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Biotechnological Upgrade of High Fibre-low Protein Industrial Plant By-products in Broiler Diets: Carcass and Organs Characteristics

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Aims: To explore the possibility of utilizing bio-fermented industrial plant by-products (composite mixture of fermented palm kernel meal, brewers dried grains and molasses) as supplementary crude protein source in broiler production.
Study Design: Two hundred and eighty-eight (288) day old birds were picked and randomized into six treatments in a completely randomize designed experiment.
Place and Duration of Study: Research study was carried out at the Teaching & Research Farm of Ekiti State University, Ado-Ekiti between June and September, 2016.
Methodology: The composite of the palm kernel meal (PKM), brewer dried grains (BDG) and molasses were prepared using a ratio of 50 L of water to 25 kg of PKM, 25 kg of BDG and 2.5 L of molasses. The fermented composite of palm kernel meal, brewer dried grains and molasses (PBMC) was dried before incorporation into experimental diets as protein supplement at 15, 20, 25, 30 and 35% inclusion levels in a completely randomized designed experiment. The control diet had no composite of PKM, BDG and molasses. At the end of the experiment, birds were randomly selected from the 6 treatments, weighed and sacrificed. After slaughtering, the carcasses were scalded at 55-60°C in water bath for 30 sec before de-feathering. The data collected were

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subjected to One Way Analysis of Variance using Minitab computer model (Version 16). The dressed chicks were eviscerated and some carcass cuts and weights of organs determined.
Results: The live weight of broilers fed the diet 1 (control diet without PBMC) was statistically similar (P>0.05) to those obtained for broiler finisher birds fed 15, 20, 25 and 35% PBMC but significantly different (P<0.05) from broilers fed 30% PBMC, respectively. Similar results were obtained for the dressed and eviscerated weights. There were predominant similarities among the weights of the determined carcass cuts and internal organs.
Conclusion: The use of PBMC can be safely practiced to further improve the utilization of PKM and BDG in poultry diets at a maximum inclusion level of 20%. This inclusion level supported carcass characteristics and standard weights of organs at the end of the finisher phase of broiler production.

Keywords: Carcass cuts; fermentation biotechnology; internal organs.

1. INTRODUCTION

Most food of animal origin consumed in developing countries is currently supplied by small-scale and mixed crop-livestock producers or by pastoral livestockkeepers produced in traditional way [1]. Traditional methods of livestock improvement have been used in the past years and served the purpose of increasing livestock productivity formeeting the protein requirement. These traditional methods can no longer sustain production; consequently, new intensive techniques including biotechnology are now required to increase productivity of animals by using different alternatives. Today, biotechnology has able to provide new opportunities for meeting enhanced livestock productivity in a way that alleviates poverty, improves food security and nutrition and promotes sustainable use of natural resources [2].

Animal feed and feeding practices are being changed by biotechnology to improve animal nutrition and to reduce environmental waste. One of the objectives of using biotechnology in animal nutrition is to improve the plane of nutrition through theuse of enzymes to improve the availability of nutrients from feed and to reduce the wastage of feed [3]. Improvements have largely come from dilution of maintenance [4], while other improvements can come from increased digestibility or nutrient availability from feeds, reduced non-productive days for dairy [5,6] or genetic selection for feed efficiency [7]. The advancement in the poultry industry is tremendous world over and continuously advancing by several improvements in the genetic potential of new broiler strains [8] and nutrition. Brewer's dry grains (BDG) are the by-products of mashing process; which is one of the initial operations in the brewery in order to solubilize the malt and cereal grains to ensure adequate extraction of the wort (water with extracted matter) [9]. BDG is a readily available, high volume low-cost by-product of brewing and is a potentially valuable resource for industrial exploitation [10]. Thus, increased endogenous metabolism, as well as high proteolytic activity in BDG, affects its composition over a short period of time [11]. BDG is a relatively good source of protein and has been used in the feeding of pigs, sheep, cattle [12] and more recently, poultry. The feeding capabilities of BDG is however, limited by its high crude fibre content and low degradability of the crude fibre.

