed significant differences ($P < 0.05$) in the density of the pellets produced, with values ranging from 0.643 to 0.669 g/cm^3. The analysis showed a significant effect in P2 (Broiler finisher pellets + 2% molasses) compared to P0 (Commercial pellets), P1 (Broiler finisher pellets + 2% tapioca), and P3 (Broiler finisher pellets + 2% sago). Duncan test results showed that the highest stack density value was found in P3 (0.669 ± 0.031 g/cm^3), followed by P0 (0.669 ± 0.031 g/cm^3) and P1 (0.668 ± 0.026 g/cm^3), while P2 produced the lowest value (0.643 ± 0.006 g/cm^3).

The lower pile density of P2 is likely due to the high moisture content of its adhesive material, molasses, which contains 23% moisture. Materials with high moisture content often require longer drying times and may not be fully dry or compact in the end, which affects the pile density (Yuan et al., 2016). Mwithiga & Sifuna (2006) also noted that feed moisture content can affect the pile density value; the higher the moisture content, the lower the pile density value.

In contrast, P3 had the highest pile density value, and did not differ from commercial pellets, indicating better feed storage or holding efficiency. Retnani et al. (2010) noted that the higher the pile density value of a feed ingredient, the more efficient the storage container needed. Conversely, P2 with the lowest stack density value requires a larger volume of storage space.

CONCLUSIONS

Physical quality testing of finisher broiler pellets using 2% tapioca flour addition has the potential to be developed as finisher period broiler pellets.

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