

CARCASS CHARACTERISTICS, ORGANS WEIGHTS, HAEMATOLOGY AND SERUM METABOLITES OF BROILERS FED GRADED LEVELS OF BENISEED (*Sesamum indicum* L.) WASTE MEAL IN PLACE OF MAIZE (*Zea mays* LINN)

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ABSTRACT

A 56-day feeding trial was conducted to investigate the effects of dietary replacement of maize with beniseed waste meal (BSW) on the carcass characteristics, organs weights, hematological and serum biochemical indices of broiler chicken. A total of 180 days old Marshal broiler chicks were randomly allotted to six treatments, each having three replicates of ten birds per replicate. Six experimental diets were formulated as follows; D1 (100% Maize: 0% BSW), D2 (80% Maize: 20% BSW), D3 (60% Maize: 40% BSW), D4 (40% Maize: 60% BSW), D5 (20% Maize: 80% BSW) and D6 (0% Maize: 100% BSW) for both broiler starters and finishers. The live weight, eviscerated weight, dressed weight, neck, thigh, wings and lower back weights were significantly ($P < 0.05$) affected by the dietary treatments. The highest percentage dressed weight (63.52) obtained in D3 (40% BSW) was significantly ($P < 0.05$) different from 60.87 (0% BSW), 61.68 (20% BSW) 60.00 (60% BSW), 55.18 (80% BSW) and 56.52 (100% BSW). The organs (lungs, liver, kidney, intestine, gizzard and proventriculus) monitored were significantly ($P < 0.05$) affected by the dietary treatments. Heart, pancreas and spleen were similar among the treatments. The serum biochemistry and haematological parameters measured were not significantly ($P > 0.05$) affected by the dietary treatments. It was concluded that maize could be safely replaced with beniseed waste meal up to 100% level (55% BSW) in broilers diets.

Key words: beniseed waste meal, maize, broilers, carcass, health status

INTRODUCTION

The continuing rise in the cost of grains due to the growing demand for the bio-fuel industry will be an ever-increasing factor in determining the profitability of livestock production. Competition exists for maize and other cereals among man, animals, pharmaceutical industries and breweries. Further complication to the issue of declining availability and increasing cost of cereal grains for animal feeding is the new challenge of the use as bio-fuel, pushing man and animals on a more serious collision course. Before, it was food and feed, now it is food, feed and fuel (Agunbiade, 2009). This has forced the price of cereal grains to increase without a corresponding increase in the price of poultry products (i.e., meat and egg) especially in developing countries of the world.

Traditionally, cereal grains such as corn, wheat, barley and triticale supply major part of the energy in poultry diets, whereas soybean meal and related soy products represent the major protein supplements

used in poultry diets. There have been several research efforts on alternative feed ingredients available to meet the poultry requirements for energy and protein (amino acids) while reducing the cost of the diet. However, there has not been the same research tempo on the effects of such presumably low-cost unconventional feed resource on health of the consuming livestock.

Result of the earlier study carried out with the use of beniseed waste meal in place of maize reveals the former as a promising cheaper and safe unconventional alternative energy resource to the later in pigs (Olajide *et al.*, 2019). Nutrition is known to affect performance, carcass and organ characteristics of birds. Increases in weight of organs of broilers were linked to the presence of anti-nutritional factors in mucuna (Carew *et al.*, 2003). Issues to look at include the suitability of these alternatives to the conventional feed resources in terms of ability to economically meet the nutrients requirement of the stock; and health implications on

the stock fed as well as quality of the final products such that consumers' health is not jeopardised and acceptability guaranteed. The health assessment could be monitored through the blood profile analysis and organs of the animals. Beniseed waste meal, a residue obtained after extracting oil from the beniseed, is available in abundance in Nigeria, and can be incorporated in the diets of broilers as substitute for maize especially when the price of the later is on the high side. There is no competition between man and livestock for the beniseed waste meal. Borchani *et al.* (2010) reported that Sesame seed has a high content of oil (52%), protein (24%) and ash (5%). Sesame oil comprises approximately 50% of the seed weight, contains large amounts of natural antioxidants, a good type of monounsaturated and polyunsaturated fatty acids (Choi *et al.*, 2008).

There is paucity of information on the effects of feeding beniseed waste meal on the carcass characteristics and health status of broilers. This study, therefore, evaluated the effect of graded levels of beniseed waste meal (BSW) in place of maize on carcass characteristics, organs weights and blood indices of the broilers.

