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ISBN 979-97243-9-2

PERFORMANCE OF BROILER CHICKS FED THE PALM KERNEL MEAL DIET SUPPLEMENTED WITH DIFFERENT ENZYME PRODUCTS

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ABSTRACT

An experiment using amino acid supplemented palm kernel meal (PKM) at a level of 30 % with or without enzymes compared with an amino acid supplemented corn-soy (CS) diet with or without enzymes was conducted to provide basic information about the effect of enzymes and high level inclusion of PKM on the performance of broiler chickens. A total of 56-day-old chicks were used in a completely randomised factorial design experiment with two different diets (PKM and CS) and five enzyme treatments (nil, Gamanase, Hemicell mannanase, Allzyme SSF and combination of Allzyme SSF and Gamanase). The birds were fed *ad libitum* for three weeks. Water was available at all times. Analysis of variance indicated that there was no significant difference between amino acid supplemented 30% PKM with the enzyme combination and the amino acid supplemented corn-soy diets in body weight, feed intake or feed conversion ratio. Interactions between diet and enzymes were found in body weight and feed intake. There was a greater body weight of birds fed the Gamanase supplemented PKM diet than of birds fed the combined enzyme supplemented corn-soy diet. The feed intake of birds fed the Gamanase supplemented PKM diet was significantly higher than the feed intake of birds fed the Gamanase supplemented corn-soy diet.

Key words: Palm kernel meal, enzymes, broilers

INTRODUCTION

Palm kernel meal (PKM) production has increased rapidly over the last decade from 3.6 million metric tonnes in 1989 to 5.9 metric tonnes in 1999. PKM is a moderate source of protein and energy for livestock. PKM is mostly used for ruminant diets, while in poultry its use is very limited because of its reputation for unpalatability, grittiness and low digestibility (Onwudike, 1986a,b; Chin, 2002, Sundu *et al.*, 2005; 2006a).

Problems associated with the use of PKM in poultry diets are its high fibre content which is contributed by mannan, contamination of nut shell (lignin) (Daud and Jarvis, 1992; Duestherhoft *et al.*, 1993; Knudsen, 1997; Sundu and Dingle, 2003; Sundu *et al.*, 2006b) and low levels of several limiting amino acids (AAs) (Nwokolo *et al.*, 1976). The early recommendation for using this feedstuff in broiler diets was in a range between 10 and 25% (Hutagalung, 1980). More recent findings by Panigrahi and Powell (1991) were that the inclusion of 40% PKM gave good results when lysine and methionine were added to the diets. Few studies on the aspect of using enzymes to improve the nutritive value of PKM have been reported.

ISBN 979-97243-9-2

Since PKM contains 46.6% NSPs, mostly linear β-mannan (Knudsen, 1997), the use of mannan degrading enzymes may increase bird performance. Of the total NSPs, xylose polymer (pentosan) and cellulose are present as 6 and 12% respectively. The main nutrients present are protein (14 - 22%) and a small amount of starch (Nwokolo *et al.,* 1976; Onwudike, 1986a; Knudsen, 1997). Since one of the main reasons for using enzymes is to release entrapped nutrients and to further hydrolyse nutrients to simple forms, the use of many enzymes becomes necessary to completely digest nutrients. Multi-enzymes become an option for producing effective results (see Balasubramaniam, 1976; Dowman, 1993; Sundu *et al.*, 2005). This study was designed to investigate the effect of enzyme products, either as a single enzyme or multiple enzymes, on birds fed a high level of PKM in the diet.

MATERIALS AND METHODS

Location and animals in the study

A total of 75-day-old male Ross chicks were available for use as experimental animals. They were placed in a floor pen from days 1 to 7 and given a control diet. After the initial seven-day period, 56 chicks were selected to minimize animal variation and transferred into individual cages in a controlled temperature room and exposed to 23 h light and 1 h dark.

Feed and water

PKM was included as 30% of the diet. The diets were formulated to meet the nutrient requirements of starter broilers as recommended by NRC (1994) (Table 1). The eight experimental diets imposed are described in Table 2. Twenty ml of "Gamanase" solution was dissolved in 250 ml tap water and sprayed onto 10 kg feed (to produce a dose rate of 0.2% α-galactosidase and β-mannanase) using a small pressure sprayer while the diets were being mixed in a cement mixer. A powdered multi-enzyme supplement, "Allzyme SSF", was mixed as 0.02% of the diet as recommended by the manufacturer. All diets were then air-dried for three days prior to feeding.
On day seven, after transferring the birds from floor pens into individual cages, the animals were fed the experimental diet by topping up feed troughs twice a day at 09.00 and 16.30 hours and water was available at all times.

