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Nutrient Content and Physical Characteristics Linkage of Palm Kernel Meal and Coconut Meal after Wet Separation using Molecular Weight Approac

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ABSTRACT

The use of palm kernel meal and coconut meal is the restriction in broiler feed due to the high crude fiber content, caused by the mixture of shells. This study aims to analyze the nutrient content, i.e., crude protein and crude fiber of palm kernel meal and coconut meal before and after using the wet separation and molecular weight approach. The wet separation process for palm kernel meal and coconut meal was carried out for 6 hours to obtain a precipitate. The palm kernel meal and coconut meal that has been separated were divided into 3 fractions, i.e., upper, middle and lower. Each fraction was analyzed for crude fiber and crude protein content for chemical characteristics, and bulk density (g l^{-1}), compacted bulk density (g l^{-1}), specific gravity (kg l^{-1}), and angle of purpose (^{o}). Crude protein and crude fiber content of palm kernel meal before being separated by wet separation were 11.72% and 13.11%, for coconut meal were 12.65% and 8.67%. The fraction of palm kernel meal has the highest crude protein content of 22.21% with the lowest crude fiber content 9.68%. Coconut meal in the middle fraction had the highest crude protein content 18.92% and the lowest crude fiber content 11.95% in the upper fraction. The physical characteristics of the upper fraction of palm kernel meal and coconut meal had the lowest values ($P<0.05$) of specific gravity (kg l^{-1}), bulk density (g l^{-1}) and compacted bulk density (g l^{-1}). It can be concluded that the wet separation process with the molecular weight approach is able to increase the nutrient content, especially of each fraction and can minimize the mixture of shells in palm kernel meal and coconut meal.

Key word: ***Broiler, Coconut Meal, Crude Fiber, Palm Kernel Meal***

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INTRODUCTION

Indonesia is one of the largest producers and exporters of palm oil and coconut. According to (Kementan, 2016), Indonesia's oil palm plantation area reaches 11.92 million hectares (Ha) with a production of 33.23 million tons. The area of coconut plantations in 2016 reached 3.57 million hectares (Ha) with a production of 2.89 million tons. The palm oil and coconut industries produce several types of by-products that have the potential to be used as animal feed ingredients, one of which is palm kernel and coconut meal. Palm kernel meal is a by-product of the palm oil industry obtained from the extraction of palm kernel oil. According to (Puastuti, et al., 2014), each fresh fruit bunch processed in oil palm processing will produce 3.5% palm kernel meal. Coconut meal is a by-product of the coconut oil extraction process which is available in very large quantities and the price is quite competitive.

The increased production of palm kernel and coconut meal has not been followed by a high level of use in poultry rations. The limitation of the use of palm kernel meal is due to the high crude fiber content of 32.95% (Yatno, 2011) and crude protein 16.43% (Alshelmani, et.al., 2016). The high crude fiber content causes the level of use of palm kernel meal to range from 5-10% in broiler rations (Sinurat, et.al., 2009). According to (Hertrampf and Piedad, 2000) the protein content of coconut meal is around 18%-24%, although it has a fairly high crude fiber content of around 13%-16%. This component interferes with the nutritional value of coconut meal when added to feed (Sundu, et.al., 2006).

The low digestibility of a feed ingredient can be caused by the high crude fiber of the feed ingredient. The cause of the high crude fiber of palm kernel and coconut meal is because the material is still mixed with the shell. Separation of shells from palm kernel and coconut meal can be done using the fractionation method. Fractionation of palm kernel and coconut meal was used to determine the distribution of the nutritional content of the ingredients, especially protein and fiber in each fraction. Knowing the distribution of nutrient content of each fraction can be done quickly by testing the physical properties of each fraction. Physical properties that need to be considered in feed ingredients include specific gravity, bulk density, compacted bulk density, and angle of purpose. These characteristics are closely related to the handling and processing of feed ingredients (Khalil, 1999a).

