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PERFORMANCE AND NUTRIENT DIGESTIBILITY IN BROILER CHICKS AS INFLUENCED BY MULTI-ENZYME ADDITION TO STARTER DIETS CONTAINING PALM KERNEL MEAL

V. E. Aya[1*], B. A. Ayanwale[2], A. T. Ijaiya[2] and A. Aremu[2]

[1]Department of Animal Science, College of Agriculture Lafia, Nigeria
[2]Department of Animal Production, Federal University of Technology Minna, Nigeria
*Corresponding author: ayabuga@gmail.com.
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Abstract: This study was conducted to investigate the performance and nutrient digestibility in broiler chicks as influenced by multi-enzyme (Hemicell +Roxazyme G) addition to starter diets containing palm kernel meal. Nine experimental diets were formulated such that diet 1 which served as control contained 0 % PKM without enzyme supplementation. Diet 2, 3, 4 and 5 contained 10, 20, 30 and 40 % PKM levels respectively with multi-enzyme supplementation while diets 6, 7, 8 and 9 contained 10, 20, 30 and 40 % PKM inclusion levels respectively without multi-enzyme supplementation. Five hundred and forty (540) day old hybro broilers of mixed sex in ratio (1: 1) were randomly assigned to nine diets in a completely randomized design. Each treatment was replicated thrice with 20 birds per replicate. The experiment lasted 35 days. The results showed that nutrient digestibility in the control and 10 % PKM with enzyme supplementation were similar but were significantly (P<0.05) higher than other PKM diets with or without supplementation. There was significant (P<0.05) improvement in body weight and body weight gain and reduce feed intake with supplementation. Birds fed with 20 % PKM with enzyme showed similarity with control birds in all the performance parameters measured. Enzyme addition significantly (P<0.05) reduced cost of feed consumed at 30 % level of inclusion with PKM while cost per kilogram weight gain and cost of production were lower at 20 % PKM level.

Key words: broiler chicks, palm kernel meal, multi-enzyme supplementation

Introduction

At the most basic level feedstuff consists of protein, starch, fat and fibre. In monogastric animal the fibre component has been considered to be wasted and in some instances compound called non-starch polysaccharide (NSP) can exert anti-nutritive activity on the animal. β-Mannan and non-starch polysaccharide are the main fibre component of Palm kernel meal (PKM) (*Sundu et al., 2006; Esuga et al., 2008*), such component are not easily digested by poultry (especially chicks). The anti-nutritional effect of these NSPs is manifested by poor growth accomplished by depressed nutrient utilization (*Annison and Choct, 1991*). These adverse effects can be overcome by dietary supplementation of exogenous enzyme (*Sultan, 2008*).

There are many enzymes available in the market. In practical poultry feeding, the choice of appropriate enzyme for a particular diet is important while it is not definitely known which enzyme will be better for PKM but initially the choice depends on the NSP content. *Duad et al. (1993)* reported that the PKM cell wall comprised 58 % mannan, 12 % cellulose and 4 % xylan. From the composition of carbohydrate of PKM, *Sundu et al. (2006)* suggested that three enzyme; mannanase, α-galactosidase and cellulase may be needed to breakdown the main polysaccharides component. *Alemawor et al. (2009)* recommended the use of a combination of various fibrolytic enzymes activities to enhance saccharification of NSPs. *Fischer (2003)* had indicated that birds at young age had their performance and digestibility improve largely due to improvement in viscosity reduction as consequence of enzyme addition.

This study was design to investigate the effect of supplementation of PKM based diets with mixture of enzyme preparation, Hemicell® and Roxazyme G® containing mannanase, α-galactosidase and cellulase as well as glucanase and xylanase for their effects on chick performance.

Materials and Methods

Experimental diets

Nine broiler starter diets representing 9 dietary treatments were formulated to be isocaloric and isonitrogenous diets with 3000 kcal/Kg ME and 22 % crude protein respectively. The starter phase lasted for 5 weeks. The control with 0 % PKM and no enzyme supplementation consisted of a basal diet with maize and soyabean as major sources of energy and protein respectively. Diets 2, 3, 4, 5 contained 10, 20, 30 and 40 % PKM levels respectively supplemented with multi-enzyme supplementation while diets 6, 7, 8, 9 contained 10, 20, 30 and 40 % PKM inclusion levels respectively without multi-enzyme supplementation as shown in Table 1.

