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Effect of β-mannanase supplementation and feed presentation on carcass characteristics and macro-mineral digestibility of growing rabbits fed palm kernel based diets

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Abstract

The influence of β -mannanase supplementation and feed presentation of palm kernel cake (PKC) based diets were assessed on grower rabbits. Twenty crossbred grower rabbits (757.5 ± 65g) of mixed sex aged between eight to ten weeks old were used during the trial in 2 X 2 factorial design conducted in a completely randomized experimental design giving four treatment interactions with five replicates of one rabbit per replicate. The treatments were; T1- diet in mash form without enzyme; T2- diet in pellet form without enzyme; T3- diet in mash form with β-mannanase (0.5g/kg) and T4- diet in pellet form with mannanase (0.5g/kg). The trial lasted for six weeks. The animals were weighed individually at the beginning of the study and weekly thereafter. At the end of the study period the feacal samples were collected and animals were slaughtered and measurements taken from the carcasses. The carcass yield showed no interaction, though full GIT weights (g) were significantly influenced (T1-23.04, T2-17.67, T3-19.99 and T4- 18.74. Enzyme inclusion and feed form elicited significant effects on carcass characteristics, with varying improvements observed. Enzyme inclusion on the mash diet gave lower organ weights compared to other diets. Feed form and enzyme inclusion influenced lengths of the segments of the GIT, with rabbit on Diet 3 having the longest length. Pelleting influenced ileum lengths positively. Rabbits fed pelleted or mash diets whether supplemented or non-supplemented with β-mannanase digested dry matter, calcium, phosphorus and magnesium in the same level. In conclusion, supplementation of diets with β-mannanase and pelleting of diets improved phosphorus digestibility in palm kernel cake based diets. In addition, rabbits feed mash and pelleted rations with addition of β-mannanase had improved loins as opposed to those fed mash and non-supplemented rabbits while other carcass and visceral organ characteristics were not significantly affected.

Keywords: β-mannanase, palm kernel cake, feed presentation, macro-minerals, carcass characteristics, rabbits

Introduction

A stiff competition exists between humans and the livestock industry for cereal grains, and secondly, the low production of grains results in its scarcity (Oluwafemi, 2009) and hence more reliance of livestock on agro-industrial by-products. One of such alternatives is Palm Kernel Cake (PKC). The Palm Kernel Cake (PKC) is a potential feedstuff obtained from the oil-palm processing industry. Palm kernel cake is a by-product of the extraction of oil from the palm kernels of the oil palm (*Elaeis guineensis*). Oil from palm kernel can extracted either manually or by appropriate organic solvents. Palm kernel cake obtained during manual extraction of palm kernel oil is of higher value because of the residual oil left unlike the solvent extracted that contains little or no residual oil. With a chemical composition close to rice bran and wheat bran, it has a potential for feeds. Its use has however been limited by its low protein, highly fibrous and gritty nature (Longe and Fagbenro-Bryon, 1990) and presence of non-starch polysaccharides (NSPs). These NSPs impair the digestibility and utilization of nutrients present in the plant feedstuff (Han, 1996). Howbeit, recent advances in biotechnology have opened opportunities for improvement of palm kernel cake for livestock utilization (Ng and Chong, 2002). The β-mannan is the main NSP found in palm kernel cake (Sundu *et al*., 2006) which is reported to be as high as 30% in the palm kernel meal (ChemGen Corp).

In relatively recent years there has been a renewed interest in the use of exogenous enzymes (feed grade enzymes) or solid state fermentation (Mosobalaje *et al*., 2012) to enhance the nutritive value of a diet, through their action on the utilization of nutrients, as well as improved health of a flock (Sarvestani *et al*., 2006).

