Physical and chemical characteristics of rabbit complete pellet feed containing different level of leucaena leaf meal

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Abstract: This research aimed to evaluate physical and chemical quality of rabbit feed complete pellet with different level of leucaena leaf meal (LLM) replacing the soybean meal. Four formulas of complete pellet with different level of LLM were tested (0%, 5%, 10% and 15%). The crude proteins of the diets were 17.7-18.1% and energy of the diets was 2,277-2,542 kcal/kg. The feed ingredients of the pellets consisted of corn, pollard, Pennisetum purpureum cv. Mott, molasses, soybean meal, LLM, copra cake, tapioca flour, and premix. The data measured were physical quality (hardness and durability), and chemical quality (dry matter, crude protein, crude fiber, extract ether, and ash). Data were analyzed based on a completely randomized design. The results showed that crude fiber and hardness of pellet were significant (P<0.01) between the treatments. The pellets with 15% LLM results highest of crude fiber and highest of pellet hardness. It is concluded that LLM can partially replace soyabean meal even at 15% without reducing the physical and chemical quality of the pellets.

1. Introduction
Pellet is one of several forms of animal feed which is a feed or ration that is compacted through a mechanical process, so that it becomes a small cylindrical shape with different diameters, lengths and strengths [1]. Pellet quality can be influenced by several factors. Among them are the size of the ingredients of the pellet composition, the content of the ingredients of the pellet composition, the water content and the adhesive material of the pellet. If there are differences in the ingredients used to make pellets, the quality of pellets to be formed will also be different. The physical quality of pellet includes the hardness of the pellet and the durability of the pellet, and the chemical quality of the pellet which includes the nutrient content of the pellet and the digestibility of the pellet [2–4]. Pellet hardness is the physical qualities of pellets indicate the level of hardness of a pellet which influenced by the composition of the material, the size of the ingredients of the pellet and the pressing process in the pellet machine [3]. While the durability of the pellet is the physical quality of the pellet which shows the level of resistance of a pellet to impact or friction which will have an effect on the distribution of the pellet. Pellet durability is influenced by the ingredients of the pellet and the pressing process in the pellet machine.

The composition of different ingredients of pellet will provide different nutrient content and pellet quality[5]. Pellet ingredients and formulation will affect pellet quality, including technology in the pellet processing and the type of binder [3].
The *Leucaena leucocephala* amino acid composition balanced can be a high quality protein source and is much cheaper than most of the other protein feeds and can replace the widely used soybean meal. Ground LLM hay can be used as an ingredient of complete pellet [6]. Hence, the objective of this study was to examine the effect of inclusion of LLM on the physical and chemical characteristics of the complete pelleted feed.

2. Materials and Methods
The research was carried out at the Feed Technology Laboratory, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, as well as at PT Indojaya Agrinusa (Japfa Medan). Proximate analysis of pellet samples was carried out in the Feed Technology Laboratory, Faculty of Animal Science, Universitas Gadjah Mada, following the AOAC method [7]. Proximate analysis includes dry matter and organic matter, extract ether, crude protein and crude fiber.

The feed given was complete feed consisting of corn, pollard, *Pennisetum purpureum* cv. Mott meal, molasses, and soybean meal, four levels of leucaena leaf meal, copra cake, tapioca meal, and premix. The feed ingredients were mixed into four treatments to produce complete pellets. The dried pellets were stored in plastic bags until analyzed. The crude protein of the pellet was 17.7-18.1% and energy of the diets was 2,277-2,542 kCal/kg.

Table 1. Feed composition of complete pellet feed treatment diets

| Ingredient                  | P0 (0% LLM) | P1 (5% LLM) | P2 (10% LLM) | P3 (15% LLM) |
|----------------------------|-------------|-------------|--------------|--------------|
| Corn                       | 30          | 30          | 30           | 30           |
| Pollard                    | 25          | 25          | 25           | 25           |
| *Pennisetum purpureum* cv. Mott | 5           | 5           | 5            | 5            |
| Molasses                   | 5           | 5           | 5            | 5            |
| Soy bean meal              | 20          | 16          | 14           | 13           |
| Leucaena leaf meal         | 0           | 5           | 10           | 15           |
| Copra cake                 | 9           | 8           | 5            | 1            |
| Tapioca meal               | 5           | 5           | 5            | 5            |
| Premix                     | 1           | 1           | 1            | 1            |
| Total                      | 100         | 100         | 100          | 100          |

2.1. Pellet physical quality
2.1.1. Hardness. The pellet hardness test was conducted at PT Japfa Comfeed Medan. Pellet hardness was measured using a pellet hardness tester (Amandulus Kahl GmbH & Co. KG). The pellet hardness test method follows the Kahl hardness test method [3]. The pellet was inserted between the two toolbars, then the pressure on the pellet was increased. The value of the pressure needed to make the pellet break was then recorded.