Palm kernel meal (PKM) as a case sample of agro-industrial by-products is an important end product of palm kernel oil from the fruits of palm oil (*Elaeis guineensis*) which is readily available in many tropical environments among which are Nigeria, Malaysia, and Indonesia. The utilization of fibrous feed materials by monogastric animals has been considered a waste becausenon-starch polysaccharides (NSPs) have the potency to confer some anti-nutritive activities on such fibrous feed materials. It was revealed that most fibrous feed components found in PKC are NSP and beta-mannan [13,14]. In this way, poultry cannot easily make use of such feed components for proper digestibility. The anti-nutritional factor associated with NSPs result to poor growth performance due to poor nutrient utilization by the animal. The biotechnology of processing palm kernel meal for possible improved utilization in broiler diets has been reported in other study [15]. This study was designed to investigate the carcass and organs characteristics of broiler birds in which bio-fermented composites of palm kernel meal, brewer spent grains, molasses were used in measured inclusion levels as crude protein supplements in broiler feeding.

2. MATERIALS AND METHODS

2.1 Experimental Site

The research study was carried out at the Teaching & Research Farm of Ekiti State University in Ado-Ekiti, a town in the Southwest Nigeria in the rain forest zone on latitude 7°40' North of the Equator and longitude 5°15' East of the Greenwich meridian. Ado-Ekiti had ambient temperature of 25-37°C; average relative humidity, 70%; wind, SSW at 11 mph (18 km/h); barometric pressure, 29.68' Hg (F) during the summer of year 2016.

2.2 Bio-fermentation Technology and Procedure for Ensiling

Palm kernel meals (PKM) were obtained from local communities (especially Ogotun-Ekiti) around Ado-Ekiti where palm oil is produced majorly by solvent extraction method. Brewers dried grains (BDG) were obtained from Nigerian Bottling Company, Ibadan through a reputable feed mill in Ado-Ekiti, Ekiti State. Mixtures of the PKM, BDG and molasses were prepared using a ratio of 50L of water to 25 kg of PKM, 25 kg of BDG and 2.5L of molasses. The mixture of PKM, BDG, molasses and water subsequently referred to as palm kernel, brewers spent grains and molasses composite (PBMC) was gently compressed into 120L plastic containers according to described method [15,16]. The compressing of the materials into containers was done manually at about 1 foot height interval until the containers were about ¾ filled. The containers were carefully covered with thick nylon covering with sand used to fill the spaces left. There were further compressions and another thick nylon was spread across the rims of the containers before the containers were finally covered with their lids to ensure air–tightness. Containers containing the ensiled PBMC were opened on day 21 [15]. Samples were taken for laboratory analyses. The ensiled PBMC was later sun-dried to achieve a moisture content of 12%. Dried samples of the ensiled PBMC were then analysed for proximate acid composition and shown in Table 1 before incorporation into feed formulation [17]. Amino acid compositions of fermented and unfermented PKM and compositions in existing literatures is presented in Table 2.

2.3 Experimental Ration Formulation

Samples of the BDG, PKM and PBMC were taken for proximate analyses after which they were incorporated into the diets. The experimental diets were formulated in Tables 4 and 5 as follows: Diet 1 was the control diet without BDG and PKM mixture; Diet 2 had PBMC at 10% inclusion level; Diet 3 had PBMC at 15% inclusion level; Diet 4 had PBMC at 20% inclusion level; Diet 5 had PBMC at 25% inclusion level; and Diet 6 had PBMC at 30% inclusion level. All diets were made isocaloric and isonitrogenous with ample supplementation of L-lysine and DL-methionine synthetic amino acids at required level [17]. Experimental diets were also taken into the laboratory for determination of proximate analyses [18].

2.4 Management of Experimental Birds

Two hundred and eighty-eight Arbor Acres chicks were randomly picked for the experiment after sexing on the 3rd day of their arrival from CHI Farms, Km 20, Ibadan-Lagos Expressway, Ibadan where they were purchased [19]. The chicks were brooded in a brooder house using electricity supplied constantly by 1KVA stand-by

Table 1. Proximate analysis of palm kernel meal (PKM), brewers dried grains (BDG) and palm kernel meal-brewer dried grain-molasses composite (PBMC) [32]

Proximate composition	PKM	BDG	PBMC	Fermented PBMC
Dry matter	86.5±2.1	87.5±4.3	87.1±2.1	89.5±3.1
Crude protein	19.1±3.0	22.1±2.7	20.2±4.5	23.1±4.2
Crude fibre	14.4±1.7	12.3±3.2	13.5±2.1	10.1±3.3
Ether extract	7.3±1.8	7.6±2.1	7.4±4.1	3.5±3.1
Ash	11.1±2.1	4.7±3.3	8.2±2.5	8.5±2.0
Nitrogen free extract	48.1±2.7	53.3±2.1	49.8±3.2	54.8±3.4
Metabolisable energy	2719	2485	2634	2789