Earlier works have shown that usage of feed in the form of pellets have physical and nutritional benefits (Behnke, 1994, 2001, Salari *et al*., 2006). Th physical benefits include improved ease of handling, reduced ingredient segregation, less feed wastage and increased bulk density. Falk, 1985, reported some of the nutritional benefits of feeding pellets. The improvements in performance of rabbits fed pelleted diets have been attributed to decreased feed wastage, reduced selective feeding, less time and energy expended for prehension, destruction of pathogens, thermal modification of starch and improvement in palatability (Behnke, 1994) and not as a result of fat deposition (Hathorn and Mowlem, 1980) . Increase in cost of pelleting must be off set by improved performance for profitability (Ziggers, 2004). To date, studies on enzyme inclusion in rabbit diets in Nigeria have been inconclusive, while studies on enzyme inclusion in pelleted diets is lacking. The purpose of this study was to determine the influence of β-mannanase and feed form (pellet and mash) on the performance of rabbits on a palm kernel cake based diet.

Materials and methods

Four isonitrogenous (17%) and isoenergetic (10.0 MJ^{-1}) practical diets were formulated (Table 1). All the diets contained 30% PKM as energy source. Two of the diets were in mash form while the other two were pelleted. Diet 3 and 4 were supplemented with β-mannanase (ChemGen Corp.) at 0.05% inclusion level. β-mannanase was added along with the micronutrients to both diets during the milling process

Experimental procedure

Twenty grower rabbits with a mean initial weight of 757.5±65g were randomly allocated to the four treatments with five (5) replicates per treatment, in a 2 x 2 factorial treatment design in a completely randomized design (CRD). At the start of the experiment, rabbits were weighed and allocated to individual cells of 40cm x 45cm x 60cm (L x B x H). The hutches were placed indoors with dwarf walls with concrete impervious floor. The rabbits were fed in the mornings and evenings. Water was given *ad-libitum*. Leftovers were removed and weighed daily. The rabbits were weighed weekly until the last week of the experimental period. The feeding trial lasted for six weeks.

Evaluation and analysis

At the beginning of the 6th week, two rabbits per replicate for each treatment were put in metabolic cages for 4 days for digestibility trial. Feed intake measured and feacal output was collected for each of the 4 days, weighed and recorded for each replicate, from which an aliquot (10%) taken and oven dried. Calcium, phosphorus and magnesium were measured by dissolving the samples in nitric acid and hydrochloric

Table 1. Composition of the experimental diets

Ingredients	Diet 1 (Mash)	Diet 2 (Pellet)	Diet 3 (Mash) + enzyme	Diet 4 (Pellet) + enzyme
Palm kernel cake	30.00	30.00	30.00	30.00
Maize	18.00	18.00	18.00	18.00
Groundnut cake	12.00	12.00	12.00	12.00
Wheat bran	11.00	11.00	11.00	11.00
Corn bran	10.00	10.00	10.00	10.00
Cowpea husk	7.00	7.00	7.00	7.00
Rice husk	7.00	7.00	7.00	7.00
Cassava starch	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50
Dicalcium phosphate	0.50	0.50	0.50	0.50
Table salt	0.25	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25	0.25
L-Lysine	0.20	0.20	0.15	0.15
Hemicell (Mannanase)	0.00	0.00	0.05	0.05
Premix	0.25	0.25	0.25	0.25
Mycofix	0.05	0.05	0.05	0.05
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated chemical composition				
Crude protein (%)	17.12	17.12	17.12	17.12
Crude fiber (%)	11.53	11.53	11.53	11.53
Digestible energy (MJ/kg)	9.97	9.97	9.97	9.97

*Composition of Premix

Vit A– 3,000,000iu/kg, Vit E–3000iu/kg, Vit B_1*–200mg/kg, Vit* B_6*–80mg/kg, Niacin-6000mg/kg, Molybdenum–200mg/kg, Iron–16,000mg/kg, Cobalt–100mg/kg, Zinc–20000mg/kg, Copper–2400mg/kg, Vit* D_3*–600000iu/kg, Vit* K_3*–800mg/kg, Vit* B_{12}*–2000mg/kg, Biotin–20000mcg/kg, Iodine–200mg/kg, Selenium–40mg/kg, Manganese–40000mg/kg, Pantothenic acid–2400mg/kg*

acid and diluting with de-ionized water to 100ml. The resultant extracts analyzed for calcium and magnesium using an atomic spectrophotometer and phosphorus using an autoanalyzer. At the end of the 6th week, all the rabbits were slaughtered, flayed and the carcasses divided into various parts and evaluated. Morphometric measurements were carried out on the gastro-intestinal tract (GIT) of the rabbits to determine the effects of the treatments on the each section.