Table 1. Composition of experimental diets containing exogenous enzyme

Ingredients(%)	Dietary Palm kernel meal levels (%)							
	With enzyme supplementation				without enzyme supplementation			
	0	10	20	30	40	10	20	30	40
Maize	61.50	54.00	45.50	37.00	27.10	54.00	45.50	37.00	27.10
Soybean meal	31.00	28.60	26.60	24.60	23.60	28.60	26.60	24.60	23.60
Palm oil	0.50	0.50	1.00	1.50	2.40	0.5.00	1.00	1.50	2.40
PKM	0.00	10.00	20.00	30.00	40.00	10.00	20.00	30.00	40.00
Bone Meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Hemicell	0.00	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00
RoxazymeG	0.00	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00
Fish meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Total	100	100	100	100	100	100	100	100	100
Calculated values									
M.E(kcal/kg)	3005.64	2998.12	2982.02	2972.92	2972.35	2998.12	2982.02	2972.92	2972.35
Protein(%)	22.18	21.89	21.77	21.64	21.64	21.89	21.77	21.64	21.64
Fibre(%)	3.20	4.46	5.76	7.04	8.35	4.46	5.76	7.04	8.35
EE(%)	3.18	3.64	4.10	4.57	5.01	3.64	4.10	4.57	5.01
Calcium(%)	1.19	1.20	1.21	1.22	1.23	1.20	1.21	1.22	1.23
P (%)	0.60	0.61	0.61	o.62	0.63	0.61	0.61	o.62	0.63

Premix* to provide the following per kg of diet vitamin A 12500 I.U. Vitd$_3$ 2500 I.U. vit E 50 mg vit K$_3$ 2.5mg; vit B$_1$ 3.0mg; vit B$_2$ 6.0mg; vit B$_6$ 6.0mg; niacin 40.0mg; calcium pantothenote 10mg; Biotin 0.80mg; vit B$_{12}$ 0.25mg; folic acid 1.0mg; choline chloride 300mg; manganese 100mg; iron 50mg; zinc 45mg; cobalt 0.25mg; iodine 1.55mg; selenium 0.1mg.

The multi-enzyme preparation is a combination of Hemicell® and Roxazyme G®. Hemicell® is a fermentation product of *Bacillus lentus* with β-mannanase as active ingredient. It also contains α- galactosidase. It was included at manufacturer's recommendation level of 0.05 % or 500 g/ton. Roxazyme G® is an enzyme complex derived from *Trichoderma vivida* with glucanase cellulase and xylanase activity. The inclusion recommendation is 200 mg/kg feed. The inclusion levels of the enzyme were as recommended by their respective manufacturers.

Experimental birds and their management

A total of 540 day old hybro broilers of mixed sexes in ratio (1:1) were used for this experiment which lasted for 35 days. The birds were randomly divided into nine experimental groups in completely randomized design (CRD) that were replicated thrice with 20 birds per replicate. The experimental chicks were brooded on deep litter system. Wood shavings were used as litter materials and constant management of the litter through aeration and litter changing when wet were carried out. The main source of heat was electricity while supplementary heat was provided with stove, charcoal and kerosene lantern. There was a gradual reduction of heat from 95 to 75^0 F for the first 4 weeks. Feed and fresh clean water were provided *ad libitum*. The feeders and drinkers were allocated one each per pen of 20 birds. Antibiotics that contain vitamins and electrolytes as constituents (*Keproceryl*) were provided in the drinking water from day 1 to 7, and from 14 to 16 days, respectively. At days 10 and 21, Gumboro vaccine was orally administered on the birds while Newcastle disease vaccine (Lasota) was also orally administered when the birds were 28 days old. Oral administration of coccidiostat (Amprolium) was done on days 23 to 25. The management practices included cleaning of the feeders and water container daily; addition of fresh feed to the stale feed in the feeders were done after the litter and droppings in the feeders have been removed. Periodic turning of the feeders to ensure feeding to appetite was also done. Dead birds were removed promptly to prevent the contamination of the other birds which might peck them.

Data collection

The response parameters taken were body weight, measured individually on a weekly basis; feed consumption was recorded on a pen basis daily by finding the difference between the amount offered and the left over collected the following day (this was later expressed on a weekly basis); body weight gain was determined weekly while feed conversion ratio was calculated by dividing feed intake by weight gain.