Chemical analysis

Representative feed samples were collected to determine dry matter (DM), crude protein (CP), lipid and gross energy (GE) content (AOAC, 1990) as well as bulk density and water holding capacity. Prior to chemical analysis, the feed was ground (0.5 mm screen). For DM, samples were oven dried at 65°C for 24 hours. Crude protein was analyzed using the automatic protein Leco Analyser FP 2000. A two g sample was used to analyze lipid content (ether extract), determined by extracting the sample with petroleum ether in a Soxhlet extractor. Gross energy was analyzed using a bomb calorimeter (C 2000 Basic, IKA@ Werke). For neutral detergent fibre (NDF) analysis, samples were defatted prior to analysis as recommended by Prosky *et al.* (1984). Bulk density was measured by weighing the feed in a litre container and was expressed in g/cm^3. The method of Kyriazakis and Emmans (1995) was used to measure water-

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ISBN 979-97243-9-2

holding capacity (WHC). A 0.5 g oven-dried sample was placed in a 15 ml tube and soaked for 24 hours in distilled water. It was then centrifuged at 6000 G for 15 min. The supernatant fraction was decanted and the fresh weight of feed was measured. After freeze-drying, the samples were weighed and the WHC was calculated as g water/ g feed. The results of these analyses are shown in Table 1.

Table 1. Ingredient and nutrient compositions of the experimental diets (g/kg)

Dietary components	**Corn-soy diet**	**30% PKM diet**
Palm kernel meal	0.0	300.0
Maize meal	602.0	332.1
Soybean meal	249.9	200.0
Fish Meal	100.0	110.0
Vegetable oil	33.8	48.9
Limestone	9.6	1.3
Sodium chloride	0.7	1.7
Vitamin and mineral mixture	2.0	1.0
DL-Methionine	1.5	2.0
L-Lysine	0.5	2.0
Calculated composition;		
ME (MJ/kg)	13.39	13.39
NDF	93.0	262.0
Crude protein	231.3	233.3
Methionine + cysteine	9.0	9.0
Available lysine	11.0	11.1
Arginine	14.3	14.0
Calcium	10.2	10.0
Available phosphorus	4.5	6.5
Analysed composition;		
Crude protein	236.0	252.0
Gross energy (MJ/kg)	18.06	19.84
Crude fibre	35.1	84.0
Lipid	75.0	121.1
Bulk density (g/cm^3)	0.69	0.71
WHC (g water/g feed)	2.59	2.73

PKM: Palm kernel meal; ME: Metabolizable energy; NDF: Neutral detergent fibre; MJ: Megajoule; WHC: Water holding capacity

Table 2. Details of experimental treatments

Diet	**Enzymes**	**Treatments**
Diet 1; corn-soy based diet (D1)	- without enzymes (E1)	- D1E1
	- with gamanase (E2)	- D1E2
	- with SSF (E3)	- D1E3
	- with gamanase + SSF (E4)	- D1E4
Diet 2; palm kernel meal based diet (D2)	- without enzymes (E1)	- D2E1
	- with gamanase (E2)	- D2E2
	- with SSF (E3)	- D2E3
	- With gamanase + SSF (E4)	- D2E4

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Parameters measured and statistical analysis

The parameters measured were feed intake, weight gain and feed conversion ratio (FCR). Feed intake was measured weekly and birds were weighed five times, at 1, 7, 14, 17 and 21 days of age or days 1, 7, 10, 14 of feeding the test diets. A completely randomized design of factorial structure with two different sources of diets, four different enzymes and seven replications was adopted in which one bird was placed into each cage. Data was analyzed by analysis of variance using the SAS 6.2 statistical program (SAS Institute, 1990)

RESULT AND DISCUSSION

RESULTS

Table 3. The effect of corn-soy and palm kernel meal diets and enzymes on broilers from day 7 to 21

Feed	Feed intake (g)	Final BW (g)	Weight gain (g)	FCR
D1 (control diet)	814.4±11.6	725.7±14.8	605.4±15.2	1.20±0.008
D2 (PKM based diet)	828.4±13.2	724.2±13.1	606.2±12.8	1.20±0.005
E1 (without enzyme)	809.1±12.9	698.5±17.1	582.1±17.0	1.20±0.008
E2 (with Gamanase)	820.4±24.8	707.9±23.6	586.6±24.6	1.21±0.013
E3 (with SSF)	823.7±10.8	734.0±14.0	614.1±13.3	1.20±0.005
E4 (with Gamanase + SSF)	832.4±19.3	759.3±20.0	640.4±20.2	1.19±0.008

No significant differences (P>0.05); FCR: Feed conversion ratio

Table 4. The effect of enzyme supplementation in two different diets on broilers from day 7 to 21

