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Haematology, serum biochemistry and economic characteristics of cockerels fed diets containing varying levels of water hyacinth [*Eichhornia crassipes* (Mart.) Solms-Laubach] meal supplemented with Maxigrain® enzyme

Malik*, A. A., Kudu, Y. S. and Gold R. O.

Department of Animal Production, Federal University of Technology, Minna, Niger State.

***Corresponding Author**: delemalik@gmail.com Phone No: +2348030637763*

Abstract

The haematology, serum biochemistry and economic characteristics of two hundred and eighty-eight (288) nine-week-old Black Harco strain cockerels fed diets containing water hyacinth (Echhornia crassipes) meal supplemented with or without exogenous enzymes was investigated. Water hyacinth was included at 0, 10 and 20 % dietary inclusion levels as replacement for wheat offal without enzyme supplementation to form Diet 1, Diet 2 and Diet 3, respectively; and then supplemented with exogenous enzymes to form Diet 4, Diet 5 and Diet 6, respectively. The cockerels were randomly allocated to six treatment groups replicated three times to have 16 chicks per replicate; and were fed the experimental diets ad libitum for 9 weeks under a deep litter management system. At the end of the feeding trial, blood samples were collected for the evaluation of the haematological characteristics and biochemical profile of the cockerels. Economic characteristics in terms of cost of feed per kg, total cost of feed consumed per animal and cost of feed consumed per kg weight gain were evaluated. Results show that only white blood cell (leucocytes) and red blood cell (erythrocytes) count were significantly ($p<0.05$) different among the treatments. There were no significant ($p>0.05$) differences in packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration; as well as in neutrophils, eosinophils, lymphocytes and monocytes concentration. For the biochemical indices, total bilirubin level, conjugate bilirubin level, alkaline phosphatase, aspartate aminotransferase, alanine aminotransferase and total protein were significantly ($p<0.05$) different among the various dietary treatments. There were no significant ($p>0.05$) differences in cost per kg weight gain between birds fed the 0, 10 and 20 % WHM; but cost savings for 10 and 20 % dietary inclusion of WHM were ₦2.36 and ₦4.89, respectively. Based on the haematology, serum biochemistry and economic characteristics of cockerels, water hyacinth meal can be included up to 20 % in the diet of cockerels at the chick phase without any detrimental effect on their performance.

Keywords: *Cockerels, haematological characteristics, water hyacinth, wheat offal*.

Description of Problem

Feed represents the major cost of poultry, constituting up to 70 % of the total cost of production in developing countries (1). Hence, there is renewed effort by animal nutritionists in these countries to explore the locally-available feed resources that are regarded as wastes and are cheaper to procure than the conventional feed ingredients.

Water hyacinth is a free floating perennial aquatic plant of *Eichhornia* genus in *Pontederiaceae* family. It is a native to tropical and sub-tropical South America. It is regarded as one of the world's most invasive aquatic weed species having adverse effects on water resources, transportation and navigation;

fisheries, irrigation, drainage canals and public health (2). Numerous international conferences and symposia have been held all over the world in an attempt to curtail the spread of this obnoxious weed. Some of these include: International Workshop on Water Hyacinth held in Lagos, Nigeria, 7-12 August, 1988; First Meeting of the International Water Hyacinth Consortium, World Bank, held in Washington between 18th and 19th March, 1997; 2nd Meeting of the Global Working Group for the Biological and Integrated Control of Water Hyacinth, Beijing, China, 9th – 12th October, 2000; Invasive Plants in Mediterranean-type Regions of the World, Mèze (France), 25th – 27th May, 2005; and a host of others. Despite the communiques issued and resolutions passed at these conferences; and despite the mechanical, chemical, biological and integrated control efforts the world over, water hyacinth is still a world menace, and is spreading into new regions at an alarming rate. Fortunately, when harvested, this troublesome notorious weed has the potential of been used as a valuable feedstuff for animals, especially poultry (3). It can be included up to 10 % in the diets of pullet chicks (replacing 50 % of wheat offal), without the addition of any exogenous enzymes (4). (5) also determined that WHM can be included up to 15 % in the diet of pullet chicks (replacing 75 % wheat offal) without any detrimental effects on their carcass characteristics and haematological profile.WHM can be included up to 20 % in the diets of growing pullets (replacing 100 % wheat offal) with no detrimental effects on growth performance and nutrient digestibility (6). Also, WHM can be included up to 20 % in layer diets with no detrimental effect on meat yield, gut morphology and sensory properties of laying hens (7).