Metabolisable energy = (0.860+0.629(GE-0.78CF) [21]; CF, crude fibre

Table 2. Amino acid composition of palm kernel cake (%)

Amino acid* existing literature		Un-ensiled PKM	Ensiled PKM
Alanine	3.83	3.10±2.3	4.12±0.1
Arginine	11.56	9.26±1.7	12.71±0.3
Aspartic acid	3.53	2.54±2.9	4.30±0.3
Cystine1.13		0.68±3.1	0.71±1.3
Glycine	4.17	2.76±2.2	3.18±1.4
Glutamic acid	16.80	14.7±3.0	15.10±2.1
Histidine	1.91	1.07±2.4	1.21±1.1
Isoleucine	3.22	3.29±3.1	4.11±2.0
Leucine	6.07	6.54±2.5	7.01±2.01
Lysine	2.68	2.72±2.4	3.21±1.7
Methionine	1.75	2.43±2.8	3.50±2.1
Phenyalanine	3.95	3.78±2.1	4.02±1.2
Proline	3.31	3.43±2.7	3.92±2.5
Serine	4.11	3.59±3.2	4.15±2.9
Threonine	2.75	3.09±3.1	3.50±3.1
Tyrosine	2.60	2.14±2.7	2.73±1.71
Valine	5.05	4.82±3.5	5.10±1.3

Source: Fasuyi et al. [15]

Table 3. Experimental diets (Starter phase, 1-28 days) [32]

Ingredients	Diets (% composite of fermented PKM, BDG & molasses)					
	1	**2**	**3**	**4**	**5**	**6**
	0	**10**	**15**	**20**	**25**	**30**
Maize (11.0% CP)	50.40	49.90	46.90	45.90	44.90	43.90
Wheat offals	10.00	10.00	10.00	10.00	10.00	10.00
Soyabean meal	33.50	26.00	24.00	19.00	15.00	11.00
Fish meal	2.00	0.00	0.00	0.00	0.00	0.00
Palm oil	0.00	0.00	0.00	1.00	1.00	1.00
Fermented PBMC*	0.00	10.0	15.0	20.0	25.00	30.0
Bone meal	2.50	2.5	2.5	2.5	2.5	2.5
Oyster shell/limestone	0.5	0.5	0.5	0.5	0.5	0.5
Nacl	0.30	0.3	0.3	0.3	0.3	0.3
DL-methionine	0.15	0.15	0.15	0.15	0.15	0.15
L-Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Premix**	0.50	0.5	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0	100.0	100.0
Calculated composition						
Crude protein, %	23.06	23.07	23.06	23.06	23.05	23.04
Crude fibre, %	4.54	5.64	5.82	6.02	7.85	9.24
Ether extract, %	7.21	7.01	7.03	9.21	9.43	9.32
ME, kcal/Kg	2893.3	2889.7	2884.0	2885.8	2879.1	2886.8

**Fermented PBMC, fermented palm kernel meal+brewers dried grains+molasses composite; **Premix contained vitamins A(10,000,000iu); D(2,000,000iu); E(35,000iu);K(1,900 mg); B12 (19 mg); Riboflavin(7,000 mg); Pyridoxine(3,800 mg); Thiamine(2,200 mg); D Panthotenic acid(11,000 mg); Nicotinic acid(45,000 mg); Folic acid(1,400 mg); Biotin (113 mg); and trace elements as Cu(8,000 mg); Mn(64,000 mg); Zn(40,000 mg); Fe(32,000 mg); Se(160mg); I_2(800 mg); and other items as Co(400 mg); Choline(475,000 mg); Methionine(50,000 mg); BHT(5,000 mg) and Spiramycin(5,000mg) per 2.5 kg; CP: Crude Protein, ME, metabolisable energy = (0.860+0.629(GE-0.78CF) [21]*

power generating plant at the Ekiti State University Teaching and Research Farms. A 5-day acclimatization period was observed before the commencement of the first phase (5-28days) of the experiment during which the broiler chicks were fed *ad libitum* on commercial chicks mash containing 23% crude protein (CP) before data collection. The chicks were managed on the floor

Table 4. Experimental diets (Finisher phase, 29-56 days) [32]