MATERIALS AND METHODS

Experimental Site

This study was carried out at the experimental section of the Poultry unit of the Teaching and Research Farm, Joseph Ayo Babalola University, Ikeji-Arakeji, Osun State, Nigeria. Ikeji -Arakeji is situated on 350.52 m above sea level at latitude 7°25'N and longitude 5°19'E. The vegetation of the area is that of the rainforest characterized by hot and humid climate. The mean annual rainfall is 1500 mm and the rain period is bimodal with a short break in August with mean annual relative humidity of 75% and mean temperature of 26-28°C (Laoye, 2014).

Experimental Birds and Management

A total of 180 day-old Marshal broiler chicks were used for this experiment. The birds were randomly allocated to six dietary treatments of 30 birds in each treatment. Each treatment was replicated three times with 10 birds per replicate. The birds were raised on deep litter in an open-sided poultry house. Experimental diets and drinking water were provided *ad-libitum*, and the study lasted eight weeks which represents both the starter and finisher phases. The experimental birds were fed starter diets containing 23.72-24.20% CP, and 3164.03-3369 kCal/kg metabolisable energy for the four weeks (Table 1). Thereafter, the birds were fed with the finisher diets (Table 2) for four weeks. The water troughs were washed daily before fresh and clean water was served. Routine vaccination and medications were administered to keep the birds healthy.

Experimental Diets and Design

Six experimental diets were formulated at the two phases. Diet1 (D1) served as the control and contained 0% BSW (as substitute for maize). Diets 2 (D2), 3 (D3), 4 (D4), 5 (D5) and 6 (D6) contained 10.80, 21.60, 32.40, 43.20 and 54% BSW (starter); and 11, 22, 33, 44 and 55% BSW (finisher) respectively that replaced 20, 40, 60, 80 and 100% maize in that order. Other ingredients in the experimental diets are shown in Tables 1 and 2. The design of the experiment was Completely Randomized Design (CRD).

Haematological and Serological Characteristics

Blood samples were collected from nine birds per treatment (3 birds per replicate) picked at random at the end of the feeding trial. The blood was collected through the wing vein. The area was disinfected with cotton wool dampened with methyl alcohol swabs and by vein puncture; 5 mls of blood was drawn and emptied into Heparin and Ethylene diamine tetra acetic acid (EDTA) bottles for serum biochemistry and haematological parameters determination respectively. All EDTA and Heparin bottles were labeled appropriately before collection. Blood samples in the EDTA bottles were subjected to haematological analysis to determine the packed cell volume (PCV), red blood cell (RBC), haemoglobin (Hb), lymphocytes (LYM), neutrophils (NEU), monocytes (MONO), basophils (BAS) and eosinophils (EOS). The biochemical components of the serum determined include glucose (GLU), total protein (TP), albumin (ALB) and globulin (GLB).

Carcass and Organ Characteristics Evaluation

At the end of the experimental period, five birds per replicate (15 birds per treatment) were randomly selected, and tagged. The tagged birds were fasted for about 12 h to empty their gastro-intestinal tract, weighed individually and slaughtered. The birds were scalded, plucked and re-weighed before eviscerated. The carcasses were weighed using sensitive weighing balance. Evisceration of the carcass was carried out and the internal organs including other gut contents were carefully removed. The organs (heart, lungs, liver, kidney, intestine, gizzard, pancreas, spleen and proventriculus) were collected from these birds. These were weighed separately and their corresponding weights expressed as percentages of carcass weight.

Chemical Analysis

Proximate analysis and energy value of the test ingredient and experimental diets were determined by the method of Association of Official Analytical Chemist (AOAC, 2005).

Data Analysis

Data obtained in the study were subjected to analysis of variance (ANOVA) using SAS statistical package, SAS (1999). The means were separated using Duncan multiple range test (Duncan, 1955).

Table 1: Percentage composition of the experimental starter diets

Ingredients	Dietary Inclusion Level (%)					
	D1	D2	D3	D4	D5	D6
Maize	54.00	43.20	32.40	21.60	10.80	0.00
Beniseed waste meal	0.00	10.80	21.60	32.40	43.20	54.00
Soybeans meal	10.00	10.00	10.00	10.00	10.00	10.00
Full fat soya	11.00	11.00	11.00	11.00	11.00	11.00
GNC	17.30	17.30	17.30	17.30	17.30	17.30
Fish meal (72%)	1.80	1.80	1.80	1.80	1.80	1.80
W/offal	1.50	1.50	1.50	1.50	1.50	1.50
Bone	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50	1.50	1.50
Broiler premix	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Determined proximate analysis and metabolisable energy						
Dry matter (%)	93.20	93.45	93.56	93.65	93.74	93.82
Crude protein (%)	23.72	23.83	23.93	24.05	24.11	24.20
Ether extract (%)	4.00	8.08	8.61	10.40	11.50	11.92
Crude fibre (%)	5.80	7.95	8.60	8.80	9.20	9.82
Ash (%)	3.40	6.00	6.21	7.10	9.35	10.70
Metabolisable energy (kCal/kg)	3164.03	3208.04	3263.85	3299.34	3315.72	3369.00