However, the problem of water hyacinth meal utilization in the animal feed industry is its low protein (13.88 %) and high fibre (21.43 %) content (4). The fibre is made up of non-starch polysaccharides (NSPs) such as cellulose, hemicellulose, pectin and lignin. Added to that is the suspected presence of galactosides, phytates and other anti-nutritional factors (ANFs) such as lectins and tannins, hence the need for the addition of exogenous enzymes for its proper utilization in livestock feeds. Addition of exogenous enzymes to fibrous feedstuffs have been known to help break down and release cell wall constituents present in the feedstuff before they reach the terminal end of the small intestine; hence improving nutrient digestibility in poultry birds. Also, enzymes increase growth rate, decrease viscosity of intestinal digesta resulting in more normal rate of passage, improved feed conversion and reduced sticky droppings (8). This study was carried out to evaluate the haematological, biochemical and economic characteristics of cockerel chicks fed water hyacinth meal based diets supplemented with and without exogenous enzymes (Maxigrain®).

Materials and Methods

Study Location

This study was carried out at the Poultry Unit of the Animal Production Teaching and Research Farm, Federal University of Technology, Bosso Campus, Minna. Minna is the capital city of Niger State of Nigeria, with an estimated population of about 500,000 and a land area of about 6,784 square kilometers. It is located in the Southern Guinea Savanna Vegetation Zone, between Latitude 9^0 $37'$ North and Longitude 6^0 $33'$ East. Its mean annual rainfall is 1300 mm, taken from an exceptionally long record of 50 years. Temperature rarely falls below 22 ^oC; the peaks are 40 ^oC (February – March) and 35 ^oC (November – December). The rainy season starts in April and lasts between 190 and 200 days (9).

Preparation of water hyacinth meal

Water hyacinth meal was prepared using the procedure of (4). Whole green plants of water hyacinth were collected from the river surface by hand and canoe at Nkukuso village along Patigi Road, near Bida, Niger State, Nigeria. They were allowed to sun-dry for a few days at the river bank until they were properly dried. Extraneous materials such as stones, metal tins, nails and other materials were removed and then packaged in polythene sacks and transported to Minna for further processing. At the Animal Production Laboratory of the Federal University of Technology, Minna, the sundried plants were further separated from any foreign matter and oven dried at 80 ^{0}C for about 24 hours to a moisture content of less than 10 %. The dried plants were then milled with an attrition mill and sieved using a 2 mm sieve. The fine-grained, powdered products obtained were then stored in plastic containers with lid until needed for formulation of the experimental diets.

Experimental Diets

Experimental diets consisted of 0 % (Diet 1), 10 % (Diet 2), and 20 % (Diet 3) dietary inclusion levels of water hyacinth meal (WHM) with no exogenous enzymes added. The same Diets 1, 2 and 3 were then treated with exogenous enzymes (Maxigrain®) to form Diets 4, 5 and 6, respectively. Other ingredients were obtained at various feed ingredients depot within Minna metropolis. Table 1 shows the percentage composition of the experimental diets for cockerels at the chick phase.

Experimental Animals and Management

A total of two hundred and eighty-eight (288) day-old cockerel chicks of the Black Harco strain were purchased from Animal Care, along Okada Road, Minna, an agent of Avian Specialties, Minna. They were fed *ad libitum* with the experimental diets for nine weeks. Routine management operations such as daily removal of left-over uneaten feed, washing of drinkers, provision of clean drinking water and cleaning of the environment were carried out. A standard vaccination programme was followed strictly, as recommended by the Nigerian Veterinary Medical Association (NVMA) for this region; and medications such as antibiotics, coccidiostats and anti-stress were administered appropriately.

