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Effects of Maxigrain® enzyme supplemented beniseed hull on performance and haematological parameters of domestic laying hens

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Abstract

A total of 180 twenty weeks old black Nera laying hens was *used to evaluate the effects of* replacement of maize, an expensive conventional energy ingredient with *Maxigrain® enzyme supplemented beniseed hull (BSH) on performance and haematological parameters* of laying hens. *The study was carried out at the Poultry Unit of the Teaching and Research Farm, Joseph Ayo Babalola University, Ikeji-Arakeji, Osun State, Nigeria. There were five (5) treatments of 36 birds per treatment. Each treatment was replicated three times comprising 12 birds per replicate in a completely randomized design (CRD) experiment. Five (5) experimental diets were compounded* with *percentage replacement of maize* at *0 (control), 25, 50, 75 and 100% BSH; designated as D1, D2, D3, D4 and D5, respectively. The substitution was weight for weight. Diets 2, 3, 4 and 5 (D2 – D5) were supplemented with Maxigrain® enzyme at 0.1% of the test ingredient in the experimental diets. The ME (13.20 MJ/kg), CP (11.82%), CF (22.15%), and EE (24.40%) of the BSH compares with ME (14.37MJ/kg), CP (10%), CF (2.00%) and EE (4.00%)of maize to serve as its substitute. The egg/day (HDP), egg weight, egg mass and FCR were significantly ($P < 0.05$) affected by the dietary treatments. The HDP (%) were 75.14(D1), 73.57 (D2), 62.86 (D3), 48.57 (D4) and 31.14 (D5). The egg mass (g) were 42.50 (D1), 43.65 (D2), 40.88 (D3), 35.24 (D4),and 23.22 (D5). The egg weight (g) were 56.67 for the birds fed D1 significantly ($P < 0.05$) increased to 58.98 (D2), 64.89 (D3), 71.91 (D4) and 74.89 (D5). The FCR in the same order were 2.49 (D1), 2.44 (D2), 2.64 (D3), 3.08 (D4) and 4.73 (D5). Other performance parameters including the average initial live weight, average final live weight, average body weight gain and average daily feed intake were not significantly ($P > 0.05$) affected across the dietary treatments***.*** *All investigated haematological variables (ESR, PCV, RBC, Hbc, Lympocytes, Neutrophils, Monocytes, Basophils, Eosinophils, MCV, MCH and MCHC) were similar ($P>0.05$) across the dietary treatments. It was concluded that maize could economically be replaced with 50% Maxigrain****®*** *enzyme supplemented BSH in layers diets; and therefore recommended in the diets.*

Keywords: Laying hens, beniseed hull, performance, enzyme supplementation, haematology

Effets de l'enveloppe de graines de bise supplémentée en enzymes Maxigrain® sur les performances et les paramètres hématologiques des poules pondeuses domestiques

Résumé

Un total de 180 poules pondeuses noires Nera âgées de vingt semaines a été utilisé pour évaluer les effets du remplacement du maïs, un ingrédient énergétique conventionnel coûteux par l'enzyme Maxigrain® supplémenté en enveloppe de graines de graines (BSH) sur les performances et les paramètres hématologiques des poules pondeuses. L'étude a été réalisée à l'unité de volaille de la ferme d'enseignement et de recherche, Université Joseph