Three birds were randomly selected from each of the three replicate groups at day 25 to conduct nutrient digestibility trial. The chickens were housed in metabolic cages for 3 days adjustment period before data collection started. Feed was allocated to all the birds on equal basis. Total droppings were collected separately for each replicate during the last 4 days of the trial as adopted by Ayanwale and Aya (2006). Proximate composition of the feacal samples was determined by A.O.A.C. (2006) methods. The percentage digestibility of the following: dry matter, crude protein, crude fibre, lipids, total ash and NFE were computed individually using the formula adopted by Iyayi and Davis (2005), that is:

Nutrient digestibility (%) = Nutrient intake- Nutrient in feaces / Nutrient intake x 100

The prevailing price of feedstuff was used to calculate cost of formulated feed per kilogram diet. The feed intake per bird for the 5- week experimental period was used to obtain the cost of feed consumed by a bird. The cost per kilogram weight gain was calculated using the procedure of *Ukachukwu and Anugwa (1995)* by taking the product of cost per kilogram fed and feed conversion ratio of birds. The cost of production was estimated as the product per kilogram weight gain and mean total weight gain.

Proximate and data analysis

Experimental diets and feacal samples were analyzed for proximate composition according to A.O.A.C (2006) methods. Data collected were subjected to multivariate analysis of variance using the general linear model (GLM) procedure of SPSS (2001) package. Where significant differences ($P<0.05$) were found, Duncan's Multiple Range test (DMRT) was applied to separate the means.

Results and Discussion

Chemical composition

The proximate composition and metabolizable energy values of experimental diets are presented in Table 2. DM (%) and CP (%) values of the experimental diets ranged from 90.75 to 91.04 and 21.10 to 22.08 respectively.

Table 2. **Proximate composition and Metabolizable Energy values of the experimental diets**

Parameters	Palm Kernel Meal level (PKM) (%)					Enzyme supplemented Palm Kernel Meal level (EPKM) (%)			
	0	10	20	30	40	10	20	30	40
DM	90.75	90.90	90.87	90.95	91.03	90.89	90.88	90.95	91.04
CP	22.08	21.98	21.89	21.88	22.03	22.00	21.92	21.88	22.0
EE	3.71	3.93	3.88	3.94	4.08	3.94	3.88	3.92	4.10
CF	3.90	4.83	5.94	7.64	8.87	4.80	5.95	7.64	8.88
Ash	4.75	4.77	5.06	6.59	6.75	4.78	5.05	6.60	6.75
NFE	56.31	55.89	50.26	49.30	45.98	55.90	50.90	49.35	45.98
ME(Kcal/Kg)	3091.28	3073.38	3021.23	2952.35	2974.35	3073.40	3021.44	2952.35	2974.40

PKM: Palm kernel meal
EPKM: enzyme supplemented PKM

The EE (%) values in the PKM with or without enzyme supplementation ranged from 3.93 to 4.10. The PKM diets with or without enzyme had CF content ranged from 4.83 to 6.75 % while the Ash and NFE were 4.77 to 6.75 and 55.89 to 49.35 % respectively. The ME ranged from 2974.35 to 3073.40 Kcal/ kg.

The effects of PKM diets with or without enzyme treatment on nutrient digestibility is presented in Tables 3. DM and EE digestibility values of 10 % enzyme diet were significantly (P<0.05) higher than the values for the control and other PKM diets with or without enzyme treatment. However, CP, Ash and NFE digestibility values in control diet were significantly (P<0.05) higher compared to all other PKM diets with or without enzyme supplementation. The CF digestibility in control and 10 % PKM inclusion with enzyme were similar and significantly (P<0.05) higher than 20, 30 and 40 % PKM with or without enzyme supplementation. Increasing levels of PKM inclusion, significantly (P<0.05) depressed nutrient digestibility in PKM diets with or without enzyme supplementation.