Statistical analysis

The data collected was subject to analysis of variance, using the general linear model (GLM) procedure of SPSS (2001) and where significant was subject to the Duncan's Multiple Range Test (Duncan, 1955).

Results

Presented in Table 2 are the values for carcass evaluation. Diet 3 produced the highest values for dressing percentage, head and shoulder weights ($P > 0.05$). Diet 2 however gave a higher value for pelt, rack ($P < 0.05$) and thighs ($P > 0.05$). Loin weights revealed that Diet 4 gave a significantly higher weight than Diets 2 and 3, Diet 3 was also significantly different from Diet 1. No significant differences were observed among the treatments for all the visceral organ weights (Table 3). Diet 1 gave the highest values for liver, abdominal fat, kidney and spleen while the lowest

Table 2. Carcass characteristics as influenced by feed form and β-mannanase supplementation on grower rabbits

Parameters (%)	Diet 1	Diet 2	Diet 3	Diet 4	SEM	Significance
Dressing out	48.22	50.78	52.02	51.09	1.86	ns
Pelt	9.17^{ab}	10.42^{a}	8.54^{b}	9.11^{ab}	0.60	*
Head	9.11	9.38	9.62	9.28	0.35	ns
Shoulders	7.36	7.26	10.72	8.59	1.31	ns
Thighs	17.56	17.59	16.84	16.82	0.75	ns
Rack	10.58^{ab}	10.95^{a}	8.20^{b}	9.11^{b}	0.59	**
Loins	12.43^{c}	14.61^{bc}	15.74^{ab}	16.39^{a}	0.92	*

a, b – means in the same row with different alphabets are significantly different.
(%) Percentages are based on live weight

values for liver, abdominal fat, kidney, spleen and lungs were observed on Diet 3. The highest values for the heart and lungs were on Diet 2.

Values for GIT evaluation showed significant differences in total gastro-intestinal tract length (Table 5). There was however difference in the duodenum, jejunum and caecum lengths. Diet 4 had the highest value for stomach length ($P < 0.05$). Ileum length was also influenced by the association between feed form and mannanase inclusion with Diet 2 having the highest value ($P < 0.05$), the same trend was observed for large intestine and colon lengths ($P < 0.05$). There was however no difference in the caecum lengths of the rabbits, though Diet 1 was observed to have the highest value (Table 4).

Macro mineral digestibility showed no difference in the values for calcium and magnesium, though Diet 4 had numerically higher values for dry matter and calcium (Table 5). Digestibility of phosphorus ($P < 0.05$) and magnesium ($P > 0.05$) was highest on Diet 3. Diet 2 was observed to give the lowest digestibility for all the

Table 3. Effect of feed form and Mannanase on visceral organ weights of grower rabbits

Parameters (%)	Diet 1	Diet 2	Diet 3	Diet 4	SEM	Significance
Heart	0.29	0.33	0.32	0.30	0.02	ns
Liver	3.17	2.75	2.72	2.78	0.21	ns
Lungs	0.56	0.60	0.48	0.60	0.08	ns
Abdominal fat	1.03	0.81	0.71	0.84	0.21	ns
Kidney	0.60	0.57	0.51	0.57	0.04	ns
Spleen	0.06	0.05	0.04	0.04	0.01	ns

(%); Percentages based on live weight

Table 4. Influence of feed form and mannanase supplementation on GIT parameters of rabbits