Ingredients	Diets (% composite of fermented PKM, BDG & molasses)					
	1	2	3	4	5	6
	0	15	20	25	30	35
Maize (11.0% CP)	55.40	41.90	42.00	40.50	39.50	39.05
Wheat offals	10.00	10.0	10.0	10.0	10.0	10.0
Soyabean meal	28.50	28.00	22.90	19.40	15.40	10.85
Fish meal	2.00	0.0	0.0	0.0	0.00	0.0
Palm oil	0.00	1.00	1.00	1.00	1.00	1.00
Fermented PBMC*	0.00	15.0	20.0	25.0	30.00	35.0
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster shell/limestone	0.50	0.5	0.5	0.5	0.5	0.5
Nacl	0.30	0.3	0.3	0.3	0.3	0.3
DL-methionine	0.15	0.15	0.15	0.15	0.15	0.15
L-Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Premix**	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.0	100.0	100.0	100.0	100.0	100.0
Calculated composition						
Crude protein, %	20.13	20.07	20.01	20.02	19.65	19.60
Crude fibre, %	5.14	5.78	6.12	7.21	8.91	9.89
Ether extract, %	7.34	7.41	7.53	9.34	9.43	9.43
ME, kcal/Kg	3101.4	3210.3	3120.3	3103.8	3134.4	3103.8

**Fermented PBMC, fermented palm kernel meal+brewers dried grains+molasses composite; **Premix contained vitamins A(10,000,000iu); D(2,000,000 iu); E(35,000 iu);K(1,900 mg); B12 (19 mg); Riboflavin(7,000 mg); Pyridoxine(3,800 mg); Thiamine(2,200 mg); D Panthotenic acid(11,000 mg); Nicotinic acid(45,000 mg); Folic acid(1,400 mg); Biotin (113 mg) and trace elements as Cu(8,000 mg); Mn(64,000 mg); Zn(40,000 mg); Fe (32,000 mg); Se(160 mg); I_2(800 mg) and other items as Co(400 mg); Choline(475,000 mg); Methionine(50,000 mg); BHT(5,000 mg) and Spiramycin(5,000 mg) per 2.5 kg; CP: Crude Protein, metabolisable energy = (0.860+0.629(GE-0.78CF) [21]*

for this phase of experiment. Appropriate veterinary routines were observed from day old. The experimental birds were randomly allocated into the 6 experimental treatments with 48 birds in each treatment while each treatment was replicated 3 times. Each replicate had 16 birds.

2.5 Carcass and Organ Characteristics

At the end of the feeding trial on the 56th day of experiment, birds were randomly selected, weighed and sacrificed by severing the jugular vein. The blood was allowed to flow freely into labelled bottles one of which contained a speck of ethylene-diamine-tetraacetic acid (EDTA). The bottle without EDTA was processed for serum for a separate study.

After slaughtering and bleeding the chicks, the carcasses were scalded at 55-60°C in water bath for 30 sec before de-feathering. The dressed chicks were eviscerated. The following data taken were taken: fasted weight, dressed weight (%), eviscerated weight, thigh, drumstick, chest, back, neck, wing, fat and head weight. Also organs (heart, spleen, liver, lungs, gizzard, intestine and bursa of Fabricius) were dissected out and weighed.

2.6 Statistical Analysis

The data collected for different parameters were subjected to analysis of variance (ANOVA) using statistical One Way Analysis of Variance of the Minitab computer model (Version 16) [20].

3. RESULTS AND DISCUSSION

The live weight, dress weight and eviscerated weight of experimental birds on the various PBMC dietary inclusions are presented in Table 5.

The live weight of broilers fed thecontrol diet without PBMC was statistically similar (P>0.05) to those obtained for broiler finisher birds fed 15% PBMC, 20% PBMC, 25% PBMC and 35% PBMC but significantly different (P<0.05) from live weight obtained for birds that received the 30% PBMC (Table 5).

The dress weight of broilers fed the control diet was statistically similar (P>0.05) to those obtained for birds on 20% PBMC, 25% PBMC and 35% PBMC. Broilers fed the 30% PBMC had the lowest dress weight value although similar (*P*>0.05) to dress weight values obtained for broilers fed the 15% PBMC, 25% PBMC and 35% PBMC (Table 5).

The lowest eviscerated weight value was obtained for birds fed the 30% PBMC but it was similar (*P*>0.05) to obtained for broilers fed 15% PBMC, 25% PBMC and 35% PBMC.

