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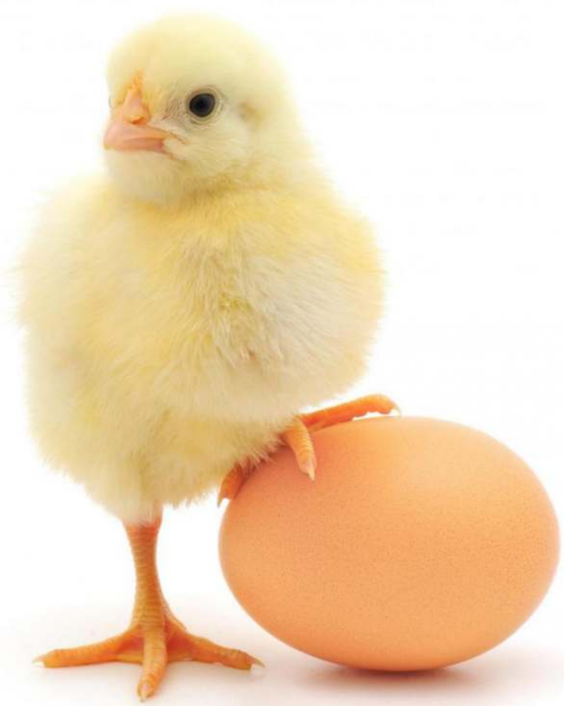

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Palm Kernel Polysaccharides as a Feed Additive for Broiler Chickens

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Abstract: The use of NaOH as a solvent to extract polysaccharides from the palm family has been widely reported. This polysaccharide is believed to be mannose based that is potential as a feed additive in broiler diet. A study was conducted to determine the use of polysaccharides extracted from palm kernel meal (PKM) with different concentrations of NaOH in a broiler diet. A total of 140 unsexed broiler chicks was used in this study. The birds were kept in cages for 6 weeks. Feed and water were available at all times. Seven different treatment diets were control diet (T-0), control+0.025% PKM polysaccharides extracted with 10% NaOH (T-1), control+0.05% PKM polysaccharides extracted with 10% NaOH (T-2), control+0.025% PKM polysaccharides extracted with 20% NaOH (T-3), control+0.05% PKM polysaccharides extracted with 20% NaOH (T-4), control+0.025% PKM polysaccharides extracted with 30% NaOH (T-5) and control+0.05% PKM polysaccharides extracted with 30% NaOH. A completely randomized design was used with seven treatments and four replicate cages. Differences among treatments found were tested with Tukey test. The results indicated that PKM extracted with 10, 20 and 30% NaOH contained 39.8, 34.1 and 28.4% polysaccharides, respectively. The birds fed the 0.025% PKM polysaccharides extracted with 20% NaOH had better feed conversion ratio, dry matter and protein digestibilities. In conclusion, palm kernel polysaccharides could replace the use of antibiotic growth promotant (avilamycin) in the diet to promote boiler performance.

Key words: Palm kernel meal, polysaccharides, broiler

INTRODUCTION

The use of palm kernel meal as a poultry diet has been reviewed by Sundu *et al.* (2006). Among the problems reported, the low in digestibility might be the main contributor to the low production of broiler chickens when this feedstuff was included in high concentration in the diet. The problem of low digestibility is partly because of the high dietary fibre present in palm kernel meal and the contamination of palm kernel meal with nut shell. Instead of handling the problem of dietary fibre to increase its digestibility, identifying the polysaccharides profile present in the dietary fibre of palm kernel meal might be important to determine the potential use of its polysaccharides as a feed additive.

Knudsen (1997) indicated that palm kernel meal had 50% carbohydrate and non-starch polysaccharide was the major constituent of the palm kernel meal carbohydrate. Of the total non-starch polysaccharides, 70% was mannose-based polysaccharides (mannan), 12% cellulose and 6% xylane (Dusterhoft *et al.*, 1991). Extrapolating from the data, mannose based polysaccharides in palm kernel meal was about 39%. This fraction is potential to be used as a prebiotic.

