

Effect of mannanase-supplemented PKE-based diets on the growth performance, feed efficiency and dressing percentage of broilers

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Abstract

A feeding trial was conducted to determine the effects of mannanase supplementation and various levels of palm kernel expeller (PKE)-based diets on the growth performance, feed intake and feed efficiency of Cobb broilers. The birds were fed 0, 8, 16 and 24% PKE-based diets with or without mannanase supplementation. The study involved a total of 160 one-day-old male Cobb chicks randomly assigned to eight treatments with four replicates each and five birds per replicate. There were no significant differences ($p > 0.05$) in feed intake, weight gain, feed conversion ratio and dressing weight percentage when comparing birds fed with PKE supplemented with or without enzyme with birds fed with corn-soybean diet (control). This study showed that PKE inclusion levels up to 24% did not result in any adverse effect on broiler production. Supplementation of PKE-based diets with mannanase had no beneficial effect on growth performance and feed efficiency.

Keywords: broilers, mannanase, PKE, Cobb 500, growth performance

Introduction

The major feed ingredient in Malaysia is the palm kernel expeller (PKE) which is a by-product from the oil palm industry after the extraction of kernel oil. It contains 14.5 – 19.6% crude protein, 13 – 20% crude fibre, and is not a very palatable by-product (Saenphoom et al. 2011). It also lacks several amino acids and has low lysine availability. Its inclusion in animal feed is often determined by its price in relation to other available protein supplements and the cost of balancing the amino acids content. In Malaysia, PKE has successfully been used as ruminant feed rather than as feed for monogastric animals (Chong et al. 2008). Improvement of the nutrient quality of the PKE by enzymatic activity or bioprocessing methods may help to improve

the digestibility of its fibre in poultry diet and thus help reduce the high cost of feed production.

Use of PKE for poultry production has been widely reported by several researchers (Yeong and Mukherjee 1983; Osei and Amo 1987; Panigrahi and Powell 1991; Perez et al. 2000; Okeudo et al. 2005; Sundu et al. 2006; Chong et al. 2008; Loh et al. 2008). In broilers, Osei and Amo (1987) found no significant differences in body weight and feed consumption but reported that feed conversion efficiency significantly declined as PKE levels reached 12.5% or higher. These authors also noted that use of PKE needs to be balanced with high-energy fat sources and suggested that more information is needed on amino acid availability. However, incorporation of high levels of

PKE in poultry feed by local feed millers is minimal due to competition from the ruminant feed industry and uncompetitive price of the by-product. Mardhati et al. (2011) reported that incorporation of up to 20% of PKE in poultry diets negatively affected the growth performance of birds compared to conventional corn-soybean based diets.

The use of appropriate enzymes is said to be one of the key technologies which can help address the challenge in feed technology and production (Choct 2006). Application of enzymes especially in improving the nutritive values of other feedstuffs have been studied, such as sunflower meal (Khan et al. 2006; Mushtaq et al. 2009), wheat-based diets (Steenfeldt et al. 1998) and corn (Yu et al. 2007).

Palm kernel expeller is known to contain high amount of fibrous material such as mannans and galactomannans. In order to optimise the use of PKE in poultry diet, supplementation of exogenous enzyme such as mannanase may be an alternative to hydrolyse the fibre. The benefits of using enzymes in poultry diets not only enhance their growth performance such as an increase in feed efficiency and conversion, improve nutrients digestibility but help to reduce the output of excreta which at the same time mitigate environmental problems (Choct 2006). Feed enzymes also act as growth promoters which reduce the overall production costs while improving the performance of birds.

Thus, the aim of this study was to determine the effect of supplementation of mannanase enzyme to various PKE-based diets on growth performance, feed efficiency and dressing percentage of male Cobb broilers.

Materials and methods

Broilers

A total of 160 one-day-old male Cobb 500 chick broilers were purchased from a hatchery in Melaka. The birds were reared in 2-tier battery cages in an open house system

with daily temperature fluctuations of 24 – 34 °C. The experiment was conducted at MARDI Serdang, Selangor. The birds were weighed individually and the initial average body weight of the chicks was approximately 46 – 47 g per bird. The birds were randomly assigned to eight treatments with four replicates per treatment and five individuals in each replicate. The feeding trial lasted for 42 days.