Determination of Blood Profile

Blood samples were collected from three birds per treatment for the evaluation of haematological characteristics and biochemical properties at the end of the 9th week of the experiment (after the feeding trial). The birds were starved of feed for 12 hours, but with unrestricted access to water before collection of blood through the wing vein using hypodermic syringes and needles. Blood collected were put inside two different bottles per bird. One of the bottles contained ethylene diamine tetra acetic acid (EDTA) to prevent blood coagulation (plasma) and the other contained no EDTA (serum). The samples were taken to the Veterinary Laboratory of the Ministry of Livestock and Fisheries Development, Minna for analysis. Determination of red blood cells count (RBC), leucocyte counts (WBC), haematocrit (PCV) and haemoglobin concentration (Hb) with absolute count of lymphocytes, monocytes, basophils and eosinophils were carried out using routine methods as described by (10). Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were then calculated using the formulae of (11). Serum samples were used in the determination of the biochemical parameters.

Determination of Economic Characteristics

Economic characteristics were determined using the procedure of (12). Cost of feed per kg were determined based on the prevailing market prices of the individual feed ingredients; total cost of feed consumed per animal were determined by multiplying the cost of feed per kg by the amount of feed consumed by an animal; while cost of feed consumed per kg weight gain were calculated by dividing the total cost of feed consumed by the total weight gain of an animal.

Statistical Analysis

Data collected were subjected to a one-way analysis of variance (ANOVA) according to the Completely Randomized Design (CRD) model using the SAS (2000) package based on a 2 × 3 factorial design. Where the means were significant, they were separated using the Duncan's Multiple Range Test as contained in the Package.

Results and Discussion

The proximate composition of the water hyacinth meal (WHM) is shown in Table 2. WHM has a high fibre (20.21 %), low protein (14.04 %) and high ash (25 %) content. These results are close to the values obtained by (4) on the average composition of WHM collected during the dry and rainy seasons from the River Niger at Lokoja, Kogi State, Nigeria. The authors obtained crude fibre content of 21.43 %, crude protein content of 13.88 % and ash content of 24.16 %. The composition of the experimental diets also meets the nutrient requirements of cockerel chicks as recommended by (13) and (14) for the tropical and subtropical regions.

The haematological profile of cockerels fed graded level of WHM shows that packed cell volume (PVC), white blood cell (WBC), red blood cell (RBC) and mean corpuscular haemoglobin concentration (MCHC) were significantly ($p<0.05$) higher for enzyme supplemented diets than for those diets without enzyme supplementation (Table 3). Birds fed 20 % level of WHM had significantly ($p<0.05$) higher RBC and WBC values than birds fed 10 % dietary inclusion level of WHM, indicating better enhancement of the haematological parameters of the birds at 20 % dietary inclusion level of WHM than at 10 %. However, there were no significant ($p>0.05$) differences between birds fed the 0, 10 and 20 % dietary inclusion levels of WHM in the values of Hb, PCV MCV, MCH and MCHC.

Of the biochemical indices determined (Table 4), total bilirubin (TBL) and conjugate bilirubin (CBL) were significantly ($p<0.05$) higher for the non-enzyme supplemented WHM diets than for the enzyme-supplemented WHM diets, while alkaline phosphatase (ALP), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were significantly ($p<0.05$) higher for the enzyme-supplemented WHM diets than for the non-enzyme supplemented WHM diets, indicating a better liver function with the enzyme suplementation. Since WHM is an energy and fibre source in poultry diets, its inclusion and supplementation with enzyme in this study seems to enhance the haematological and biochemical characteristics of cockerels. This finding is similar to the result obtained by (15) that increased consumption of dietary fibre improves serum lipid concentrations, improves blood glucose control, promotes regularity and appears to improve immune function by modulating various properties of the immune system. Blood examination has its tangible values in poultry rearing; it provides information on the assessment of poultry health (16). Haematological indices have been reported as a diagnostic tool to various illnesses in domestic animals (17). It can commonly be used to determine the body status and to assess the impact of environmental, nutritional and pathological stress.