2.1.2. Durability. The pellet durability test was conducted at PT Japfa Comfeed Medan. Pellet durability testing method using the durability holmen method. The tool used was the Holmen NHP 100 type. Pellet durability index (PDI) was calculated by the following formula:

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PDI = \frac{\text{The weight of the pellet after being strained (before being inserted) \times 100%}}{\text{Pellet momentary weight after being removed from the test equipment}}
\]

The data obtained were then analyzed using one-way analysis of variance (ANOVA) on Completely Randomized Design (CRD). Then, if there were significant differences among treatments, it was followed by the DMRT.
3. Results and Discussion

3.1. Physical Quality

The physical quality of pellets is closely related to whether or not pellets break. Thomas et al.[3] proposed that the main parameters that determine the physical quality of pellets are the value of durability and hardness of pellets. Pellet durability and hardness analysis results can be seen in Table 2.

**Table 2.** Pellet Durability Index and hardness of rabbit pelleted feed containing different level of leucaena leaf meal (LLM).

| Treatment | PDI (%) | Hardness (kg) |
|-----------|---------|--------------|
| P0: 0% leucaena leaf meal | 98.00±0.001 | 7.67±0.577 |
| P1: 5% leucaena leaf meal | 98.00±0.001 | 8.00±0.001 |
| P2: 10% leucaena leaf meal | 97.67±0.577 | 5.30±0.577 |
| P3: 15% leucaena leaf meal | 97.33±0.577 | 12.00±1.001 |

The pellet durability value or Pellet Durability Index (PDI) is a number that is able to determine the physical quality of the pellet. Pellets with high durability indicate that the pellet is more resistant to impact. Durability of pellet did not show significant difference in all treatments: P0, P1, P2, and P3, with value 98%, 98%, 96.7%, and 97.3%, respectively. Mukodingsih et al.[8] stated that feed nutrients such as protein, extract ether, carbohydrate, and crude fiber were the main components that affect pellet quality, although conditioning, feed ingredient condition, and pelleting may have some influence. Cavalcanti dan Behnke[9] reported that protein content gives a positively effect on pellet durability, but in this study level of LLM did not affect the pellet durability.

Pellet hardness is a value that is associated with the level of pellet resistance to pressure. Pellet hardness was significantly different (P < 0.01), among the treatments of P0, P1, P2 and P3 were 7.67 kg, 8 kg, 5.3 kg, and 12 kg, respectively. The highest hardness value was obtained in pellets with 15% LLM, while the lowest was in pellets with 10% LLM. Pellet nutrient content greatly affects the physical quality of pellets. Sitaula[2] stated that pre-gelatinization degree is the highest factor impacted in hardness and durability pellet. Behnke[10] stated that addition of protein ingredients in pellet processing increased pellet quality. Thus, Martens[11] stated that biological performance of rabbits were not affected by 7-13 kg of pellet hardness consumption.

3.2. Chemical Quality

The results of the chemical analysis of rabbit pellets with different level of LLMs shown in Table 3.

**Table 3.** Chemical composition of rabbit pelleted feed containing different level of leucaena leaf meal

| Nutrient (%) | P0 | P1 | P2 | P3 |
|--------------|----|----|----|----|
| Crude protein | 17.66±0.462 | 17.74±0.292 | 17.84±0.441 | 17.74±0.256 |
| Dry matter | 87.30±0.222 | 88.25±0.148 | 90.39±0.076 | 90.31±0.147 |
| Extract ether | 6.65±0.240 | 7.39±2.364 | 7.21±2.476 | 7.03±0.705 |
| Crude fiber | 15.11±0.037 | 16.58±0.290 | 17.19±0.020 | 17.45±0.182 |
| Ash | 9.49±0.202 | 9.60±0.632 | 9.79±0.081 | 7.98±0.173 |