D1, 0% BSW; D2, 20% BSW; D3, 40% BSW; D4, 60% BSW; D5, 80% BSW; D6, 100% BSW. Vitamin mineral premix contains the following: Vit. A, 10,000,000 IU; D3, 3,000,000 IU; Vit. K, 2.3 g; Thiamine-B1, 1.7 g; Riboflavin-B2, 5.0 g; Pyridoxine-B3, 3.1 g; Vit. B12, 16 mg; Biotin, 60 mg; Niacin, 31.0 g; Pantothenic acid, 8 g; Folic acid, 0.8 g; Manganese, 85 g; Zinc, 50.0 g; Iron, 25.0 g; Copper, 6.0 g; Iodine, 1.1 g; Selenium, 120.0 mg; Cobalt, 220.0 mg; B.H.T., 60.0 g; Ethoxyquin, 65.0 g; Choline chloride, 200.0 g.

Table 2: Percentage composition of the experimental finisher diets

Ingredients	Dietary Inclusion Level (%)					
	D1	D2	D3	D4	D5	D6
Maize	55.00	44.00	33.00	22.00	11.00	0.00
Beniseed waste meal	0.00	11.00	22.00	33.00	44.00	55.00
Soybeans meal	6.90	6.90	6.90	6.90	6.90	6.90
Full fat soya	15.00	15.00	15.00	15.00	15.00	15.00
GNC	11.00	11.00	11.00	11.00	11.00	11.00
Fish meal (72%)	1.00	1.00	1.00	1.00	1.00	1.00
PKC	6.70	6.70	6.70	6.70	6.70	6.70
Bone	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50	1.50	1.50
Broiler premix	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Determined proximate analysis and metabolisable energy						
Dry matter (%)	94.00	94.17	94.24	94.38	94.44	94.52
Ether extract (%)	4.00	6.36	7.03	8.00	8.63	9.26
Crude fibre (%)	7.60	7.84	8.14	9.20	11.72	12.80
Ash (%)	4.73	5.11	5.70	7.00	7.30	8.80
Metabolisable Energy (Kcal/kg)	3041.79	3152.00	3164.89	3270.28	3301.44	3310.13

D1, 0% BSW; D2, 20% BSW; D3, 40% BSW; D4, 60% BSW; D5, 80% BSW; D6, 100% BSW. Vitamin mineral premix contains the following: Vit. A, 10,000,000 IU; D3, 3,000,000 IU; Vit. K, 2.3 g; Thiamine-B1, 1.7 g; Riboflavin-B2, 5.0 g; Pyridoxine-B3, 3.1 g; Vit. B12, 16 mg; Biotin, 60 mg; Niacin, 31.0 g; Pantothenic acid, 8 g; Folic acid, 0.8 g; Manganese, 85 g; Zinc, 50.0 g; Iron, 25.0 g; Copper, 6.0 g; Iodine, 1.1 g; Selenium, 120.0 mg; Cobalt, 220.0 mg; B.H.T., 60.0 g; Ethoxyquin, 65.0 g; Choline chloride, 200.0 g.

RESULTS

Gross Composition of the Experimental Diets

The experimental birds were fed starter diets with ME values ranging from 3164.03 to 3369.00 kCal/kg and crude protein values ranging from 23.72 to 24.20% (Table 1). The gross composition, the metabolisable energy and proximate composition of the experimental finisher diets are shown in Table 2. The metabolisable energy, crude protein, crude fibre, ash and ether extract of the experimental finisher diets increased as the levels of beniseed waste meal increased in the diets. The ME ranged from 3041.79 to 3310.13 kCal/kg and the crude protein also ranged from 21.02 to 21.82%.

Proximate Composition and Metabolisable Energy of Beniseed Waste Meal

The proximate composition of BSW indicated a crude protein of 18.89%, ether extract of 35.70%, ash content of 13.60% and crude fibre of 15.70%. The ME of BSW is 3984.24 kCal/kg (Table 3).