Due to the fact that palm kernel meal contains mostly mannan (mannose based polysaccharides), the idea of using palm kernel polysaccharides for poultry attracts many authors to intensively investigate the efficacy of palm kernel polysaccharides, since yeast mannose-based oligosaccharides has been successfully used to improve performance and health status of poultry over the last three decades. Mannose-based polysaccharides from coconut has recently been reported to be as effective as yeast mannose-based oligosaccharides in improving bird performance (Sundu and Damry, 2008). Early investigation indicated that the efficacy of using palm kernel meal to minimize the population of pathogenic bacteria in the digestive tract of broiler chickens was reported by Fernandez *et al.* (2000). This finding might indicated the positive effect of mannose-based polysaccharides in palm kernel meal. The use of alkali solution, particularly NaOH as a solvent to extract mannose-based polysaccharides in palm, have been carried out by Balasubramaniam (1976) in copra meal and Daud and Jarvis (1992) in palm kernel meal. Balasubramaniam (1976), Kusakabe and Takashi (1988) and Velasco and Meinban (1989) used high concentration of NaOH (24-34%) to generate mannose-based polysaccharides (mannan) from copra meal. The negative impact of the use of a relatively high concentration of NaOH are numerous, such as: the expensiveness of the alkali solutions and the liquid waste produced due to extraction process. Accordingly, a study was conducted to determine the efficacy of extracted palm kernel meal with various NaOH concentrations in broiler diets.

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MATERIALS AND METHODS

Extraction of palm kernel polysaccharides: Palm kernel meal was sieved to remove any foreign materials including nut shell. The palm kernel meal was ground to pass through a 2 mm screen. A method of Kusakabe and Takashi (1988) was modified to extract mannose based polysaccharides from palm kernel meal. The modification process was done by reducing the concentration of NaOH with different level. A total 16 liters NaOH with different concentration (10 20 and 30%) were added to 2 kg of palm kernel meal in a plastic bucket. The mixture of palm kernel meal and NaOH was occasionally stirred for 24 h at room temperature. The fluid mixture was then filtered through a cloth bag. The filtrate was then neutralized with 12 N H_2SO_4 until the pH solution was about 5.5. Resultants precipitate (mannose based polysaccharides of PKM) collected by centrifugation, was dialyzed against tap water to remove salts. The leftover residue was as a mannose based polysaccharides of palm kernel meal as it was analyzed by Kusakabe and Takashi (1988).

Birds and feed: A feeding trial was conducted in the poultry house at the University of Tadulako Palu, Indonesia. A total of 140 day old unsexed Cobb chicks was used as experimental animals. They were placed in brooder cages for two weeks. The brooder cages were heated by a 75 Watts bulb in each brooder cage. The birds were vaccinated on day 4 against Newcastle diseases. On day 14, the birds were transferred into the cages. From day 1-21, the birds were fed starter diets and grower diets (Table 1) were offered from day 22-42. Seven experimental diets used in this experiment are shown in Table 2. Each cage was equipped with a plastic feeder and drinker. The birds were allowed to consume feed and water *ad-libitum* throughout the trial. The house and cages were routinely cleaned.

Sample collection and chemical analysis: Total faecal discharges from the birds in the metabolism cages were collected for three consecutive days (days 40 to 42). The 3 days faecal samples from each cage were pooled. The faeces was weighed after discarding any foreign materials, such as feather and spilled feed particles. Representative samples (feed and faeces) from each treatment were then oven-dried at 60°C for 48 h. Feeds and faeces were analyzed for protein based on the methods of AOAC (1990). A two g sample was used to analyze lipid content (ether extract), determined by extracting the sample with petroleum ether in a Soxhlet extractor. Crude fibre of the diets was determined by the Weendee method (AOAC, 1990). DM digestibility was calculated by using the total faecal collection method.

Statistical analysis: A completely randomized design was used in this study with seven treatment diets and four replicate cages of five birds each cage. Data were analyzed by analysis of variance using the Minitab 14 statistical program (Minitab, 2003) and differences among treatments were further tested for significance by using Duncan's Multiple Range Test (Steel and Torrie, 1980). All the statements of significance were based on $p<0.05$.