Ayo Babalola, Ikeji-Arakeji, État d'Osun, Nigéria. Il y avait cinq (5) traitements de 36 oiseaux par traitement. Chaque traitement a été répété trois fois comprenant 12 oiseaux par répétition dans une expérience de conception entièrement randomisée (CER). Cinq (5) régimes expérimentaux ont été composés avec un pourcentage de remplacement du maïs à 0 (témoin), 25, 50, 75 et 100 % BSH ; désignés respectivement par D1, D2, D3, D4 et D5. La substitution était poids pour poids. Les régimes 2, 3, 4 et 5 (J2 – J5) ont été supplémentés avec l'enzyme Maxigrain® à 0,1 % de l'ingrédient à tester dans les régimes expérimentaux. Le ME (13,20 MJ/kg), le CP (11,82 %), le CF (22,15 %) et l'EE (24,40 %) du BSH se comparent au ME (14,37 MJ/kg), au CP (10 %), au CF (2,00 %) et EE (4,00 %) de maïs pour lui servir de substitut. L'œuf/jour (HDP), le poids de l'œuf, la masse de l'œuf et le FCR ont été significativement (P < 0,05) affectés par les traitements diététiques. Les HDP (%) étaient de 75,14 (D1), 73,57 (D2), 62,86 (D3), 48,57 (D4) et 31,14 (D5). La masse d'œufs (g) était de 42,50 (D1), 43,65 (D2), 40,88 (D3), 35,24 (D4) et 23,22 (D5). Le poids des œufs (g) était de 56,67 pour les oiseaux nourris D1 significativement (P < 0,05) augmenté à 58,98 (D2), 64,89 (D3), 71,91 (D4) et 74,89 (D5). Les FCR dans le même ordre étaient de 2,49 (D1), 2,44 (D2), 2,64 (D3), 3,08 (D4) et 4,73 (D5). D'autres paramètres de performance, notamment le poids vif initial moyen, le poids vif final moyen, le gain de poids corporel moyen et l'apport alimentaire quotidien moyen, n'ont pas été significativement (P > 0,05) affectés par les traitements diététiques. Toutes les variables hématologiques étudiées (ESR, PCV, RBC, Hbc, lymphocytes, neutrophiles, monocytes, basophiles, éosinophiles, MCV, MCH et MCHC) étaient similaires (P> 0,05) pour tous les traitements diététiques. Il a été conclu que le maïs pouvait être remplacé de manière économique par 50 % de BSH additionné d'enzymes Maxigrain® dans les régimes alimentaires des poules pondeuses ; et donc recommandé dans les régimes alimentaires.

Mots-clés : Poules pondeuses, cosse de benis, performance, supplémentation enzymatique, hématologie

Introduction

The search for alternative to maize, the chief energy feed ingredient source in poultry diets has been a major concern of the Monogastric Animal Nutritionists. Despite being the largest producer of maize in Africa with 11 million tonnes produced in 2019 (Oyewole *et al.,* 2020) citing the FAS/USDA (2019) statistics reported that Nigeria imported 200,000, 400,000 and 400,000 metric tonnes of maize in 2017, 2018 and 2019 respectively. With naira consistently losing ground to most of the foreign currencies in the last few years, such importations would have dwindled the foreign reserve of the country. The conventional feed-stuffs such as the grains and pulses are being consumed by human beings; and may not be available for raising livestock (Abubakar, 1998). The question is which of the competing options for maize should be prioritized. The answer to the maize producers or sellers is most likely to be for option with highest competitive price. Maize and other cereals are being competed for by humans, industries and livestock among others. This stiff competition has led to high cost of maize which is a major ingredient for poultry feed. Maize is currently sold for ' 250,000:00 per ton and Soybean for ' 317,000:00 per ton; higher than the prices obtainable at the beginning of this study. Since the energy ingredients form the bulk in poultry feed formulation, using alternative and cheaper feed-stuffs will lower the ever-increasing cost of livestock feed cost. Beniseed (*Sesamum indicum* Linn) is a tropical and subtropical plant cultivated for its seeds. It is grown in large quantity in the middle belt of Nigeria (Mahmuod *et al.,* 2015). The ranges of proximate composition for whole Sesame cultivars were 4.18 – 5.41% moisture, 45.6 – 46.1% fat, 21.9 – 23.6 protein, 4.70 – 7.15% crude fiber, 6.16 – 7.34% ash, and 10.8 – 17.0% carbohydrate (Makinde and Akinoso, 2013). The hulls of the two high yielding Sesame cultivars (White-NCR1-98-60 and black-NCR1-97-28) contain lower amount of protein, fat and carbohydrate than the whole Sesame cultivars. The authors also reported that processing (soaking, germination, autoclaving, roasting and cooking) decreased the phytate and oxalate contents significantly in both whole and dehulled cultivars. The beniseed hull is a by-product obtained from the dehulling of sesame seeds after its oil has been extracted. The hulls are abundant in most beniseed hull mills in Nigeria untapped. Previous reports showed that the waste if properly harnessed could form an essential feed ingredient in poultry diets. Kehinde *et al.* (2013) obtained better performance of broilers fed fermented rice offal supplemented with Maxigrain® enzyme compared with the un-processed, reground and cooked rice offal. Ewa *et al.* (2019) reported better performance of broilers with 7.5% boiled *Mucuna sloanei* seed meal treated with Maxi-grain® enzyme than those fed with the conventional soya meal based ration. This study examined the proximate chemical composition of the beniseed hull and its suitability when supplemented with Maxigrain® enzyme as alternative energy ingredient in place of maize in layers' diets.