There were apparent similarities in the relative values of live weights, dress weights and eviscerated weights among the birds on the various PBMC inclusion levels in the different experimental diets in this study with a decline in these parameters as PBMC inclusion increased. The decline in these parameters as PBMC dietary inclusion increased could be as a result of the reduced digestibility of PBMC diets by the broilers. Although some previous studies indicated the depressive effect in live weight when fed with diet containing high fibre ingredients such as palm kernel cake [22,23], some relevant literatures manifestly indicated the use of palm kernel cake and brewer spent grain as protein supplements in manufactured feeds for monogastric animals with various degrees of processing (enzyme fortification, solid state fermentation, etc) [15,24, 25,26].

Ensiled palm kernel meal with Roxazyme G2 (cellulase, glucanase and xylanase) fortification used to replace significant quantities of energy and protein ingredients at 10, 20 and 30% inclusion levels in broiler starter diets and 30, 40 and 50% inclusion levels in broiler finisher diets promoted similar growth performance with broilers on conventional diets and constantly surpassed the growth performance of broiler starter and finisher chicks fed unfermented palm kernel meal [15].

Average weights of carcass cuts and internal organs of the broiler birds at slaughter are also indicated in Table 5. Birds on diet 1 and birds on 30% had similar (*P*>0.05) and the highest average weight for head. The average weight of neck for birds on 20% PBMC inclusion was the highest but it was statistically similar (*P*>0.05) to the values obtained for birds on the control diet without PBMC, 25% PBMC and 30% PBMC. The average neck weight values obtained for birds fed 15% PBMC and 35% PBMC were similar (*P*>0.05). The average wing weight was the highest for birds fed the control diet and it was significantly different (*P*<0.05) from the other average wing weight values. The average wing weights obtained for birds on 30% PBMC and 35% PBM Cwere similar (*P*>0.05) and were the two lowest values. The average weight of thighs was also significantly the highest for birds on the control diet without PBMC. The lowest average thigh weight was obtained for birds on 35% PBMC.

The highest average significant (*P*<0.05) drumstick weight was also obtained for birds on the control diet. The breast had the highest average significant (P<0.05) value for birds on the control diet 1. The average weight of chicken back was the highest for the birds on 25% PBMC but it was similar (*P*>0.05) the back weight obtained for birds on the control diet 1. The average weight of gizzard had the highest value for birds fed 20% PBMC but similar (*P*>0.05) to the average values obtained for the birds on 35% PBMC, 30% PBMC and 25% PBMC. The liver had the highest average weight for birds fed 20% PBMC) but similar (*P*>0.05) to those obtained for birds on diet 1 and diet 4. The highest average heart weight was obtained for birds on diet 1 whereas the lowest average values for the parameter were obtained for birds that received diets containing 15% PBMC and 30% PBMC. The lungs had the highest average weight value for birds fed 35% PBMC and the lowest value for birds that received 15% PBMC. The highest average weight of intestine was obtained for birds fed 20% PBMC but the value was similar (*P*>0.05) tothe value obtained for birds fed the 25% PBMC. The bursa of Fabricius had the highest average weight for birds on diet 1 but similar (*P*>0.05) to that of animals fed the diet 5. The pancreas also had the highest weight value diet 1 but this value was similar (*P*>0.05) to the average weight values btained for birds fed 15% PBMC and 20% PBMC. The proventriculus has the highest average weight for birds fed 25% PBMC but similar (*P*>0.05) to average weight values obtained for birds fed 15% PBMC, 20% PBMC and 30% PBMC. The spleen and the crop also had similar (*P*>0.05) average weights across the treatments means.

The predominant similarities among relative weights of carcass cuts and weights of internal organs in the present study agreed with a previous work [27] which reported that weights of internal organs were not significantly (*P*>0.05) affected in broilers fed decorticated fermented