**Notes:**
- ns not significant
- Different superscript the same row showed significant difference (P < 0.01)

P0: 0% leucaena leaf meal
P1: 5% leucaena leaf meal
P2: 10% leucaena leaf meal
P3: 15% leucaena leaf meal
The four treatments had similar crude protein contents as required by growing rabbits and represent a major portion of the diet. It is known that different protein content would produce pellets of different physical characteristics. Loar and Corzo [12] suggested that increasing the protein levels in the preparation of rations is likely to improve the quality of the pellet. Cheeke [13] advocated that crude protein requirements for fattening rabbits range from 16.11-18.00% (DM), thus the protein content on this research complete pellet is adequate to the requirements.

Dry matter becomes an important component in affecting the quality of pellets. In this study the dry matter of the pellets from different treatment ranged from 87.3 to 90.39% which were suitable storage without risks of fungal growth. The molds would grow when the dry matter of pellet feed is lower than 85% (but some mycotoxin-type can grow well if the dry matter content of the product is below 91-90% (DM)) with room humidity above 65% and at specific temperatures (most fungi grow at temperatures above 25° C) [14]. Molds will reduce the quality of pellets because can absorb feed nutrients and produce toxic substances (mycotoxins) which can reduce animal productivity.

The ether extract of pellets in treatments P0, P1, P2, and P3 were not significantly different. They were 6.65%, 7.39%, 7.21%, and 7.03%, respectively. The extract ether content in feed was appropriate for growing rabbits.

The crude fiber showed significant differences (P<0.01), among the treatment groups. The values for P0, P1, P2, and P3 were 15.11%, 16.58%, 17.19%, and 17.45%, respectively. The crude fiber content in the P0 and P1 treatments were in accordance with the needs of crude fiber for fattening rabbits, which is 15% to 16.7%, while for treatments P2 and P3 slightly exceeds the needs of crude fiber for fattening rabbits. The slightly high crude fiber was probably due to the fiber in the LLM.

The ash content showed significant differences (P<0.01) for the treatments of P0, P1, P2, and P3, those were 9.49%, 9.60%, 9.79%, and 7.98%, respectively. The difference of ash in this research probably due to the different of pellet ingredients.

4. Conclusion
Replacing soybean meal with leucaena leaf meal even at levels of 15% did not affect the physical and chemical qualities of the rabbit pellets. However, those with 15% leucaena leaf meal had slightly higher crude fiber content.

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References
[1] Thomas M, Van Vliet T and Van Der Poel A F B 1998 J. Anim. Feed Sci. Technol. 70 59–78
[2] Sitaula Y 2011 Effect of Starch Source, Screw Configuration and Steam Injection on Physical Quality and Color Development of Extruded Fish Feed Yogendra Sitaula Department of Aquacultural and Animal Sciences (Norwegian: University of Life Sciences)
[3] Thomas M and Van Der Poel A F B 1996 Physical quality of pelleted animal feed 1. Criteria for pellet quality Anim. Feed Sci. Technol.
[4] Pond W G, Church D C and Pond K R 1995 Basic Animal Nutrition and Feeding vol 126 (Chichester: John Wiley & Sons)
[5] Briggs J L, Maier D E, Watkins B A and Behnke K C 1999 J. Poult. Sci. 78 1464–71
[6] Makinde O 2016 Trakia J. Sci. 14 80–6
[7] AOAC 2005 Official Method of Analysis (Wasington DC: The Association of Official Analytical Chemist)
[8] Mukodiningsih S, Sutrisno I, Sulistyanto B and Hadi B W E 2014 Pengendalian Mutu Pakan (Semarang: UPT UNDIP Press Semarang)
[9] Cavalcanti W B and Behnke K C 2005 I Cereal Chem. 82 455–61
[10] Behnke K C 2015 J. Feed Tech. 5 21–35
[11] Martens L 2010 Feeding system for intensive production. In: Nutrition of The Rabbit/Edited by Crlos de Blas and Julian Wiseman (UK: CAB International 2010, CPI Antony Rowe Ltd.)
[12] Loar R E and Corzo A 2011 Worlds. Poult. Sci. J.
[13] Cheeke P R 2005 Applied animal Nutrition: Feeds and Feeding (New Jersey: Pearson Education, Inc.)
[14] Michael B N 1987 Feed and Feeding of Fish and Shrimp (Rome)