Materials and methods

Location of the study

This study was conducted at the Poultry Unit of the Teaching and Research Farm, Joseph Ayo Babalola University, Ikeji-Arakeji, Osun State, Nigeria. Ikeji-Arakeji is situated on 350.52m above sea level at latitude 7^0 25'N and at longitude 5^0 19'E. The vegetation of the area is that of the rainforest characterized by hot and humid climate. The mean annual rainfall is 1500mm and the rain period is bimodal with a short break in August with mean annual relative humidity of 75% and mean temperature of 26 – 28^0 C (Ajibefun, 2011).

Source and processing of the test ingredient

The beniseed hull (BSH) used for this study was purchased from Omisanya and Son Stores, Ibadan, Oyo State, Nigeria. The unwanted particles and other dirt were handpicked leaving the clean materials to formulate the commercial laying hens' diets. The composition of BSH is as presented in Table 1.

Table 1: Proximate composition (g/100g) of beniseed hull (BSH)

Nutrient	Value
Dry Matter (%)	96.04
Crude protein (%)	11.82
Ether extract (%)	24.40
Crude fibre (%)	22.15
Ash (%)	19.95
Nitrogen Free Extract (%)	17.72
Metabolisable energy (MJ/kg DM)	13.20
Calculated values	
Organic matter	80.05
Protein/fat	0.48
Fatty acid	19.52

Source: Olajide *et al.* (2019)

Experimental diets

Five (5) experimental diets were formulated to meet the nutrients' requirements of laying birds (NRC, 1994). The diets were compounded from the percentage replacement of maize with 0 (control), 25, 50, 75 and 100% BSH; designated as D1, D2, D3, D4 and D5 respectively. The substitution was weight for weight. Diets 2, 3, 4 and 5 (D2 – D5) were supplemented with Maxigrain® enzyme at 0.1% of the test ingredient in the experimental diets. The gross composition of the diets is presented in Table 2.

Table 2: Gross composition of the BSH-based diets supplemented with Maxigrain® enzyme

Ingredients	Diets (% inclusion levels of BSH)				
	D1 0% BSH	D2 25% BSH	D3 50% BSH	D4 75% BSH	D5 100% BSH
Maize	60.00	45.00	30.00	15.00	0.00
Beniseed hull (BSH)	0.00	15.00	30.00	45.00	60.00
Soybean meal	10.50	10.50	10.50	10.50	10.50
Wheat offal	10.03	10.03	10.03	10.03	10.03
Groundnut cake	7.52	7.52	7.52	7.52	7.52
Fish meal	1.50	1.50	1.50	1.50	1.50
Oyster shell	7.80	7.80	7.80	7.80	7.80
DCP	1.80	1.80	1.80	1.80	1.80
*Premix (layers)	0.15	0.15	0.15	0.15	0.15
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15
Methionine	0.10	0.10	0.10	0.10	0.10
Vegetable Oil	0.20	0.20	0.20	0.20	0.20
**Enzyme	-	+	+	+	+
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis					
Crude protein (%)	16.26	16.33	16.36	16.39	16.43
Crude fibre (%)	2.45	5.47	8.50	11.52	14.54
Metabolisable energy (MJ/kg)	14.74	14.59	14.58	14.56	14.54