Feed formulations

The feeds formulated in this study were isocaloric and isonitrogenous based on the nutritional requirement of the broilers in relation to their specific age groups (Table 1). The test feed was also formulated based on the digestible lysine, methionine and cystine content of the feedstuff. The three different age groups were categorised as starter: 1 – 10 days, grower: 11 – 22 days, and finisher: 23 – 42 days with their energy and protein (CP) requirements (Table 2). The feed was formulated according to the nutrient recommendations of the Cobb breeder company (Anon. 2012).

Water was supplied *ad libitum* throughout the experiment. The feed offered to the birds were all in mash form. The enzyme used in this study was ECONASE® MP 100 (AB Enzymes GmbH, Germany), an enzyme containing mainly mannanase (used mainly to degrade the mannan in the PKE). The enzyme was supplemented in the feed directly to improve digestibility of the feed in broilers.

Eight different treatments were compared with four different levels of PKE (0, 8, 16 and 24%) incorporated. Each level of PKE used was supplemented with or without enzyme at 0.04% w/w. The treatments were comprised of treatment A = Standard corn-soybean (control treatment); B = Control (Diet A) + enzyme; C = Diet with 8% PKE; D = Diet with 8% PKE + enzyme; E = Diet with 16% PKE; F = Diet with 16% PKE + enzyme; G = Diet with 24% PKE; and H = Diet with 24% PKE + enzyme.

Table 1. Feed formulation of the test diets at different levels of PKE inclusion and broiler stages

Ingredients PKE inclusion level	Starter				Grower				Finisher			
	0%	8 %	16%	24%	0%	8 %	16%	24%	0%	8 %	16%	24%
Corn	50.9760	51.7250	37.4950	23.2640	50.8660	54.0580	41.7630	26.7620	55.2390	40.2770	31.3210	26.3910
Soybean meal	29.7310	23.9150	26.7800	29.6440	30.2070	19.1900	18.0780	22.5300	19.3010	17.3120	17.6160	18.5490
Palm kernel expeller	0.0000	8.0000	16.0000	24.0000	0.0000	8.0000	16.0000	24.0000	0.0000	8.0000	16.0000	24.0000
Wheat middlings	8.0000	0.0000	0.0000	0.0000	8.0000	0.0000	0.0000	0.0000	8.0000	8.0000	5.7950	0.0000
Gluten meal	4.7280	6.6110	4.4670	2.3240	1.6920	9.0000	8.0840	5.5000	9.2920	10.5570	10.4260	9.2700
Fish meal	0.5000	3.0000	3.0000	3.0000	0.3000	2.0540	3.6980	3.0000	0.3000	0.3000	0.3000	0.9340
Rice bran	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.1730	5.0000	5.0000	5.0000
Palm oil	1.6340	2.2290	7.8260	13.4230	4.7340	3.2970	8.0040	13.9450	2.5290	6.3640	9.3690	11.7160
Dical. Phos.	1.8570	1.9210	1.9370	1.9530	1.7680	1.8470	1.8890	1.8940	1.6600	1.6740	1.6940	1.7160
Limestone	1.3510	1.3010	1.2120	1.1230	1.2940	1.2710	1.1930	1.1000	1.2710	1.2120	1.1390	1.0660
Common salt	0.4610	0.4630	0.4620	0.4610	0.4380	0.4390	0.4390	0.4380	0.4360	0.4300	0.4290	0.4290
L-Lysine HCl	0.1830	0.2510	0.2020	0.1540	0.0890	0.2970	0.2810	0.2210	0.2840	0.3360	0.3460	0.3260
DL-Methionine	0.2060	0.1920	0.2230	0.2540	0.2190	0.1520	0.1670	0.2040	0.1500	0.1530	0.1630	0.1790
Mineral premix	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1050
Antibiotic CTC 15%	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Choline-Cl 70%	0.0800	0.0990	0.1030	0.1070	0.1000	0.1030	0.1120	0.1140	0.0650	0.0860	0.1010	0.1190
Salinomycin 12%	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
Vitamin premix	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0430	0.0500	0.0500	0.0500	0.0500

Table 2. Nutrient composition of the test diets at different levels of PKE inclusion for various broiler stages