The fiber content in palm kernel and coconut meal is higher if there is a mixture of palm shells. The palm shells are very difficult to be degraded biologically or chemically, so it is necessary to do physical treatment, namely by separation. According to (Yatno, 2011), the separation of the shell by the fractionation method (filtering) shows that the non-shell portion is concentrated in a 30-400 mesh sieve while the shell portion is concentrated in an 8-16 mesh sieve. Based on research conducted by (Sinurat, et.al., 2013) on palm kernel meal by fractionation (filtering) using a 4 mm diameter sieve only reduced the shell content to 21.49% and from unfiltered palm kernel meal. Screening with 2 mm and 1 mm diameter sieves reduced the content of palm kernel meal shells to 9.92% and 8.58%. This study aims to analyze the distribution of nutrient content of the material on the physical properties (specific gravity, bulk density, compacted bulk density, angle of purpose) and chemical properties (protein and crude fiber) in palm kernel and coconut meal before and after fractionation using a molecular weight approach.

MATERIALS AND METHODS

The materials that will be used in this research are palm kernel meal, coconut meal, and chemicals needed for proximate analysis. Palm kernel meal and coconut meal from a feed shop in Bogor, West Java, Indonesia.

The particle size of palm kernel and coconut meal can be determined with the help of a vibrator ball mill consisting of several

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sieves. The filters are arranged vertically from the course to the finest (4, 8, 16, 30, 50, 100, and 200 mess). Each sample weighed as much as 250 grams and poured on the top filter, then the ball mill vibrator was vibrated for 10 minutes. The weight of each material that did not pass in each shaker was recorded to calculate the average diameter of the material (ASAE, 1983). Modulus of Fineness (MF) or the level of fineness is a measurement of the coarseness or fineness of certain aggregates calculated using the formula:

$$MF = \frac{\sum(\%\ material\ left\ on\ each\ mesh\ \times Agreement\ Number)}{100}$$

Furthermore, the materials were categorized based on the MF value with the provisions of 4.1 x 7.0 coarse category, 2.9 x < 4.1 medium categories, < 2.9 categories. The average particle size (D) was calculated using the formula (Henderson and Perry 1976):

$$D = 0.0041 \times 2^{MF} \times 2.54 \text{ cm} \times 10 \text{ mm}$$

The glass column is in the form of a beam with a length of 15 cm, a width of 15 cm and a height of 150 cm with a faucet to drain 20 cm of water from the bottom of the column. The glass column was filled with 25 liters of water and then inserted a 60-mesh sieve in the form of a beam with a length of 13.5 cm, a width of 13.5 cm and a height of 25 cm to a depth of 130 cm. The 1.25 kg of materials were put together in a glass column and stirred so that the material did not agglomerate. The material was allowed to settle for 6 hours in a sieve. After 6 hours, the material that floats on the surface of the water was taken and separated. The water and filter in the column were removed and drained for 45 minutes. The filter containing the drained sediment was opened on a predetermined side slowly in a vertical position. The height of the precipitate formed was measured using a ruler. The fraction whose height has been measured then divided into 3 parts, namely the top 1/3, middle 1/3 and bottom 1/3. The three fractions were separated and placed in separate containers. The material that has been separated based on the fraction is put in an oven at 60^{o}C for 48 hours. Materials before and after the fractionation process were analyzed for crude protein and crude fiber content using the AOAC 2005 method. The physical properties that were measured and analyzed were specific gravity, bulk density, compacted bulk density and angle of purpose.

The experimental design used was CRD (Completely Random Design) Factorial 2 × 3 × 3 for physical test data. Factor A is palm kernel meal and coconut meal and factor B is the position of the fraction (1/3 top, 1/3 middle, 1/3 bottom) and 3 replications. The physical properties data obtained were analyzed using variance (ANOVA), if there was a significant difference, the data would be further tested with Duncan's test. The linkage of Nutrient content and physical properties data were analyze using regression. Nutrient content as chemical test data in the form of moisture content, crude protein and crude fiber obtained were analyzed descriptively.