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	SEM	Significance
GIT Length (m)	3.46^{b}	3.86^{ab}	4.16^{a}	3.89^{a}	0.17	*
Stomach (cm)	15.60^{c}	16.44^{bc}	18.62^{b}	23.16^{a}	1.08	**
Duodenum (cm)	42.60	48.40	58.10	42.44	4.01	ns
Jejenum (cm)	71.00	66.54	75.84	68.60	7.85	ns
Ileum (cm)	88.60^{b}	117.0^{a}	87.38^{b}	82.40^{b}	9.32	*
Large intestine (cm)	28.64^{b}	37.90^{a}	31.50^{ab}	31.40^{ab}	2.62	*
Caecum (cm)	49.90	47.32	49.36	46.98	4.07	ns

a, b, c – means in the same column with different alphabets are significantly different
GIT – gastro-intestinal tract length

Table 5. Influence of feed form and mannanase supplementation on dry matter, calcium, phosphorus and magnesium digestibility in grower rabbits

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	SEM	Significance
Dry matter	0.62	0.58	0.64	0.65	0.037	ns
Calcium	0.67	0.64	0.68	0.71	0.032	ns
Phosphorus	0.53^{ab}	0.41^{b}	0.65^{a}	0.61^{a}	0.046	*
Magnesium	0.41	0.40	0.52	0.49	0.055	ns

a, b, c – means in the same column with different subscripts are significantly different

metabolites.

Discussion

The non-significant effects on most of the visceral organs and carcass characteristics of simple stomach animals fed enzyme-supplemented rations have been reported (Garcia *et al*., 2003; Iyayi and Davies, 2005). These findings were contrary to Olayemi *et al*. (2006) who observed a significant reduction in empty carcass weight of growing rabbit on diet with exogenous enzyme inclusion when maize replaced maize milling wastes. The results in this study showed that enzyme supplementation on the mash diet gave lower values of organ weights (as a percentage of the live weight) while the mash diet without supplementation gave the highest values suggesting that enzyme supplementation had a negative influence on organ weights. An explanation to this observation is that perhaps enzyme supplementation increased transit time, which made less nutrients available in the short run. Pelleting without enzyme inclusion led to increased ileum lengths, possibly a response to an increased surface area for the absorption of digesta. The reduced large intestine and colon lengths and the increased caecum of the rabbits on the sole could be a reflection of more undigested matter thus requiring more space for microbial degradation, to meet the animal's nutrient requirements. Al Bustany (1996) found that enzyme supplementation was more effective on the mash than on the pelleted diets for improving the feed conversion ratio. Garcia *et al*. (2003) observed that using amylase enzyme of maize/soy diets improved feed efficiency, but it had no significant effect on carcass traits. Olayemi *et al* (2006) however observed that carcass weight of growing rabbits was significantly reduced on diet with enzyme inclusion when replacing maize with maize milling waste. Iyayi and Davies (2005) however observed no significant difference in the organ weights of birds fed a PKC-enzyme supplemented diet and a control diet, though the kidney weight was observed to be significantly lower.

Mannanase inclusion on the mash diet had the greatest influence on GIT length. Diets with reduced fiber resulted in gut hypomotility, and prolonged retention time in the hindgut leading to an enlargement of the hindgut Cheeke (1994). Wang *et al.* (2005) had stated that the inclusion of exogenous enzymes significantly altered the morphology of the different GIT. NSPs bind to nutrients and reduce surface area for intestinal digestion. The presence of exogenous enzymes could hydrolyse complexes formed, thus reducing digesta viscosity and enabling better absorption of metabolites across the intestinal lumen. This could have been responsible for the better digestibility observed on diets containing mannanase. The influence of supplementation of diets with exogenous enzymes varied according to different authors.

Conclusion

This study demonstrated that enzyme supplementation and pelleting improved the carcass output. Pelleting positively influenced gastro-intestinal tract parameters but had a negative impact on mineral digestibility. Organs of rabbits fed enzyme supplemented diets showed reduction weights. Pelleting other than exogenous enzyme inclusion in the diets appeared effective means of improving rabbit performance however the cost of pelleting will add to the cost of production.

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