PKE inclusion level chemical composition	Starter				Grower				Finisher			
	0%	8 %	16%	24%	0%	8%	16%	24%	0%	8 %	16%	24%
Avail. Phos.	0.50	0.50	0.50	0.50	0.48	0.48	0.48	0.48	0.45	0.45	0.45	0.45
Calcium	1.00	1.00	1.00	1.00	0.96	0.96	0.96	0.96	0.90	0.90	0.90	0.90
Choline	1600.00	1600.00	1600.00	1600.00	1500.00	1500.00	1500.00	1500.00	1400.00	1400.00	1400.00	1400.00
Digest. Lysine	1.08	1.08	1.08	1.08	0.99	0.99	0.99	0.99	0.95	0.95	0.95	0.95
Digest. Met	0.51	0.53	0.54	0.56	0.49	0.49	0.50	0.52	0.47	0.48	0.49	0.50
Digest. Met + Cys	0.80	0.80	0.80	0.80	0.76	0.75	0.75	0.75	0.74	0.74	0.74	0.74
Ether extract	4.75	5.85	11.30	16.75	7.57	7.10	11.84	17.55	6.17	10.54	13.67	16.15
Linoleic acid	1.38	1.29	1.51	1.73	1.63	1.40	1.57	1.81	1.53	1.71	1.77	1.79
Lysine	1.20	1.20	1.21	1.23	1.10	1.10	1.11	1.12	1.05	1.06	1.07	1.08
Met + Cys	0.90	0.90	0.90	0.90	0.84	0.85	0.86	0.85	0.84	0.85	0.85	0.85
Metab. Energy (ME)	12.50	12.50	12.50	12.50	12.90	12.90	12.90	12.90	13.20	13.20	13.20	13.20
Methionine	0.55	0.57	0.58	0.60	0.52	0.52	0.54	0.56	0.50	0.51	0.53	0.54
Protein	22.00	22.00	22.00	22.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
Sodium	0.20	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

The use of antibiotic and coccidiostat followed the recommendations of the manufacturer with a withdrawal period of 7 days before slaughter. The experimental diets were analysed for proximate composition using the Association of Official Analytical Chemist (AOAC 1990) recommended procedures.

Data collection

The birds were weighed on day 10 and 22 for transition from starter to grower and finisher feeding regimes. Average body weight and feed intake were measured and recorded at those times. At 42 days old, the final body weight of all birds was recorded. The feed conversion ratio (FCR) was calculated based on the ratio of kg of feeds consumed per kg of weight gained. For carcass analysis, two birds from each replicate were randomly sampled and weighed to measure their body weight gain. The birds were killed and the carcasses scalded in hot water and de-feathered. The head, shank and the internal parts were removed to get the dressing weight.

Statistical analysis

Data on weight gain, feed intake, feed conversion ratio (FCR), dressing weight and dressing weight percentage of broilers fed various levels of PKE were analysed using the ANOVA procedure from the SAS program and the differences between means were compared using LSD test.

Results and discussion

The final body weight and weight gain of the broilers fed various levels of mannanase-supplemented PKE-based diets are shown in Table 3. At 42 days of age, there were no significant differences ($p > 0.05$) in final body weight between groups fed different levels of PKE with or without enzyme supplementation compared to the control group. During the starter phase (up to 10 days of age), weight gain was not significantly different ($p > 0.05$) among all treatments. At 42 days old, the group

that was fed with 8% PKE with enzyme supplementation showed the highest weight gain (2439.37 g/bird) and was significantly higher ($p < 0.05$) compared to those fed with 16% PKE with enzyme, and 24% inclusion of PKE with and without enzyme. For each level of PKE used, treatments with enzyme supplementation showed no significant advantage ($p > 0.05$) over treatments without enzyme supplementation.

The major increment of weight gain for each treatment occurred during the finisher stage, which was at day 23 – 42 (*Table 3*). The similarity in terms of weight gain between all treatments may be due to the isocaloric and isonitrogenous composition of the diets. Each diet was supplemented with sufficient amount of metabolisable

energy, amino acids, minerals and vitamins to meet the requirement for the starter, grower and finisher phase (NRC 1994). As the nutrients supplied fulfilled the nutrient requirements of Cobb broilers, the weight gain was almost similar in all the treatments despite increasing levels of PKE in the diet. Inclusion of PKE up to 24% had no detrimental effect on the growth performance of the birds and this result was in contrast to the study by Mardhati et al. (2011) who reported that inclusion of 20% PKE and PKC in broiler feed negatively affected growth performance of the birds.