Table 3. **Nutrient digestibility of broiler chickens fed palm kernel meal with exogenous enzyme supplementation at the starter phase**

Treatments		DM %	CP %	CF %	EE %	Ash %	NFE %
Diets	**Level (%)**						
Control	0	69.86^{b}	60.12^{a}	39.55^{a}	67.11^{b}	65.34^{a}	77.49^{a}
PKM	10	64.44^{c}	57.27^{c}	38.15^{b}	52.50^{c}	43.22^{d}	69.45^{d}
EPKM	10	71.18^{a}	59.45^{b}	39.91^{a}	68.05^{a}	51.18^{b}	74.53^{b}
PKM	20	59.24^{d}	54.55^{e}	37.40^{c}	53.05^{d}	42.20^{e}	67.65^{e}
EPKM	20	68.27^{c}	57.26^{c}	38.56^{b}	58.42^{c}	44.31^{c}	72.35^{c}
PKM	30	58.59^{e}	46.37^{f}	26.56^{f}	48.40^{f}	35.29^{g}	63.44^{h}
EPKM	30	64.55^{c}	55.86^{d}	33.93^{d}	53.85^{d}	40.32^{f}	69.85^{d}
PKM	40	54.01^{f}	39.33^{g}	21.32^{g}	28.38^{g}	30.29^{h}	58.37^{g}
EPKM	40	58.43^{e}	46.59^{f}	28.31^{e}	49.34^{e}	35.59^{g}	65.37^{f}
	SEM	1.07	1.31	1.24	2.12	0.18	1.05
	LS	*	*	*	*	*	*

a-g means in the same column with different superscripts differ significantly (P<0.05)
SEM standard Error of means; PKM: Palm kernel meal; EPKM: enzyme supplemented PKM; LS: level of significant; *: significant (P<0.05)

Results of performance of enzyme supplemented PKM birds during first 5 weeks (Starter phase) are presented in Table 4. All the initial body weights were similar to the values for the control and all the valued ranged from 50.23 to 50.39g. Feed intake was similar to the control in treatment with 10 % and 20 % enzyme supplemented diets but significantly (P<0.05) lower compared with other diets with or without enzyme supplementation. Feed intake increased with increasing levels of PKM inclusion with or without enzyme supplementation but enzyme supplementation reduced feed intake in each of the groups.

Table 4. **Performance of broiler chickens fed palm kernel meal diets with exogenous enzyme supplementation at the starter phase**

Treatments		Initial body wt (g)	Feed intake (g)	Final Body weight (g)	Body wt gain (g)	Feed: gain Ratio
Diets	**Level (%)**					
Control	0	50.23	2128.88[g]	1174.31[b]	1124.08[b]	1.89[e]
PKM	10	50.39	2172.13[f]	1150.52[b]	1100.13[c]	1.82[e]
EPKM	10	50.91	2113.29[g]	1245.53[a]	1194.62[a]	1.77[e]
PKM	20	50.36	2373.89[e]	1145.48[b]	1095.12[c]	2.17[c]
EPKM	20	50.36	2146.94[fg]	1173.47[b]	1113.11[bc]	1.91[de]
PKM	30	50.39	2476.43[c]	1059.60[c]	1009.21[e]	2.45[b]
EPKM	30	50.37	2434.37[d]	1088.45[c]	1038.08[d]	2.35[d]
PKM	40	50.36	2724.43[a]	1041.67[c]	991.31[e]	2.78[a]
EPKM	40	50.36	2565.54[b]	1077.63[c]	1027.27[e]	2.50[ab]
	SEM	0.74	13.74	13.24	6.03	0.17
	LS	ns	*	*	*	*

a-g: means in the same column with different superscripts differ significantly (P<0.05)
SEM: standard Error of means; LS: level of significant; ns: not significant (P>0.05); * significant (P<0.05)
PKM: Palm kernel meal; EPKM: enzyme supplemented PKM

The body weight and body weight gain of birds fed 10 % PKM enzyme treated diets were significantly (P<0.05) superior to the control. However 20 % PKM enzyme treated birds was similar to control. Enzyme supplementation improved body weight and body weight gain in 10 % EPKM compared to 10 % PKM fed broilers at starter phase. Feed: gain ratio of the birds fed 10, 20 % enzyme supplemented diets and 10 % non-enzyme diets were similar. Enzyme supplementation had no effect on the performance of birds at 40 % level of inclusion.

Effect of diets on economic of broiler chick is presented in Table 5. The feed cost per kg in the control (N80.34) was significantly (P<0.05) higher compared with 20, 30, and 40 % PKM with or without enzyme supplementation but was similar to that of 10 % PKM with or without enzyme supplementation. Feed cost per kg decreased with increase in inclusion level of PKM with or without enzyme supplementation. Cost of feed consumed in 20 % PKM with enzyme was significantly (P<0.05) lower compared to control and other PKM diets with or without enzyme supplementation. However no significant difference (P>0.05) was observed in the cost of feed consumed in control, 20 % PKM without enzyme and 30 % PKM with or without enzyme supplementation diets. Diet with 40 % PKM without enzyme had significantly (p<0.05) higher cost of feed consumed. Cost per kg weight gain and cost of production in 10 % PKM with or without enzyme and 20 % PKM with enzyme supplementation were similar but were significantly

(P<0.05) higher compared to control and other PKM diets with or without supplementation.