Table 1: Composition of the experimental basal diet (%)

Ingredients	Starter diet	Grower diet
Full fat soybean meal	24.99	18.97
Corn	60.20	62.10
Fish meal	11.20	11.00
Rice bran	2.0	3.9
Palm oil	0.38	1.0
Dicalcium phosphate	1.30	1.2
Salt	0.07	0.2
Methionine	0.15	0.15
Lysine	0.05	0.11
Vitamin and Mineral Mixture	0.20	0.20
Calculated		
Crude protein	23.13	21.00
Crude fibre	3.50	3.6
ME (K Cal/kg)	3200	3187
Lysine	1.1	1.0
Methionine	0.4	0.4
Calcium	1.4	1.0
Phosphorous	0.9	0.7

RESULTS AND DISCUSSION

The data on PKM polysaccharides extracted with various concentrations of NaOH were shown in Table 3. The effects of treatments on body weight gain, feed intake and feed conversion ratio, faecal dry matter and nutrient digestibilities were shown in Table 4 and 5. Results indicated that the body weight gain, feed intake, faecal dry matter and crude fiber digestibilities were not affected by treatment diets ($p>0.05$), while feed conversion ratio, dry matter digestibility and protein digestibility were significantly affected by treatment.

The extraction of palm kernel meal by using different concentrations of NaOH produced residue (extract) in different quantity. Extracts, obtained by using NaOH and H_2SO_4, were polysaccharides. According to Daud and Jarvis (1992) and Balasubramaniam (1976), polysaccharide produced from palm kernel meal or the palm family is mainly a mannose-based polysaccharides. In general, it can be said that the content of palm kernel polysaccharides extracted by using various concentrations of NaOH is approximately between 27 and 30%. The concentration of the palm kernel polysaccharides tended to decrease as the NaOH concentration increased. These findings are in accordance with the finding of Huang *et al.* (2010) who stated that yield of polysaccharides extracted from *Ganoderma lucidum* were affected by temperature, length of time and concentration of alkaline.

Table 2: Treatment diets

Treatment diets	Replications	Birds
Basal diet + 10 ppm avilamycin	4	5
Basal diet + 0.025% extracted PKM with 10% NaOH	4	5
Basal diet + 0.05% extracted PKM with 20% NaOH	4	5
Basal diet + 0.025% extracted PKM with 30% NaOH	4	5
Basal diet + 0.05% extracted PKM with 10% NaOH	4	5
Basal diet + 0.025% extracted PKM with 20% NaOH	4	5
Basal diet + 0.05% extracted PKM with 30% NaOH	4	5

Table 3: Extract percentage of palm kernel meal

Treatments	Dried weight (g)	After extraction (g)	Extract (%)
PKM extracted with 10% NaOH	500	147.4	29.5
PKM extracted with 20% NaOH	500	135.4	27.1
PKM extracted with 30% NaOH	500	1134.4	26.9

Table 4: Effects of treatment on broiler performance at 6 week of age

	Parameters		
Treatments	BWG (g)	Feed Intake (g)	FCR
Basal + Avilamycin	2136	3940	1.84[a]
Basal + 0.025% mannan PKM, 10% NaOH	2203	3921	1.78[ab]
Basal + 0.05% mannan PKM, 10% NaOH	2246	3981	1.77[ab]
Basal + 0.025% mannan PKM, 20% NaOH	2259	3954	1.75[b]
Basal + 0.05% mannan PKM, 20% NaOH	2150	3907	1.82[ab]
Basal + 0.05% mannan PKM, 30% NaOH	2193	3947	1.80[ab]
Basal + 0.05% mannan PKM, 30% NaOH	2225	3942	1.77[ab]
Standard Error Means	36.6	46.3	0.02
p-value	0.196	0.950	0.028

Different letter superscripts (abc) within a column are significantly different ($p<0.05$)

Table 5: Effects of treatments on digestibility of the diets

	Parameters (%)			
Treatments	DM of feces	DM digestibility	Protein digestibility	Crude fibre digestibility
Basal + Avilamycin	24.6	75.3[b]	77.8[b]	19.9
Basal + 0.025% mannan PKM, 10% NaOH	22.5	77.7[ab]	80.0[ab]	23.5
Basal + 0.05% mannan PKM, 10% NaOH	27.0	77.0[ab]	79.8[ab]	24.7
Basal + 0.05% mannan PKM, 20% NaOH	21.6	83.2a	85.1[a]	28.2
Basal + 0.05% mannan PKM, 20% NaOH	26.2	76.0[ab]	83.1[ab]	22.7
Basal + 0.025% mannan PKM, 30% NaOH	16.6	78.7[ab]	82.7[ab]	21.8
Basal + 0.05% mannan PKM, 30% NaOH	16.6	79.0[ab]	81.3[ab]	27.0
Standard error means	3.2	1.6	1.2	2.6
Nilai probabilities	0.165	0.049	0.006	0.308