At 42 days of feeding period, the feed intake (*Table 4*) of broilers showed no significant differences between treatments and the control diets. However, feeding

Table 3. Effect of mannanase supplementation on weight gain of broilers fed different levels of PKE

Treatment		Final body weight (g)	Weight gain (g)		
		DOC Wt + Wt gain 42 days	42 days	23 days	10 days
A	Control corn-soy	2371.50abc	2324.62abc	795.12ab	228.12a
B	Control + enzyme	2358.83bc	2312.61bc	834.78a	232.78a
C	8% PKE	2453.96ab	2407.29ab	805.09ab	209.84a
D	8% PKE + enzyme	2485.50a	2439.37a	798.87ab	208.87a
E	16% PKE	2431.00abc	2384.00ab	774.5b	231.00a
F	16% PKE + enzyme	2336.04bc	2290.43bc	801.64ab	214.89a
G	24% PKE	2308.63c	2262.04c	781.16b	223.41a
H	24% PKE + enzyme	2297.63c	2250.18c	765.06b	214.06a

abc-means with the same superscript do not differ significantly

Table 4. Effect of mannanase supplementation on feed intake (grams) at various phases of broilers fed different levels of PKE

Treatment		Feed intake		
		42 days	23 days	10 days
A	Control corn-soy	3838.00ab	1255.00a	295.00ab
B	Control + enzyme	3902.1ab	1247.50a	287.50ab
C	8% PKE	3865.8ab	1250.13a	282.0ab
D	8% PKE + enzyme	4062.4a	1210.31a	267.50b
E	16% PKE	3948.00ab	1260.50a	307.00a
F	16% PKE + enzyme	3961.78ab	1250.95a	282.83ab
G	24% PKE	3814.5ab	1246.85a	292.00ab
H	24% PKE + enzyme	3795.4b	1204.50a	274.5ab

abc-means with the same superscript do not differ significantly

Table 5. Effect of mannanase supplementation on feed conversion ratio (FCR) of broilers fed different levels of PKE

Treatment		Feed conversion ratio (FCR)		
		42 days	23 days	10 days
A	Control corn-soy	1.65ab	1.58abc	1.29ab
B	Control + 0.04% enzyme	1.69ab	1.50c	1.23b
C	8% PKE	1.61b	1.55abc	1.36a
D	8% PKE + enzyme	1.66ab	1.52bc	1.29ab
E	16% PKE	1.66ab	1.63a	1.33ab
F	16% PKE + enzyme	1.73a	1.56abc	1.32ab
G	24% PKE	1.69ab	1.60ab	1.31ab
H	24% PKE + enzyme	1.69ab	1.57abc	1.28ab

^{abc}-means with the same superscript do not differ significantly

with 8% PKE supplemented with enzyme was significantly higher ($p < 0.05$) than the treatment with 24% PKE supplemented with enzyme at 42 days (Table 4). This showed that even at higher level of PKE incorporation in the diet for broilers, no adverse effect on feed intake was observed. For day 10 and day 23, there were no significant differences in feed intake between the control and all treatment groups (Table 4). Feed intake in this study was comparable to those reported by Mardhati et al. (2011) but was lower than the proposed feed intake of 4.8 kg/bird (Anon. 2012) for the 42-days of growing period. Feeding broiler diets in the form of mash rather than the recommended crumble and pellet may have reduced the feed intake. When the birds were fed with feed in the form of mash, they will have to utilise more energy to pick up the feed due to the smaller particle size of the feed, thus causing a decline in feed intake.

The high temperature during the experiment may be another reason for the low feed intake. Higher temperatures will cause the birds to feed less in order to maintain their body temperature. During the hot season, the heat released via feeding activity will only cause the bird's body temperature to rise and may cause higher mortality rate. John (2008) in his paper also

mentioned that as the temperature rises, the birds have to maintain the balance between heat production and heat loss, thus reducing feed consumption in order to reduce the heat produced from metabolism.

The FCR of all treatments showed better results at day 42, where it ranged between 1.61 and 1.69 except for treatment F (Table 5). The best FCR was recorded in treatment C with 1.61 while the highest was in treatment F with 1.73. The FCR in all treatments showed no significant differences from the control diet. On the whole, the FCR recorded in this study was found to be good and comparable to the normal commercial FCR which is around 1.65 at day 42 (Anon. 2012).

The FCR on days 23 and 10 were not significantly different from the control diet, in all treatments. This showed that PKE can be incorporated up to 24% in the diets of broilers without any detrimental effect on the FCR. By comparison, Loh et al. (2008) reported that diets with 10% and 20% PKE and supplemented with mannanase (Acezime) showed poorer FCR compared to the control corn-soy based diets. Iyayi and Davies (2005) in their study using 0.01% of enzyme also reported that enzyme supplementation of PKE gave a poorer FCR as the birds grew older.