Table 5. **Economics of producing broiler chicks fed palm kernel meal diets with exogenous enzyme supplementation**

Treatments			feed cost (₦/kg)	Cost of feed consumed (₦)	Cost per Kg wt gain(₦)	cost of production(₦)
Diet	Level (%)					
Control	0		80.34^{a}	171.03^{c}	151.84^{e}	178.31^{c}
PKM	10		76.63^{ab}	166.45^{d}	139.46^{f}	162.20^{e}
EPKM	10		77.46^{ab}	163.69^{e}	137.10^{f}	168.94^{d}
PKM	20		72.30^{bc}	171.63^{c}	156.89^{d}	179.71^{bc}
EPKM	20		73.14^{b}	157.03^{f}	139.69^{f}	163.92^{e}
PKM	30		68.84^{cd}	170.48^{c}	168.65^{c}	178.70^{c}
EPKM	30		70.81^{c}	172.38^{c}	166.40^{c}	181.12^{b}
PKM	40		68.27^{d}	185.99^{a}	189.79^{a}	197.69^{a}
EPKM	40		70.73^{c}	181.46^{b}	176.83^{b}	190.56^{b}
	SEM		0.85	4.14	0.75	5.51
	LS		*	*	*	*

a-g means in the same column with different superscripts differ significantly (P<0.05)
SEM: standard Error of means. PKM: Palm kernel meal; EPKM: enzyme supplemented PKM
LS: level of significant; * significant (P<0.05)

The results of the chemical composition of the experimental diets were in closed agreement with the calculated values and were within the recommended values of 20-25 %, 4.5-5.5% and 2800-3200 Kcal/kg CP, CF and ME respectively for broilers in the tropics as reported by *Oluyemi and Roberts (2000).* However, the fibre content of 8.87 % in the diet was slightly above the recommended values of 4.5- 5.5% CF for broilers in the tropics (*Sundu, et al., 2006*). This high level is due to the level of PKM above 10 % in the experimental diets.

The results of nutrient digestibility agreed with *Sundu et al. (2008)* that most of the dietary fibre in PKM was in the form of mannan which is indigestible by monogastric animals. The decrease in digestibility with increase in inclusion levels of PKM indicates that most of the dietary fibre in PKM could not be digested. *Sundu et al. (2008)* reported that 30 % digestibility of fibre indicated that the bird may be gaining some benefit from the source of carbohydrates. This could explain the moderate performance recorded in PKM diets without enzyme supplementation. Effect of enzyme supplementation of PKM on nutrient digestibility showed that nutrient digestibility in diets with enzyme was higher compared to diets without enzyme which could have contributed to the higher body weight gain and improved FCR observed among birds fed enzyme supplemented diets. There was a significant (P<0.05) variation in fat digestibility in all the treatments which was higher in the control and enzyme treated diets compared to diets without enzyme supplementation. *Salih et al. (1991)* and *Moharrery, (2006)* suggested that the low lipid digestibility in broilers chicken fed diets with a high content of NSPs might be due to bacterial overgrowth in the small intestine and subsequent excessive deconjugation of bile acids, which reduced their efficacy in solubilizing lipids. *Sekoni et al (2008)* reported an improvement in the body weight and feed conversion efficiency due to an increase in fat digestibility which consequently increased bioavailability of fat soluble vitamins and protein digestibility when enzyme *maxigrain*® was fed to broilers.

The increase in digestibility of crude fibre observed with enzyme supplementation is an indication of the breakdown of the non-starch polysaccharides by the enzyme in the PKM. *Iyayi and Davis (2005); Iyayi, Ogunsola and Iyayi (2005)* and *Sekoni et al. (2008)* observed increased in crude fibre digestibility and concluded that the enzymes must have acted on cellulose, glucoronoxylans, arabinoxylans and mannan thereby reducing the crude fibre content and subsequently increased the energy contents and NFE digestibility. The degrading of mannan to mannose by enzyme probably release large amounts of soluble carbohydrate thus accounting for the high level of NFE digestibility among the enzyme treated diets compared to untreated diets.