Different letter superscripts (abc) within a column are significantly different ($p<0.05$)

Sundu *et al*. (2006) reviewed the use of mannose based polysaccharides from coconut in broiler chicken diets. They indicated that body weight gain of broilers increased by 7% when this polysaccharides used. As coconut and oil palm belong to the same family, the use of polysaccharides of palm kernel meal in replacing antibiotic growth stimulants (avilamycin) in the present study showed promising result. Body weight gain of broilers fed polysaccharides from palm kernel meals produced relatively the same results as the weight of broiler chickens fed antibiotics growth promotants (avilamycin). An increase in body weight gain by more than 100 g compared to the birds fed the control avilamycin diet was found in broilers fed the 0.05% palm kernel polysaccharides extracted with 10% NaOH and the 0.025% palm kernel polysaccharide extracted with 20% NaOH. However, the increase in the body weight gain was not statistically significant. Feed consumption was also relatively unchanged when avilamycin-supplemented diet was replaced with diets containing different level of palm kernel polysaccharides and diets extracted with various concentrations of NaOH. Since the use of antibiotic growth promotant is still in controversy, replacing antibiotic growth promotants in broiler diets with palm kernel polysaccharides could be promoted, particularly in palm kernel meal producing countries.

There was a significant increase in feed Conversion ratio (FCR) when the avilamycin supplemented diet was replaced with a feed containing 0.025% palm kernel polysaccharides, extracted with 20% NaOH. The reason of the increase might be due to the accumulation of an increase in bodyweight gain and a decrease in FCR in birds fed the diets supplemented with 0.025% palm kernel polysaccharides, extracted with 20% NaOH.

These data may indicate that the use of 0.025% palm kernel polysaccharides, extracted with 20% NaOH may be effective in improving the quality of the diet and gut health. Increasing the concentration of NaOH from 20 to 30% to extract palm kernel meal polysaccharides and increasing palm kernel polysaccharides in the diets from 0.025 to 0.50% did not improve FCR.

Dry matter of the feces excreted by the broiler chickens fed different diet treatments was relatively the same. Interestingly, the birds fed the diets containing polysaccharides of palm kenel extracted with high concentration of NaOH (30%) tended to produce wetter faecal discharges, being only 16.6% dry matter. However, this was not statistically significant. Dry matter digestibility of feed was in the range between 75 and 83%. The 75% dry matter digestibility was found in the diet supplemented with avilamycin as an antibiotic growth promotant. The supplementation of the diets with polysaccharides from palm kernel meal increased the digestibility of dry matter to 77-83%. The increase became significant when the diet supplemented with 0.05% palm kernel polysaccharides extracted with 20% NaOH. It is hard to explain this increase in dry matter digestibility. This might be through the improved health status of the digestive tract of the birds, compared to the birds fed the diet supplemented with avilamycin. It can be speculated that the birds fed the 0.05% palm kernel polysaccharides extracted with 20% NaOH had healthier gut as avilamycin might only effectively kill gram-positive pathogenic bacteria (Boll *et al.*, 2006). Further study is needed to clarify this speculation.

The same trend was also shown in the digestibility of the protein in which the protein digestibility of broiler chickens fed the palm kernel polysaccharides extracted with various NaOH concentrations increased from 78% (diet supplemented with avilamycin) to between 80 and 85%. A significant increase by 9.4% in protein digestibility was found in the diet containing 0.025% palm kernel polysaccharides extracted with 20% NaOH. Although there was an increase in the digestibility of crude fiber by between 9 and 41% due to the addition of palm kernel polysaccharides, the improvement was statistically undetected.

Conclusions: Concentration of palm kernel polysaccharides extracted with different concentrations of NaOH varied between 27 and 30%. The use of palm kernel polysaccharides can replace antibiotic growth stimulants (avilamycin) in poultry diets. Digestibility of dry matter and crude protein of 0.05% palm kernel polysaccharides diet extracted with 20% NaOH was better than the avilamycin-supplemented diet.

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