Diet	Enzymes	Feed intake (g)	Final BW (g)	Weight gain (g)	FCR
D1	E1	812.8 ± 15.9^{ab}	704.9 ± 25.9^{ab}	585.7 ± 27.6^{ab}	1.20±0.014
D1	E2	763.0 ± 28.0^{b}	660.6 ± 35.8^{b}	539.3 ± 37.6^{b}	1.23±0.024
D1	E3	844.0 ± 11.2^{ab}	752.6 ± 7.32^{ab}	630.7 ± 7.98^{ab}	1.19±0.008
D1	E4	837.9 ± 24.0^{ab}	784.6 ± 21.7^{a}	666.0 ± 20.6^{a}	1.18±0.007
D2	E1	805.4 ± 21.4^{ab}	692.2 ± 24.2^{ab}	578.5 ± 22.0^{ab}	1.20±0.007
D2	E2	877.8 ± 27.9^{a}	755.1 ± 20.0^{ab}	633.9 ± 21.3^{ab}	1.19±0.009
D2	E3	803.4 ± 15.7^{ab}	715.5 ± 26.1^{ab}	597.5 ± 24.7^{ab}	1.20±0.007
D2	E4	826.8 ± 32.1^{ab}	734.0 ± 32.5^{ab}	614.9 ± 33.6^{ab}	1.20±0.014

Values with the same superscript within a column are not significantly different (P>0.05)

Table 5. Body weight of birds on days 7, 14 and 21

Diet / Enzymes	Day 1	Day 7	Day 14	Difference (%)	Day 21	Difference (%)
D1	42.9±0.1	120.3±1.7	398.5±6.7	0	725.7±14.8	0
D2	42.9±0.1	118.0±1.6	386.3±6.1	-3	724.2±13.1	-0.2
E1	42.9±0.1	116.5±2.5	388.3±9.8	0	698.5±17.1	0
E2	42.9±0.1	121.3±2.1	389.0±10.4	0.2	707.9±23.6	1.3
E3	42.9±0.1	119.9±2.4	389.7±9.3	0.4	734.0±14.0	5
E4	42.9±0.1	118.9±2.4	402.7±7.8	4	759.3±20.0	9

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ISBN 979-97243-9-2

The means of feed intake (FI), body weight (BW), live weight gain (LWG) and FCR of birds fed different diets with different enzyme treatments are shown in Table 3. Provided the AA requirements were met, the use of 30% PKM in the diet did not impair the body weight, live weight gain, feed intake or FCR of meat chickens. Enzyme supplementation did not significantly affect any of the parameters measured. There were significant interactions between feed and enzymes in FI, BW and LWG (see Table 4). There was a significantly greater feed intake by chickens fed the PKM with Gamanase than by those fed the corn-soy (CS) control diet with Gamanase; and there was a significantly greater body weight and weight gain of chickens fed the control diet with Gamanase + SSF than for chickens fed the control diet with Gamanase alone. The effects of enzymes on the BW were greater in the third week than in the second week (Table 5).

DISCUSSION

The results demonstrate that chicks fed the 30% PKM-based diet exhibited good performance in terms of BW, FI and FCR. This indicates that 30% PKM was equivalent to approximately 25% corn + 5% soybean. Thus the substitute protein amount was equivalent although slightly more methionine and lysine supplements were required to equate with the quality of the protein substituted. It is important to note that provided the diet contains the required nutrients then good performance of birds can be achieved if optimal feed intake can be met. Failure to meet optimal intake or to formulate a balanced diet can lead to poor performance of birds. It may be for this reason that Onwudike (1986b) found poor performance of starter birds fed a PKM based diet.

It has long been believed that enzymes can improve FI and weight gain of birds. Although, FI and weight gain of birds fed the PKM diets were not significantly different from the control diets, there was a tendency for an increase in either FI or weight gain due to enzyme supplementation, particularly in birds fed a combination of enzymes. A longer data collection period may result in the improvement being statistically significant. From Table 5, it can be seen that the difference in weight gain became greater as the birds were kept for a longer period. The gap of BW between birds fed the enzyme-unsupplemented diet and the combined enzyme supplemented diet, for instance, got wider from 4% in week 2 to 9% in week 3.