Table 3: Proximate composition and ME of BWM

Parameter	Beniseed waste meal (BWM)
Dry matter (%)	94.32
Crude protein (%)	18.89
Crude fibre (%)	15.70
Crude fat (%)	35.70
Ash (%)	13.60
Nitrogen free extract (%)	10.43
Metabolisable energy, ME (kCal/kg)	3989.46

Carcass Characteristics of Broilers Fed Graded Levels of Beniseed Waste Meal-Based Diets

The carcass characteristics of the experimental broilers are shown in Table 4. There were significant ($P < 0.05$) differences in the values obtained for live weight, eviscerated weight, dressed weight, neck, thigh, wings and lower back weights. Live weight of birds fed control diet D1 (0% BSW) and D2 (20% BSW) were the highest, 1898.27 g/b and 1863.32 g/b, respectively, while the live weight (1385.96 g/b) was recorded in D6 (100% BSW). The highest ($P < 0.05$) dressed weight (63.52%) was obtained in birds fed diet 3 (40% BSW); compared with 60.87% (D1), 61.68% (D2) and 60.00% (D4), the last three being similar. Beyond 60% BSW (D4), the dressed weight declined to 55.18% (D5) and 56.52% (D6) respectively. The bled weight, plucked weight, head, shank, drumstick, breast and upper back were not significantly ($P > 0.05$) affected by dietary treatments.

Organ Weights of Broilers Fed Graded Levels of Beniseed Waste Meal (BSW)

Organ weights of the experimental broilers are shown in Table 5. The values obtained for the lung, liver, kidney intestine, gizzard and proventriculus differed significantly ($P < 0.05$) across the dietary treatments. The organs with variations consistently increased numerically in weight with increasing BSW in the diets. However, the heart, pancreas and spleen weights were not significantly ($P > 0.05$) affected by the dietary treatments.

Haematological/Biochemical Indices of Broilers Fed Graded Levels of Beniseed Waste Meal

Table 6 shows the haematological and blood serum biochemical indices of broilers fed graded levels of BSW-based diets. The packed cell volume, red blood cell, white blood cell, haemoglobin, lymphocytes, neutrophils, monocytes, eosinophils, glucose, total protein, albumin and globulin; which were the haematological and serum biochemical indices investigated were similar ($P > 0.05$) across the dietary treatments.

DISCUSSION

The feeds were formulated to meet the nutrient requirement and maintain rapid growth/development of broilers as recommended by Oluyemi and Roberts (2000). There were differences in the live weight, eviscerated weight, dressed weight, neck, thigh, wings and lower back. The decreasing values of the live weight as the BSW increases in the diets was a reflection of the performance trend of the experimental birds. As the level of beniseed waste meal inclusion in the diets increased, feed intake and weight gain of the birds decreased which invariably resulted in decreased final live weight across the treatments. Farran *et al.* (2000) recommended maximum use of

sesame hull at 8% and 14% levels respectively in broilers and layers diets. The dressed weight is also very important to poultry meat consumers. There were no significant differences across the treatments for bled weight, plucked weight, head, shank, drumstick, breast and upper back weights.

High fibre content of the beniseed waste meal led to the increase in weight of gizzard, proventriculus and intestine as the inclusion level of beniseed waste meal increased in the diets. The increase in weight of gizzard in birds fed beniseed waste meal was higher due to more grinding work that the gizzard had to do (Ofuya and Nwajuiba, 1990). The increased weight of intestine, gizzard and proventriculus could also be attributed to the high crude fibre level which tends to activate the intestine and more occurrence of peristaltic movement. Nahashon *et al.* (1996) reported that intestine length and weight is known to be very plastic and varies with age, body weight, feed type, and body demands. Esonu *et al.* (2008) reported that organ weight is an indication of nutrient retained by the birds. The heart, pancreas and spleen weights were not different across the dietary treatments. Non significant differences observed in the weight of heart among the treatment means can be explained with the observation of Hight and Barton (1965), that heart, being a vital organ attained most of its mature weight during development of foetus. Therefore, varying level of diet did not change the heart weight in the later stage of growth. Ahamefule *et al.* (2006) reported that abnormalities would arise as a result of increased metabolic rate of the organ in an attempt to reduce toxin metabolites or anti-nutritional factors to non-toxic metabolites. Result of the study in question is in agreement with the present study as there was significant increase in weight of liver as the level of BSW increased in the diets. This is suggesting presence of anti-nutritional factors which could partly be responsible for the increased liver weight. Kidney, another organ of biotransformation, involved in detoxification also increased with dietary inclusion of BSW. Jacob *et al.* (1996) reported that sesame meal contains 2.15% tannins. Tannins often interfere with nutrient digestion by binding the protein in feed (Kamel *et al.*, 2015), chelate minerals (Fe and Zn) thereby limiting the absorption of these nutrients (Akande *et al.*, 2010). High crude fibre is a major attribute of most unconventional feed ingredients. For example, the crude fibre (15.70%) of BSW is comparable to 16.40% of high roughage diet fed to West African Dwarf Sheep (Osita *et al.*, 2019). Crude fibre and other anti-nutritional factors have been reported to affect weights of organ is in broilers (Olajide and Akinsoyinu, 2011). Osita *et al.* (2019) recommend dietary inclusion of 1.5 g/kg diet of yeast, *Saccharomyces cerevisiae*, to enhance the performance and digestibility coefficients of WAD Sheep fed high roughage diets.