The reduction in DM, CP, EE, Ash and NFE digestibility in the PKM diets was attributed to the effect of replacement of highly digestible carbohydrate source, maize by PKM which was of low digestibility. High fibre in the diet resulted in the increase rate of passage of the fibrous feed through the gastro-intestinal tract with a consequent reduction in the time of ingesta (in nutrient) exposure to enzymatic degradation and time of contact with the absorptive membrane as explained by *Iyayi et al. (2005)*.

Performance of birds at the first 5 weeks with or without enzyme supplementation showed increase in body weight, body weight gain, improved feed: gain ratio, PER and EE in the control and enzyme treated diets relative to diets without enzyme supplementation. This is due to enzyme effect as reported by *Choct (2006),* who stated that when enzymes are added to high fibre monogastric diets, they cause the degradation of β- Mannan and 70 % NSPs into soluble metabolizable products for monogastric. Feed intake was decreased in the control and enzyme diets compared to diets without enzyme. *Ezieshi and Olomu (2004)* reported higher feed intake in birds fed PKM based diets compared with maize-based diets due to its faster rate of passage through the digestive tract. Feed to gain ratio was better among enzyme supplemented diets and the control compared with all other diets without enzyme supplementation. This is similar to the reports of *Atteh (2000)* and *Esuga et al. (2008)* who separately observed improvements in weight gain and feed: gain ratio in birds fed enzyme supplemented diets. *Esuga et* *al. (2008)* also observed lower weight of birds fed increasing levels of PKM without enzyme supplementation.

Enzyme supplementation was able to reduce cost of feed consumed with PKM level of inclusion at 30 % while cost per kilogram weight gain and cost of production were lower at 20 % PKM with enzyme supplementation. This shows that it is more profitable and economical to supplement PKM diets for chicks with multi-enzyme. The higher feed consumption of birds fed 20, 30 40 % PKM without supplementation increased cost per kilogram and as such not recommended. These findings pointed to the role of enzymes in degrading NSPs in PKM based diets. Increased nutrient availability and metabolizable energy due to NSP degradation by enzyme could be the reason for the improvement observed.

Proizvodne performanse i svarljivost hranljivih materija kod brojlerskih pilića pod uticajem dodatka multi-enzima starter obrocima koji sadrže sačmu od palminog jezgra

V. E. Aya, B. A. Ayanwale, A. T. Ijaiya, A. Aremu

Rezime

Cilj ove studije je bio da se ispitaju performanse i svarljivost hranljivih materija kod brojlerskih pilića, pod uticajem multi-enzim aditiva (Hemicell +Roxazyme G), u starter obrocima koji sadrže sačmu palminog jezgra. Devet eksperimentalnih obroka su formulisani tako da je brok 1, koji je služio kao kontrola, sadržavao 0% PKM, bez dodatka enzima. obroci 2, 3, 4 i 5 su sadržavali 10, 20, 30 i 40% PKM, respektivno, sa multi-enzimskim dodatkom, dok su obroci 6, 7, 8 i 9 sadržavali 10, 20, 30 i 40% PKM, bez dodatka multi-enzima. Hibro brojleri starosti petstotina četrdeset (540) dana, mešovitog pola u odnosu (1:1) su nasumično raspoređeni u devet grupa sa različitim obrocima. Svaki tretman je triput ponovljen sa 20 grla u svakom ponabljanju. Eksperiment je trajao 35 dana. Rezultati su pokazali da je svarljivost hranljivih materija u kontroli i obroku sa 10% PKM sa enzimom slična, ali je značajno ($P<0.05$) veća nego kod drugih PKM obroka, sa ili bez dodatka enzima. Utvrđeno je značajno ($P<0.05$) poboljšanje telesne mase i prinosa telesne mase, kao i smanjenje unosa hrane koja je sadržavala dodatke. Brojleri hranjeni sa 20% PKM sa enzimom pokazali su sličnost sa kontrolnim brojlerima u svim izmerenim proizvodnim parametrima. Enzim značajno ($P<0.05$) smanjuje troškove konzumirane hrane u obroku sa 30% PKM, a cena po kilogramu prirasta težine i troškova proizvodnje bila je niže kod obroka sa 20% PKM.

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