DCP = Dicalcium phosphate

*Premix contains: Vit A, 4x10 ^{6,} I.U; Vit D_3, , 8x10^{5,} I.U; Tocopherols. , 4x10 ^{3,} I.U; Vit K_3, 800mg; folacin, 200mg; Thiamine, 600mg; Riboflavin, 1,800mg; Niacin, 600mg; Calcium panthothenate, 2g; Pyridoxine, 600mg; Cyonocobalamin, 4mg; Biotin, 8mg; Manganese, 30g; Zinc, 20g; Iron, 8g; Choline chloride, 80g; Copper, 2g; Iodine, 480mg; cobalt, 80mg; selenium, 40mg; BHT, 25g; Anti-caking agent, 6g.

** 100 g Maxigrain® enzyme/ton feed

Management of the experimental birds

A total of One hundred and eighty (180) five-month old black Nera laying hens used for this study were randomly placed on 5 experimental diets; with each diet representing a treatment. Each treatment was replicated three times and each diet was offered to 3 replicates comprising 12 birds each (36 birds per treatment) in a completely randomized design (CRD) experiment. The birds were weighed individually both at the beginning and the completion of the study. All other daily routine management practices required were provided. Feed and water were supplied ad libitum. The feed remaining at the end of the week were subtracted from the feed supplied at the beginning of the week to determine the weekly feed intake from which average daily feed intake was calculated.

Data collection and cost estimates

The performance parameters (feed intake, HDP or egg/day and egg weight) were measured for 10 weeks after an initial 2 weeks of acclimatization and feeding, during which no data was collected. Both HDP (egg/day) and egg weight were used to calculate the egg mass as number of eggs (HDP) multiply by egg weight. The FCR was computed as average daily feed intake divided by egg mass. Cost per kg feed for each of the diets was calculated from the prevailing cost of feed ingredients at the time of the purchase, and this was subsequently used to compute the cost of feed per unit (mass) of egg.

Haematological parameters of the experimental laying birds

Thirty (30) birds at the rate of six birds per dietary treatment and two per replicate were used for haematological studies. At the end of the feeding trial, blood samples were collected from the wing vein of the randomly selected experimental birds for haematological analysis. Blood was collected from each bird into labelled sterile universal bottle containing anti-coagulant ethylene-diamine-tetraacetic acid (EDTA) for the determination of haematological components. The samples were taken to the Laboratory for analysis. The packed cell volume (PCV) was determined using the micro-hematocrit technique. The red blood cells (RBC) and white blood cells (WBC) counts were determined using the improved Neubauer hematocytometer method, and haemoglobin (Hb) using the cyanomethemoglobin method described by Kelly, (1979).

Proximate analyses of BSH and experimental diets

The BSH and the experimental diets were analysed for proximate composition using the procedures of AOAC (2005). The official reference numbers for the methods of analysis include the CP (AOAC 988.05), EE (AOAC 2003.06), DM (AOAC 967.08), Ash (AOAC 942.05), CF (AOAC 958.06). The NFE was determined by difference as 100- (% moisture + % CP + % EE + % CF + % Ash). The metabolizable energy was calculated according to the method of Pauzenga, (1985) as ME (kcal/kg DM) = 37 x % protein + 81.8 x % fat + 35.5 x %NFE.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using the procedure of SAS, (1999). The means were separated using the Duncan Multiple Range Test of the same package.