Table 4: Carcass characteristics of broilers fed graded levels of beniseed waste meal-based diets

Parameters	D1 (0%BSW)	D2 (20%BSW)	D3 (40%BSW)	D4 (60%BSW)	D5 (80%BSW)	D6 (100%BSW)	SEM
LW (g.)	1898.27 ^a	1863.32 ^a	1654.12 ^b	1583.67 ^b	1392.10 ^c	1385.96 ^c	51.86
BW (% LW)	95.50	96.71	95.03	95.77	97.51	95.27	0.33
PW (% LW)	92.14	93.67	92.24	92.49	93.49	92.22	0.36
EW (% LW)	74.58 ^{ab}	77.40 ^a	75.71 ^a	72.68 ^{abc}	67.78 ^c	69.77 ^{bc}	0.98
DW (% LW)	60.87 ^{ab}	61.68 ^{ab}	63.52 ^a	60.00 ^{ab}	55.18 ^c	56.52 ^c	4.39
Head (g/kg)	29.45	31.65	27.87	29.83	32.26	31.15	0.72
Neck (g/kg)	50.83 ^{ab}	50.73 ^{ab}	54.21 ^a	49.46 ^{ab}	43.04 ^b	45.89 ^b	1.18
Shank g/kg)	46.25	48.29	51.12	51.77	52.41	56.39	1.42
DRK (%LW)	103.64	109.91	109.35	101.61	97.13	106.05	1.74
TGH (%LW)	106.99 ^a	103.56 ^{ab}	103.66 ^{ab}	100.27 ^{abc}	96.23 ^{bc}	93.24 ^c	1.51
WG (%LW)	95.21 ^a	94.83 ^a	93.24 ^c	92.08 ^{ab}	90.26 ^{ab}	86.74 ^{ab}	1.44
BRT (%LW)	174.51	173.87	170.10	168.85	153.56	147.24	3.91
UB (%LW)	67.11	60.80	58.17	58.15	53.86	51.20	2.16
LB (%LW)	75.72 ^a	67.18 ^{ab}	66.53 ^{ab}	59.90 ^{bc}	58.11 ^{bc}	54.10 ^c	2.09

abc: Means within the same row with different superscripts differed significantly ($P < 0.05$); SEM, standard error of the mean; LW, live weight; BW, bled weight; PW, plucked weight; EW, eviscerated weight; DW, dressed weight; DRK, Drumstick; TGH, Thigh; WG, Wing; BRT, breast; UB, upper back; LB, lower back

Table 5: Organ weights of broilers fed graded levels of beniseed waste

Parameters (g/kg)	D1 (0%BSW)	D2 (20%BSW)	D3 (40%BSW)	D4 (60%BSW)	D5 (80%BSW)	D6 (100%BSW)	SEM
Heart	3.90	4.30	4.33	4.53	4.71	4.88	0.15
Lungs	5.07 ^b	5.28 ^{ab}	5.52 ^{ab}	5.53 ^{ab}	6.36 ^{ab}	7.31 ^a	0.28
Liver	21.09 ^c	21.92 ^{bc}	23.59 ^{bc}	24.13 ^{bc}	25.27 ^{ab}	28.51 ^a	0.69
Kidney	4.88 ^c	5.93 ^{bc}	6.11 ^{bc}	6.63 ^{bc}	7.46 ^{ab}	8.61 ^a	0.35
Intestine	64.58 ^c	72.09 ^c	78.62 ^{bc}	84.51 ^{bc}	108.01 ^{ab}	135.79 ^a	6.92
Gizzard	39.79 ^b	40.61 ^b	42.73 ^{ab}	43.51 ^{ab}	50.78 ^a	51.52 ^a	1.46
Pancreas	2.86	2.97	3.13	3.17	3.26	3.83	0.18
Spleen	0.54	0.69	0.84	0.97	1.00	1.20	0.11
Proventriculus	4.40 ^b	5.22 ^{ab}	5.31 ^{ab}	5.72 ^{ab}	5.76 ^{ab}	6.47 ^a	0.24