RESULT AND DISCUSSION

Physical Properties of Palm Kernel and Coconut Meal after Wet Separation Process

The physical properties of feed ingredients are one of the factors to determine the quality and efficiency of the production process. The observed physical properties consist of specific gravity, bulk density, compacted bulk density and angle of purpose. The raw materials obtained have different particle sizes, to eliminate the effect of differences in particle size, the materials are filtered using mesh 16. The raw materials used for fractionation are materials that pass through a 16-mesh sieve. The initial raw material has a particle size of 1.094±0.030 mm for palm kernel meal and 1.262±0.017 mm for coconut meal.

Specific Gravity

Value of specific gravity of palm kernel meal material before and after grinding the mess 16 is bigger than coconut meal. This difference is due to the denser structure of palm kernel meal and the possibility there are still contaminants in the form of shells, while the structure of coconut meal is less dense, there are few contaminants in the form of the outer skin of coconut flesh and many voids between particles. Results of specific gravity before grinding were obtained lower than (Jaelani, 2007) ranging from 1.36-1.52 g mL^{-1} and the same as (Khalil, 1999b) study of 1,300 kg L^{-1}. The specific gravity of the core palm oil meal after milling is higher than (Saidah, 2017) which states that the specific gravity of palm kernel meal after filtering is 1.16±0.11 kg L^{-1}. Whereas the specific gravity of coconut meal after grinding is lower than (Oktavia, 2017) which states that the specific gravity of coconut meal after filtering 1.23±0.02 kg L^{-1}. The treatment of the type of material, the type of fraction, and the interaction was significant ($P<0.05$) and affect the specific gravity. The higher the fraction the lower ($P<0.05$) the specific gravity value.

Table 1 Physical Properties of Palm Kernel and Coconut Meal After Wet Separation Using Molecular Weight Approach

Material	Fraction	Parameter			
		SG (kg L^{-1})	BD (g L^{-1})	CBD (g L^{-1})	AP (°)
Palm kernel meal	1	1.123±0.002a	278.24±0.40a	492.90±1.64a	46.154±0.084c
	2	1.155±0.002b	327.68±0.27b	523.63±0.91b	42.410±0.066b
	3	1.240±0.005c	431.06±0.42c	661.84±0.97c	36.273±0.062a
Coconut meal	1	1.071±0.008a	272.74±1.52a	456.41±0.70a	48.175±0.065c
	2	1.142±0.005b	309.43±1.81b	497.51±0.28b	43.268±0.143b
	3	1.232±0.003c	396.48±1.20c	619.05±2.25c	36.551±0.024a

Different letters in the same column indicate significant differences ($P<0.05$), SG: specific gravity; BD: bulk density; CBD: compacted bulk density; AP: angle of purpose.

Fractionation through the molecular weight approach divides palm kernel and coconut meal into 3 fractions, namely fractions 1 (top), 2 (middle) and 3 (bottom) based on the height of the fractionated precipitate. The value of specific gravity of palm kernel meal and upper fraction coconut meal is lower than middle and lower fractions. Based on the research results (Sinurat, et.al., 2013) providing filtering and blowing treatment on palm kernel meal shows the highest percentage of shell contamination is in the weight fraction while the lowest percentage is in the light fraction. At a falling distance, the further away the concentration of shells on palm kernel meal will be slight, the density is getting smaller. Oil palm shells have a fairly high specific gravity, which is 1.46 kg L^{-1} (Olanipekun, et.al., 2006).

The higher specific gravity tends to have a granular and coarse texture, while palm kernel and coconut meal are heavy the low variety has a powdery shape and a smooth texture. Results observations show differences in the value of the specific gravity of the material based on the type of fraction that will determine the characteristics of the material. High specific gravity indicates the difference in mass per unit volume is larger and requires more detailed accuracy in the dosing process automatic. The results obtained are in accordance with the opinion of (Situmorang, 2011) that part of palm kernel meal with a smaller particle size has a weight of lower type.