Table 5 shows the effect of feeding graded levels of WHM and enzyme supplementation on the economic characteristics of cockerel chicks. Cost per kg feed were significantly ($p<0.05$) higher for the enzyme supplemented diets than for those without enzyme supplementation; while the cost per kg feed reduced significantly ($p<0.05$) as the dietary inclusion level of WHM increased from 0 to 20 %. On the overall, there were no significant ($p>0.05$) differences in cost per kg weight gain between birds fed the 0, 10 and 20 % WHM; but cost savings for 10 and 20 % dietary inclusion of WHM were ₦2.36 and ₦4.89, respectively. This is in agreement with the result of (18) who observed a decrease in the cost per kg feed and cost of feed per kg weight gain as the level of cassava meal supplemented with palm oil was increased as substitute for maize in broiler diets.

Conclusion and Application

1. WHM can be included up to 20 % in the diets of cockerel chicks, replacing 100 % of wheat offal, without any detrimental effect on their blood profile.
2. Inclusion of WHM resulted in reduced feed cost thus implying higher profit margin.

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Table 1: Gross composition of the experimental diets for cockerel chicks

Feed ingredients (%)	Without Enzyme			With Enzyme		
	0% WHM (Diet 1)	10% WHM (Diet 2)	20% WHM (Diet 3)	0% WHM (Diet 4)	10% WHM (Diet 5)	20% WHM (Diet 6)
Maize	45.39	45.39	45.39	45.39	45.39	45.39
Groundnut cake	25.11	25.11	25.11	25.11	25.11	25.11
Wheat offal	20.00	10.00	0.00	20.00	10.00	0.00
Water hyacinth meal	0.00	10.00	20.00	0.00	10.00	20.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00
Palm oil	1.00	1.00	1.00	1.00	1.00	1.00
L-Lysine	0.50	0.50	0.50	0.50	0.50	0.50
DL-Methionine	0.50	0.50	0.50	0.50	0.50	0.50
Bone meal	4.50	4.50	4.50	4.50	4.50	4.50
Limestone	0.50	0.50	0.50	0.50	0.50	0.50
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	100	100	100	100	100	100
Calculated Analysis						
Crude protein (%)	20.00	19.70	19.40	20.00	19.70	19.40
Metabolizable energy (Kcal/kg)	2707	2710	2713	2707	2710	2713
Crude fibre (%)	3.44	4.64	5.84	3.44	4.64	5.84
Lysine (%)	1.28	1.20	1.12	1.28	1.20	1.12
Methionine (%)	1.02	0.88	0.75	1.02	0.88	0.75
Calcium (%)	1.09	1.09	1.09	1.09	1.09	1.09
Phosphorus (%)	1.92	1.92	1.92	1.92	1.92	1.92

*Each 2.5 kg of the premix contained vitamin A, D_3, E, K_3, B_1, B_2, B_6, and B_{12} at 10,000,000 IU, 2,000.000 IU, 2,3000 mg, 2,000 mg, 1,800 mg, 5,500 mg, 3,000 mg, and 15,000 mg respectively. It contained niacin at 27,500 mg, pantothenic acid 7,500 mg, folic acid 750 mg, biotin 60 mg, chlorine chloride 300,000 mg, cobalt 200 mg, copper 3,000 mg, iodine 1,000 mg, iron 20,000 mg, manganese 40,000 mg, selenium 200 mg, zinc 30,000 mg and antioxidant with 1,250 mg. WHM = Water hyacinth meal

Table 2: Proximate composition of water hyacinth meal

Parameter	% composition
Dry matter	93.90
Crude protein	14.04
Crude fibre	20.21
Ether extract	5.00
Ash	25.00
Nitrogen free extract	29.65

Table 3: Effect of feeding graded levels of water hyacinth meal and exogenous enzyme supplementation on the haematological characteristics of cockerel chicks