abc: Means within the same row with different superscripts differed significantly ($P < 0.05$); SEM, standard error of the mean

Table 6: Haematological and biochemical indices of broilers fed graded levels of beniseed waste

Parameters	D1 (0%BSW)	D2 (20%BSW)	D3 (40%BSW)	D4 (60%BSW)	D5 (80%BSW)	D6 (100%BSW)	SEM
Haematology							
PCV (%)	23.33	26.00	26.00	26.67	27.00	29.33	1.08
RBC ($\times 10^6 \text{ mm}^{-3}$)	2.60	2.90	2.90	2.95	3.00	3.23	0.12
WBC ($\times 10^3 \text{ mm}^{-3}$)	6.93	6.97	6.97	7.40	7.53	8.27	0.49
Hb (g/100ml)	7.77	8.63	8.67	8.90	9.03	9.77	0.36
Lym (%)	29.33	30.67	32.33	36.67	37.00	37.33	1.71
Neu (%)	60.33	62.00	62.33	64.67	66.00	68.33	1.37
Mono (%)	0.67	1.00	1.00	1.67	1.67	1.67	0.32
Eos (%)	0.00	0.00	0.67	1.33	1.66	1.67	0.28
Biochemical							
Glucose (mg/dl)	156.00	158.00	159.00	159.67	162.33	167.67	2.14
TP (g/dl)	27.67	28.66	29.66	30.34	30.34	31.00	0.77
ALB (g/dl)	16.67	17.33	18.33	18.67	18.67	19.00	1.16
GLB (g/dl)	11.00	11.33	11.33	11.67	11.67	12.00	0.45

abc: Means within the same row with different superscripts differed significantly ($P < 0.05$); SEM, standard error of mean;

PCV, packed cell volume; RBC, red blood cells; WBC, white blood cells; Hb, haemoglobin; Lym, lymphocytes;

Neu, neutrophils; Eos, eosinophils; Mono, monocytes; TP, total protein; ALB, albumin; GLB, globulin

Serum and haematological indices were not influenced by dietary inclusion of BSW. Blood biochemical results did not indicate any negative effect that could be attributed to the dietary treatments. The use of biochemical indices as a pointer to conditions that may not be readily noticed by performance indices cannot be overemphasized. Blood represents the means of assessing clinical and nutritional health status of animal in feeding trials (Aletor and Egberongbe, 1992). Togun and Oseni (2005) noted that hematological indices such as RBC, WBC, PCV and Hb have been found useful for disease prognosis, for therapeutic and feed stress monitoring. Babatunde *et al.* (1992) reported that blood parameters are the major indices of physiological, pathological

and nutritional status of an organism. Changes in the constituents' compounds of blood when compared to normal values could be used to interpret the metabolic stage of an animal as well as the quality of feed. The values of PCV, RBC, WBC, Hb, Lym, Neu, Mono and Eos were similar across the dietary treatments. The values fall within the recommended 24.90-45.20% and 1.58-40 ($\times 10^6 \text{ mm}^{-3}$) for PCV and RBC, respectively. The increasing numerical WBC could also be linked to the need for defense. Afolabi *et al.* (2017) linked the elevation of WBC (leucocytes) in broilers to challenge of the body by capsaicin in dried hot red pepper. These antibodies can fight foreign bodies, in the present study, the residual anti-nutritional factors in BSW. The biochemical indices

(glucose, total protein, albumin and globulin) of the birds fed varying dietary levels of BSW were similar across the treatments. The numerical increase in glucose with increasing BSW within recommended range of 152-182 mg/dl (Mitruka and Rawnsley, 1977) may suggest more free energy for the birds.

CONCLUSION

Results of this study revealed that beniseed waste meal had no deleterious effects on health status (organs, serum and haematological parameters) of the experimental broilers; and could safely replace maize up to 100% (55% BSW) in the diets; and is therefore recommended.

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