Results and discussion

The proximate composition and the calculated ME of the BSH were presented in Table 1. This composition shows that BSH compares favourably with ME (14.37 MJ/kg), CP (10%), CF (2.00%) and EE (4.00%) of maize to serve as its substitute(Pfizer Nutrient Plan and Nutrient Levels of Feed Ingredients). The crude protein, ether extract, crude fibre, ash and ME values obtained for the BSH in this study were higher than the values obtained by Ngele, et al., (2011).

Shown in Table 2 is the gross composition of the BSH-based experimental diets supplemented with Maxigrain® enzyme. The crude protein (CP) was D1 (16.26%), D2 (16.33%), D3 (16.36%), D4 (16.39%) and D5 (16.43%); and crude fibre (CF) were D1 (2.45%), D2 (5.47%), D3 (8.50%), D4 (11.52%) and D5 (14.54%). The ME (MJ/kg) decreasing with increasing contents of BSH were D1 (14.74), D2 (14.59), D3 (14.58), D4 (14.56) and D5 (14.54) in the diets. The CP and CF increased with the contents of BSH in the diets. The experimental diets were formulated to meet the NRC, (1994) recommended 11.92 MJ ME/kg diet and CP of 16% for laying birds. Several authors have recommended nutrients and energy values in layers' diets, including 10.04 MJ/kg ME (Olomu, 1979), 10.04 – 10.88

MJ/kg ME (Fetuga, 1984), 10.04 – 11.72 MJ/kg ME (NAERLS, 1990), 16 – 18% CP and maximum of 7% CF (Fetuga, 1984) for laying chickens in Nigeria. Almeida et al., (2012) obtained the best performance of layers with diet containing 11.30 MJ/kg ME and 15% CP. Olajide et al., (2013) fed diets containing 10.47 – 11.62 MJ, 17.16 – 17.52% CP, and 3.99 – 7.54% CF; and obtained HDP (56.97 – 73.04%) and average egg weight (49.42 – 50.79g). Yang et al., (2016) recommended optimal dietary ME of 11.09 MJ/kg and 15% CP for layers at 33 – 41 week of age.

Table 3: Performance of laying hens fed graded levels of Maxgrain® enzyme supplemented BSH - based diets

Parameters	Treatments					SEM
	D1 0% BSH	D2 25% BSH	D3 50% BSH	D4 75% BSH	D5 100% BSH	
AIW (kg/b)	1.68	1.66	1.66	1.67	1.67	0.01
AFBW (kg/b)	2.08	2.01	2.00	2.01	2.02	0.02
ABWG (kg/b)	0.40	0.35	0.34	0.34	0.35	0.001
ADFI (g/d)	105.74	106.70	107.83	108.56	109.94	2.74
Egg/day	0.75^{a}	0.74^{a}	0.63^{b}	0.49^{c}	0.31^{d}	0.02
Egg weight (g)	56.67^{c}	58.98^{b}	64.89^{b}	71.91^{a}	74.89^{a}	2.12
Egg mass (g)	42.50^{ab}	43.65^{a}	40.88^{b}	35.24^{c}	23.22^{d}	1.35
HDP (%)	75.14^{a}	73.57^{a}	62.86^{b}	48.57^{c}	31.14^{d}	1.78
FCR	2.49^{c}	2.44^{d}	2.64^{b}	3.08^{b}	4.73^{a}	0.34
Cost/kg feed (')	146.92	135.82	124.53	112.70	100.30	NSA
Cost of feed/mass of egg (')	365.83	343.63	328.76	347.12	474.42	NSA

BSH = beniseed hull; SEM = standard error of the means; NSA= not statistically analysed, AIW = average initial weight, AFBW = average final body weight, ABWG = average body weight gain, ADFI = average daily feed intake, HDP = hen day production, FCR = feed conversion ratio

^{a,b,c,d}Means in the same row with different superscripts differ significantly(P< 0.05).