Bulk Density

The bulk density value of palm kernel meal is lower than according to (Yatno, 2011) at 0.56 g m L^{-1} and (Saidah, 2017) at 698.00±8.37 g L^{-1}. The bulk density of the palm kernel meal after grinding was lower than (Saidah, 2017) which stated that the density of the palm kernel meal after being

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filtered was 480.67±54.18 g L^{-1}. The bulk density value of the coconut meal before grinding is 517.5±9.57 g L^{-1} and the coconut meal bulk density after grinding is lower than (Oktavia, 2017) which states that the coconut meal bulk density after being filtered is 404±46.95 g L^{-1}. This difference could be due to the different particle sizes of the research conducted. The treatment of the type of fraction, the type of material, and their interactions significantly ($P<0.05$) affected the bulk density.

The higher the real fraction ($P<0.05$), the lower the stack density value. Palm kernel meal has a significantly higher stack density value ($P<0.05$) than coconut meal (Table 1). The low value of bulk density can be caused by the presence of less shell in palm kernel and coconut meal. Separation by fractionation through the molecular weight approach can distribute the shell content based on the type of fraction, The lower the type of fraction, the greater the shell content. According to Renjani (2014), the shell of palm kernel meal has a higher bulk density than the non-shell part. The results obtained are in accordance with the opinion of (Saw, et.al., 2012), that the bulk density value of palm kernel meal will be higher with increasing particle size. Letsche, et.al (2009) also stated that the reduction in particle size through milling can cause a decrease in the density value of the feed heap.

Compacted Bulk Density

The compacted bulk density value of the palm kernel meal stack is higher than that of coconut meal. This is because palm kernel meal is more cohesive than coconut meal so the mass of the material tends to occupy less space in each unit volume. Separation by fractionation through the molecular weight approach can distribute the shell content based on the type of fraction. The lower the type of fraction, the greater the shell content. The shell in palm kernel meal has a higher compacted bulk density value than the non-shell portion (Renjani, 2014) According to Yatno (2011), compacted bulk density is closely related to bulk density. The compacted bulk density will increase as the bulk density increases. The low compacted bulk density of palm kernel and coconut meal indicates that the volume of space required for storage is greater. The compacted bulk density is also affected by the intensity and manner of compaction.

Angel of Purpose

The angle of the purpose of the palm kernel meal before grinding is almost the same as (Yatno, 2011) at 35.44°. The angle of the purpose of the palm kernel meal after grinding is relatively the same as (Saidah, 2017) which states that the angle of the palm kernel meal after being filtered is 42.50±2.96°. The angle of the purpose of the coconut meal before and after grinding was higher than (Oktavia, 2017) which stated that the initial and after filtered coconut meal stack angles were 21.19±0.28° and 39.06±3.18°. The high value of the stack angle was caused by shell contamination in palm kernel and coconut meal less and less due to the distribution of shells in the lower fraction. The angle of purposes of palm kernel and coconut meal is relatively the same for each fraction.

This result will determine the characteristics of the flow rate of the material for each fraction. High stack angles on feed ingredients will cause lower freedom of particle movement, making it difficult to pour into other containers (Ramli, et al., 2008). According to Syamsu, et.al (2015) the angle of purpose is influenced by the shape and surface area of the particles, moisture content, specific gravity and bulk density of a material. The higher the specific gravity and bulk density of a material, the lower the resulting angle of purpose.

Nutrient Content of Palm Kernel and Coconut Meal

Feed ingredients with increasingly finer (smaller) particle sizes will have greater water binding ability (Widjanarko and Suwasito, 2014). Based on the chemical composition data in Table 2, the higher the fraction, the crude protein content of palm kernel meal increases but is different from coconut meal. Meanwhile, the higher the fraction, the crude fiber content of palm kernel and coconut meal tends to decrease.

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The crude protein content of palm kernel meal before and after fractionation is relatively the same as the crude protein content of coconut meal. The upper fraction of palm kernel meal had the highest crude protein content and the middle fraction of coconut meal had the highest crude protein content.