Interactions between the feed and enzymes were found in all parameters except FCR. The birds fed the Gamanase supplemented CS based diet had a mean BW and weight gain of 661 and 539 g respectively. These values were the lowest with the CS diets. But when Allzyme SSF was added in combination with Gamanase, the BW and weight gain were increased significantly ($P<0.05$). This indicates that Allzyme SSF is more effective in increasing the growth of broilers fed a CS diet than is Gamanase. The reason for this may be associated with the substrate target, because Allzyme SSF was developed mainly for use in soy diets but mannan, the main target of Gamanase, is not present in large quantity in a CS diet. The multi-enzyme product, Allzyme SSF, may work well in any diet due to its capability of releasing seven different nutrients. In contrast, the highest BW and weight gain of birds fed the PKM based diet were found in Gamanase fed birds. Since this enzyme was designed for guar gum, locust bean and

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other mannan rich feedstuffs, it was a better match for the PKM substrate target. The effectiveness of using Gamanase to release nutrients in PKM has been reported by a number of workers and it has been used effectively in the laboratory to measure the digestibility of dietary fibre in PKM (Dowman, 1993; Dusterhoft, *et al.,* 1993).

In conclusion, the use of 30% PKM for broiler chickens can be recommended because the weight gain of chicks was not significantly different from those fed the CS diet. The two different enzyme products used worked effectively in the different diets. Gamanase was more suitable for the PKM diet and Allzyme SSF for the CS diet. Overall, the combination of enzymes gave a good performance by the birds.

REFERENCES

AOAC. 1990. *Official Methods of Analysis* (15th Ed). Association of Official Analytical Chemists, Arlington, VA.

Chin, F. Y., 2002. Utilization of palm kernel cake (PKC) as feed in Malaysia. *Asian Livestock Magazine,* October – December, pp: 19 – 23.

Daud, M. J. and M. C. Jarvis, 1992. Mannan of oil palm kernel. *Phytochem.* 31: 463-464.

Dowman, M. G., 1993. Modification to the neutral detergent cellulase digestibility method for the prediction of the metabolizable energy of compound feedstuffs containing palm kernel meal. *J. Sci. Food Agric.* 61: 327 – 331.

Dusterhoft, E. M., A. W. Bonte, J. C. Venekamp, and A. G. J. Voragen, 1993. The role of fungal polysaccharidases in the hydrolysis of cell wall materials from sunflower and palm kernel meals. *World J. Microbiol.Biotech.* 9: 544-554.

Hutagalung, R. I., 1980. Availability of feedstuffs for farm animals. *Proceedings Abstract First Asia-Australasia Anim. Sci. Congress, Abstract No,* 40: 15.

Knudsen, K. E. B., 1997. Carbohydrate and liginin contents of plant materials used in animal feeding. *Anim. Feed Sci. Technol.* 67: 319-338.

Kyriazakis, I. and G. C. Emmans. (1995). The voluntary feed intake of pigs given feed based on wheat bran, dried citrus pulp and grass meal, in relation to measurements of feed bulk. *Br. J. Nutr.*73: 191-207.

NRC, 1994. *Nutrient Requirements of Poultry.* National Academy Press, Washington, DC.

Nwokolo, E. N., D. B. Bragg, and H. S. Saben, 1976. The availability of amino acids from palm kernel, soybean, cotton seed and rape seed meal for the growing chick. *Poult. Sci.,* 55: 2300-2304.

Onwudike, O. C. (1986a). Palm kernel meal as a feed for poultry.1. composition of palm kernel meal and availability of its amino acids to chicks. *Anim. Feed Sci. Technol.,* 16: 179-186.

Onwundike, O.C., 1986b. Palm kernel as a feed for poultry 2. Diets containing palm kernel meal for starter and grower pullets. *Anim. Feed Sci.Techno\l.,* 16: 187-194.

Panigrahi, S. and C. J. Powell. 1991. Effects of high rates of inclusion of palm kernel meal in broiler chick diets. *Anim. Feed Sci. Technol.,* 34: 37-47.

Prosky, L., N. G. Asp, I. Furda, J. W. DevVries, F. Schweizer, B. Tand Harland. 1984. Determination of total dietary fiber in foods, food products and total diets: interlaboratory study. *J. Assoc. Off. Anal. Chem.,* 67: 1044-1052.

ISBN 979-97243-9-2

SAS Institute, 1990. *SAS/STAT Users guide: statistic version 6.12*. Cary, North Carolina, SAS Institute Inc.

Sundu, B., A. Kumar, and J. Dingle, 2006. Palm kernel meal in broiler diets: Its effect on chicken performance and health. *World's Poult.Sci. J. (In Press).*

Sundu, B. and J. Dingle, 2003. Use of enzymes to improve the nutritional value of palm kernel meal and copra meal. *Queensland Poult. Sci. Symp.* 11, (14): 1-15.

Sundu, B., A. Kumar, and J. Dingle, 2005. Response of birds fed increasing levels of palm kernel meal supplemented with different enzymes. *Aust. Poult. Sci. Symp.*, 17: 227-228.

Sundu, B., A. Kumar, and J. Dingle. 2005. Comparison of feeding values of palm kernel meal and copra meal for broilers. *Recent Adv. Anim.Nutr. in Austr.*, 15: 28 A.