The performance characteristics of the laying birds fed the BSH-based experimental diets supplemented with Maxigrain® enzyme is presented in Table 3. The egg/day (HDP), egg weight, egg mass and FCR were significantly (*P < 0.05*) affected across the dietary treatments. The HDP (75.14%) of the birds fed D1 (0% BSH) was similar (P > 0.05) to 73.57 (D2), but both significantly (*P < 0.05*) reduced to 62.86 (D3), 48.57 (D4) and 31.14 (D5). The highest (*P < 0.05*) egg mass (g) 43.65 (D2) was similar (P < 0.05) to 42.50 (D1), however, higher compared to 40.88 (D3), 35.24 (D4), 23.22 (D5). The egg weight (g) was 56.67 for the birds fed D1 (0% BSH) significantly (*P < 0.05*) increased to 58.98 (D2), 64.89 (D3), 71.91 (D4) and 74.89 (D5). The FCR in the same order were 2.49 (D1), 2.44 (D2), 2.64 (D3), 3.08 (D4) and 4.73 (D5). The average initial live weight, average final live weight, average body weight gain and average daily feed intake were similar (*P > 0.05*) across the dietary treatments**.** The increasing egg weight with the increasing contents of BSH in the diets is desirable since this means more income per unit of eggs. However, the highest hen day production (HDP) was obtained in the birds fed 0% BSH-based diets which was similar to those fed 25% BSH-based diet (D2). Beyond this level, the HDP reduced with contents of BSH. The highest egg mass was obtained in birds fed 25% BSH-based diets, followed by the control (0% BSH); and thereafter reduced across the dietary treatments. The best FCR obtained in birds fed 25% BSH-based diets (D2), followed by the control and then increased with contents of BSH in the diets. The experimental diets were almost iso-nitrogenous and iso-caloric with the CP and ME values of the BSH-based diets close to those of the control. These may suggests an expected similar performance of the experimental laying birds across the dietary treatments. The CF, however, increased with the levels of inclusion of BSH across the dietary treatments. While the egg weight increased with the dietary inclusion of BSH, the HDP and egg mass beyond 25% BSH decreased; and FCR increased. The declining performance (egg/day or HDP, egg mass and FCR) after 25% level of BSH inclusion may suggests the nutrients in these diets were not similarly digested and utilized by the experimental birds. Since the CF levels above 25% BSH (D2) were higher than the recommended for layers, coupled with the presence of other anti-nutritional factors could be suspected. Obeta *et al.* (2020) reported that the processed beniseed flour contained 0.60 - 0.63% phytate and 0.73% phytate in unprocessed form; and 1 - 1.59% tannin in boiled flour compared with 1.59% in roasted beniseed flour. Also, the high level of CF beyond the threshold of the recommended 0.1% of diets would have affected the enzyme action negatively. High substrate concentration for the Maxgrain® enzyme to bio-degrade the test ingredient (BSH) in the BSH-based diets could be another probable reason. The fibre levels beyond 50% BSH across the dietary treatments are however higher than the threshold of what the endogenous enzymes and exogenous enzyme (Maxgrain® enzyme) could handle, making their effects insignificant. Enzymes and substrates' concentrations are very important among the various factors affecting enzyme action. Examples of enzyme substrates include fibre, starch (amylose, amylopectin), phytic acid (phytate), proteins, lipids (fats, triglycerides) and arabinoxylan among others. The Maxgrain® enzyme is a multi-substrate enzyme capable of digesting many substrates. The substrates in the present study is the fibre and possibly other anti-nutritional factors. Olajide *et al.* (2013) recorded better HDP of 73.04% with 7.54% CF level in the diets compared with HDP of 56.97% with 5.74% CF level when brewers dried grains-based diets supplemented with Grandizyme® enzyme as a partial substitute for maize in Isa-brown laying hens. Meanwhile, Harms *et al.* (2000) reported that egg production was not affected by dietary energy level.