Table 5. Carcass characteristics and organ weight of broilers at 56th day

Parameters	Diets					
	Inclusion level of PBMC in diets					
	1	**2**	**3**	**4**	**5**	**6**
	0%	**15%**	**20%**	**25%**	**30%**	**35%**
Live weight	2565±20.2^{a}	2032±37.6^{ab}	2495±18.4^{a}	2029±35.3^{ab}	1869±35.7^{b}	2009±40.7^{ab}
Dress weight	2303±31.5^{a}	1881±41.0^{ab}	2211±32.2^{a}	1861±42.3^{ab}	1752±40.3^{b}	1881±34.7^{ab}
Evisc. Weight*	1984±27.5^{a}	1586±39.6^{ab}	1978±25.5^{a}	1611±24.3^{ab}	1551±23.4^{ab}	1589±20.2^{ab}
Relative carcass weight, gbodyweight^{-1}						
Head	68.5±17.7^{a}	59.0±9.1^{b}	54.0±1.4^{b}	68.5±2.1^{a}	45.3±2.9^{c}	58.5±6.5^{b}
Neck	93.0±8.5^{a}	83.5±5.0^{b}	98·3±7.2^{a}	93.5±1.4^{a}	98.0±1.4^{a}	85.0±5.7^{b}
Wing	156.5±2.0^{a}	143.0±2.4^{b}	141.9±2.4^{b}	142.5±1.4^{b}	131.6±1.4^{c}	131.1±7.0^{c}
Thigh	239.5±7.2^{a}	199.6±7.0^{b}	197.7±10.3^{b}	198.5±6.8^{b}	149.2±2.3^{c}	131.0±2.0^{d}
Drumstick	194.6±3.9^{a}	182.6±3.2^{b}	166.4±6.2^{c}	183.5±7.2^{b}	155.5±5.0^{d}	154.5±4.5^{d}
Breast	395.5±13.4^{a}	360.2±17.1^{b}	340.4±20.2^{bc}	313.5±11.1^{d}	344.5±12.0^{b}	327.8±14.1^{cd}
Back	279.0±19.9^{a}	201.1±18.4^{c}	177.2±1.0^{cd}	288.2±19.0^{a}	170.1±16.1^{d}	276.0±10.9^{b}
Organs, gbodyweight^{-1}						
Gizzard	42.50±5.1^{b}	36.50±5.0^{c}	48.50±3.5^{a}	44.5±2.1^{ab}	45.5±9.0^{a}	48.0±9.0^{a}
Liver	46.0±8.5^{a}	34.5±0.70^{bc}	48.5±2.1^{a}	45.5±9.0^{a}	31.0±1.4^{c}	38.0±7.1^{b}
Heart	11.5±2.1^{a}	7.0±1.4^{c}	8.0±1.4^{b}	8.0±2.1^{b}	7.5±0.7^{bc}	8.0±0.7^{b}
Lungs	6.0±2.8^{c}	5.5±0.7^{d}	6.0±1.4^{c}	6.5±0.8^{bc}	7.5±0.7^{b}	9.0±1.4^{a}
Intestine	106.0±7.0^{c}	117.5±10.6^{b}	129.5±14.7^{a}	125.0±3.5^{a}	108±3.5^{c}	109.5±4.9^{c}
Proventiculus	8.0±0.1^{b}	10.1±2.1^{a}	9.5±0.2^{a}	11.0±2.4^{a}	9.5±2.5^{a}	9.0±1.5^{b}
Bursa	19.0±1.4^{a}	11.5±0.7^{d}	14.5±3.6^{c}	15.5±0.7^{bc}	18.5±0.7^{ab}	17.5±0.7^{b}
Pancreas	6.0±0.9	5.0±0.8^{ab}	5.0±0.7^{ab}	4.0±0.7^{b}	4.0±0.7^{b}	4.0±0.7^{b}
Spleen	2.5±0.5	3.0±0.9	2.0±0.6	2.0±0.5	2.5±0.7	2.5±0.5^{a}
Crop	16.0±0.6	18.5±0.7	17.5±0.9	18.5±0.8	16.0±0.7	17.0±0.5

*Means with different superscript in the same horizontal row are significantly different ($p<0.05$); ±, (SD, standard deviation of 2 values in a replicate); *Evisc. Weight, Eviscerated weight*

Prosopis africana seed meal except for kidney and lungs. Reports from more recent studies [28, 29,30] also corroborated the present result as no significant differences (*P*>0.05) occurred in carcass performance and internal organ weights among broilers fed various high fibre ingredients with and without degrading enzymes. There were no consistent differences between the intestinal lengths of birds across the different treatment groups in the present study which agreed with an earlier report [31].

4. CONCLUSION

The use of a composite of molasses ensiled PKM and BDG (PBMC) can be safely practiced to further improve the utilization of PKM and BDG in poultry diets with a maximum inclusion level of 20%. This inclusion level supported carcass characteristics and standard weights of organs at the end of the finisher phase of broiler production.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

COMPETING INTERESTS

Author has declared that no competing interests exist.

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