Table 6. Effect of mannanase supplementation on dressing weight and dressing percentage of broilers fed different levels of PKE

Treatment		Body weight (g)	Dressing weight (g)	Dressing weight percentage (%)
A	Control corn-soy	2367.83ab	1891.65ab	79.8604ab
B	Control + enzyme	2335.67ab	1883.17ab	80.6211a
C	8% PKE	2361.50ab	1881.18ab	79.5640ab
D	8% PKE + enzyme	2464.50a	1981.23a	80.4093a
E	16% PKE	2300.83ab	1812.90bc	78.7566bc
F	16% PKE + enzyme	2307.50ab	1785.35bc	77.2864cd
G	24% PKE	2198.17b	1688.77c	76.8260d
H	24% PKE + enzyme	2323.00ab	1825.03abc	78.4782bc

abc-means with the same superscript do not differ significantly

The present study also proved that dietary inclusion of PKE and enzyme supplementation did not influence feed efficiency. According to De Bot (2005), maximum enzymatic hydrolysis of PKE with mannanase (Econase MP 1000) was achieved after 48 h and this incubation period was also reported by Wong and Wan Zahari (1992) to achieve optimal PKE digestion in ruminants. As feed retention time in poultry is less than 8 h, supplementation of PKE based diets with mannanase enzymes was ineffective in increasing PKE digestibility.

The body weight of birds observed in all treatments did not differ significantly ($p > 0.05$) when compared to the control diets. There were no significant differences in the body weight of birds in all treatments (Table 6). Only treatment D and G differed significantly ($p < 0.05$). As for the dressing weight there were also no significant differences ($p > 0.05$) between treatments compared to the control, with the exception of treatment G. Treatment G had the lowest dressing weight of 1688.7 g/bird (Table 6) which was significantly lower than treatment A, B, C and D. In terms of dressing weight percentage, only treatment F and G differed significantly from the control treatment. The highest dressing weight percentage was found in the birds fed with ration of control diet plus enzyme with the percentage of 80.62% (treatment B). The lowest dressing

weight percentage (76.83%) observed was in treatment G. Except for treatment F, there was a slight increase in the dressing weight percentage of birds in all treatments with enzyme supplementation compared to without enzyme for each level of PKE inclusion.

Conclusion

This study showed that PKE inclusion levels up to 24% in broiler diets can produce comparable performance to those fed with the conventional corn-soy based diets in terms of growth rate and FCR. Supplementation of mannanase enzyme in the feed was expected to further enhance and increase the absorption of nutrients, improve the digestibility value of the palm kernel expeller and improve growth performance of broilers. However, the present findings indicated that the supplementation of enzyme in PKE-based diets had no beneficial effect in terms of weight gain, feed intake, FCR and the carcass quality. The use of large quantities of palm kernel expeller in poultry diets is often determined by its price in relation to other protein supplements and the cost of balancing amino acids content. To enhance its competitiveness as a feed ingredient for the local poultry, further R&D is needed to enhance its nutritive value in terms of metabolisable energy and digestible amino acid.

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Abstrak

Satu kajian pemakanan telah dijalankan untuk menentukan kesan penambahan mannanase dalam makanan berasaskan pelbagai aras isirung hampas kelapa sawit (PKE) terhadap prestasi pertumbuhan, pengambilan makanan dan kadar kecekapan pemakanan ayam pedaging Cobb. Ayam tersebut diberi makan makanan berasaskan PKE pada kadar 0, 8, 16 dan 24% sama ada mengandungi mannanase ataupun tanpa mannanase. Sebanyak 160 ekor anak ayam jantan Cobb berumur sehari telah digunakan dalam kajian ini dan diagihkan secara rawak kepada lapan rawatan dengan empat replikat dan lima ekor ayam setiap replikat. Tiada perbezaan yang nyata ($p > 0.05$) pada berat badan ayam, kadar pengambilan makanan, FCR dan berat karkas apabila membandingkan ayam yang diberi makan PKE berserta mannanase atau tanpa enzim dengan ayam kawalan (makanan berasaskan jagung dan mil soya). Kajian ini menunjukkan penggunaan PKE pada tahap 24% tidak memberi kesan buruk terhadap pengeluaran ayam pedaging. Penambahan mannanase dalam makanan berasaskan PKE juga tidak menunjukkan kesan bermanfaat terhadap prestasi pertumbuhan dan kecekapan pemakanan.