The best FCR was obtained at 25% BSH (D2) followed by 0% BSH (D1), beyond D2, the FCR increased with BSH in the diets. The cost/kg feed decreased from 0% BSH (control) with increasing BSH in the diets. The cost of feed/egg mass of the birds fed 25, 50 and 75% BSH-based diets were lower (50% BSH being the lowest) than that of 0% BSH; but the highest being at 100% BSH. Thus D2 (25% BSH), D3 (50% BSH) and D4 (75% BSH) are lower than the control D1 (0% BSH) but the cheapest (most economic) is D3 (50% BSH) at the cost of ' 328.76. The performance in this study compares favourably with standards. Almeida *et al.* (2012) reported egg mass (40.35 – 49.33 g/hen/day) and HDP (74.51 – 87.64%). The average egg weights (49.42 - 50.79g), HDP (56.97 - 73.04%), feed intake (81.88 - 95.06g/b/d) was obtained with Isa-brown laying hens fed brewers dried grains supplemented by Grandizyme® enzyme (Olajide *et al.,* 2013). Yang *et al.* (2016) obtained egg weights (51.8 – 52.30g) and HDP (79.34 ± 1.63 - 82.25 ± 1.15) for layers. The differences could be due to breeds, nutrition and location.

Table 4: Haematological variables of laying hens fed diets in which graded levels of Maxigrain® enzyme supplemented BSH replaced maize

Parameters	Diets					SEM
	D1 0% BSH	D2 25% BSH	D3 50% BSH	D4 75% BSH	D5 100% BSH	
ESR (mm/hr)	5.00	5.00	4.50	5.32	4.86	0.12
PCV (%)	29.60	29.58	28.76	28.84	28.29	0.32
RBC (mm^3 x 10^6)	2.40	2.25	2.38	2.41	2.22	0.06
Hbc (g/dl))	10.40	10.27	11.18	11.39	11.46	0.05
Lymphocytes (%)	59.56	59.90	59.30	59.90	59.53	0.12
Neutrophils (%)	24.34	23.02	24.57	24.93	23.53	0.11
Monocytes (%)	13.07	13.23	12.87	12.30	13.32	0.34
Basophils (%)	2.33	2.58	2.58	2.33	2.44	0.38
Eosinophils (mm^3 x 10^3)	1.10	1.10	1.05	1.10	1.00	0.13
MCV (μ^3)	82.00	81.70	81.85	81.60	81.60	2.54
MCH (µµg)	31.72	32.24	32.14	32.08	32.10	1.13
MCHC (%)	32.81	32.08	34.83	35.59	35.81	1.31

BSH = beniseed hull , SEM = standard error of the means; ESR = erythrocyte sedimentation rate; PCV = packed cell volume; RBC = red bloodcells; Hbc = haemoglobin concentration; MCV = mean cell volume; MCH = mean cell/corpuscular haemoglobin; MCHC = mean corpuscular haemoglobin concentration
[a,b,c,]Means in the same row with different superscripts differ significantly($P<0.05$).

Table 4 presented the haematological parameters of the laying hens fed diets in which graded levels of Maxigrain® enzyme supplemented BSH replaced maize. All the haematological variables (ESR, PCV, RBC, Hbc, Lympocytes, Neutrophils, Monocytes, Basophils, Eosinophils, MCV, MCH and MCHC) were similar ($P>0.05$) across the dietary treatments. These values compare favourably with the standards (Mitruka and Rawnsley, 1977). The non-significant values of all the haematological indices investigated and favourable comparison with the standards may suggests the safety of BSH as suitable alternative to maize as energy ingredient.

Conclusion

It was concluded that maize could safely be replaced with, but most economically by 50% Maxigrain® enzyme supplemented BSH in layers diets; and therefore recommended in the diets.

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