Table 2. Nutrient Content of Palm Kernel and Coconut Meal Before and After Wet Separation Using Molecular Weight Approach

Material	Fraction	Parameter		
		DM (%)	CP (%)	CF (%)
Palm kernel meal	Before wet separation	91.12	11.72	13.11
	1	86.09	22.21	9.68
	2	86.18	16.37	16.35
	3	88.09	15.84	21.08
Coconutmeal	Before wet separation	90.05	12.65	8.67
	1	88.26	16.95	11.95
	2	91.67	18.92	17.19
	3	91.20	16.12	25.11

DM: dry matter; CF: crude fiber; CP: crude protein.

This shows that the separation by fractionation through the molecular weight approach can distribute crude protein content based on the type of fraction. The lower the fraction, the relatively lower crude protein content. Crude fiber is a limiting factor in the use of palm kernel and coconut meal in poultry feed.

Palm kernel meal contains 32.95% crude fiber (Yatno, 2011). This high crude fiber content is caused by the presence of a fairly high shell, which is 9.1% - 22.8% (Sinurat, et.al., 2009). The crude fiber content of palm kernel meal before fractionation was much lower than (Yatno, 2011) because the material was sifted with mess 16 first, so many shells were separated. The crude fiber content of coconut meal before fractionation is the same as that of (Sundu, et.al., 2006) which states that the crude fiber content of coconut meal is 7% - 15%. The crude fiber content of coconut meal is because it comes from non-sugar polysaccharides (non-starch polysaccharides) which contain mannan.

According to Sinurat, et.al (2013), filtering and blowing can reduce the percentage of shell contamination in palm kernel meal. Reducing the percentage of this shell will cause the crude fiber content in palm kernel meal to decrease.

The crude fiber content of palm kernel mealis smaller than coconut meal. This is because the palm kernel meal material before fractionation is filtered using mess 16 so that the shell contamination of the material becomes less. This is in accordance with the research (Chin, 2002), that screening of palm kernel meal can reduce the percentage of shells in palm kernel meal by as much as 53%.

Nutrient Content and Characteristics Linkage

The values of specific gravity, bulk density and compacted bulk density of palm kernel and coconut meal in the lower fraction showed the highest values compared to the middle and upper fractions. The highest crude fiber content was also shown in palm kernel mealand lower fraction coconut meal. The shell containing lignin is thought to have a higher molecular weight than the other content, which causes the shells to be abundant in the lower fraction so that the specific gravity, bulk density and compacted bulk density are high. In this study, the upper fractions of palm kernel and coconut meal had low specific gravity, bulk density and compacted bulk density and high angle of purpose. Low bulk density values and high angles of purpose cause longer flow times and require large storage volumes.

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Table 3. Nutrient content and physical characteristics linkage of palm kernel and coconut meal

	DM	CP	CF	SG	BD	CBD	AP
DM	1	-0.247	0.605	0.368	0.276	0.207	-0.356
CP		1	-0.695	-0.480	-0,640	-0.539	0.572
CF			1	0.916*	0.883*	0.834*	-0.928**
SG				1	0.934**	0.944**	-0.981**
BD					1	0.988**	-0.977**
CBD						1	-0.968**
AP							1

**: P<0.05 **: P<0.01; DM: dry matter; CF: crude fiber; CP: crude protein; SG: specific gravity; BD: bulk density; CBD: compacted bulk density; AP: angle of purpose.*

According to Syamsu et.al (2015), the angle of purpose is influenced by the shape and surface area of the particles, moisture content, specific gravity and bulk density of a material. The higher of specific gravity and bulk density of a material, indicating that the material flows easily, the angle of the resulting pile will be lower.

CONCLUSIONS

Fractionation using a molecular weight approach with wet separation affect the physical and chemical properties of palm kernel and coconut meal. The more the high fraction the value of specific gravity, bulk density and compacted bulk density of the material is getting lower, while the value of the angle of purpose is getting higher. The higher the fraction, the lower the crude fiber content. The protein content is increasing except for coconut meal.

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