Factors	HB	PCV	WBC	RBC	MCV	MCH	MCHC	N	M	L	E
Enzyme											
Without	5.38	15.96^{b}	1.92^{b}	1.78^{b}	89.22	29.33	32.39^{b}	60.22^{b}	0.16	38.11^{a}	0.10
With	5.58	16.84^{a}	3.34^{a}	1.91^{a}	87.89	29.67	33.12^{a}	66.22^{a}	0.13	31.11^{b}	0.67
SEM	0.11	0.28	0.88	0.02	0.71	0.46	0.13	1.47	0.03	1.37	0.03
LS	NS	*	**	*	NS	NS	*	*	NS	*	NS
WHM level											
0 %	5.50	16.35	2.77^{a}	1.85^{ab}	87.83	29.83	31.93	64.67^{a}	0.13	33.50^{a}	0.13
10 %	5.32	16.97	2.13^{b}	1.77^{b}	89.33	29.33	33.30	63.83^{a}	0.15	33.83^{a}	0.67
20 %	5.62	16.88	3.00^{a}	1.93^{a}	88.50	29.33	33.03	61.17^{a}	0.17	36.50^{a}	0.05
SEM	0.13	0.33	1.05	0.03	0.85	0.55	0.16	1.77	0.04	1.65	0.03
LS	NS	NS	**	*	NS	NS	NS	NS	NS	NS	NS
Interaction	NS	*	**	*	NS	NS	*	*	NS	*	NS

NS = Not significant, * = Significant at 5 % α-level, ** = Significant at 1 % α-level, SEM = standard error of means,
HB = haemoglobin, PVC = packed cell volume, WBC = white blood cells, RBC = red blood cells, MCV = mean corpuscular volume, MCH = mean corpuscular haemoglobin, MCHC = mean corpuscular haemoglobin concentration, E = eosinophils, N = neutrophils, M = monocytes, L = lymphocytes,

Table 4: Effect of feeding graded levels of water hyacinth meal and exogenous enzyme supplementation on the serum biochemical indices of cockerel chicks

Factors	AB	GB	TP	TBL	CBL	ALP	AST	ALT
Enzyme								
Without	4.76	2.34	7.10^{a}	10.62^{a}	5.16^{a}	47.12^{b}	20.30^{b}	47.70^{b}
With	4.76	1.84	6.60^{b}	9.70^{b}	4.64^{b}	55.67^{a}	24.80^{a}	51.90^{a}
SEM	0.04	0.04	0.05	0.14	0.11	0.52	0.57	0.61
LS	NS	NS	*	*	*	**	*	**
WHM level								
0 %	4.78	2.12	6.90^{a}	11.50^{a}	5.93^{a}	52.37^{a}	23.70^{a}	49.20^{b}
10 %	4.75	1.95	6.70^{b}	9.65^{b}	4.63^{b}	49.53^{b}	24.80^{a}	51.60^{a}
20 %	4.78	2.12	6.90^{a}	9.33^{b}	4.13^{c}	52.28^{a}	19.90^{b}	48.70^{b}
SEM	0.06	0.06	0.06	0.17	0.14	0.63	0.68	0.74
LS	NS	NS	*	*	*	**	*	**
Interaction	NS	NS	*	*	*	**	*	**

NS = Not significant, * = Significant at 5 % α-level, ** = Significant at 1 % α-level, SEM = standard error of means, TBL = total bilirubin level, CBL = conjugate bilirubin level, ALP = alkaline phosphatase, AST = aspartate aminotransferase, ALT = alanine aminotransferase, TP = total protein, AB = albumin, GB = globulin.

Table 5: Effect of feeding graded levels of water hyacinth meal and exogenous enzyme supplementation on the economic characteristics of cockerel chicks

Factors	Cost/kg feed (₦)	Cost of feed/kg weight gain (₦)	Cost savings (₦)
Enzymes			
Without	115.58[b]	495.16	3.80[a]
With	116.98[a]	540.72	1.34[b]
SEM	0.02	36.69	0.02
LS	*	NS	*
WHM level			
0 %	118.78[a]	506.04	-
10 %	115.98[b]	507.33	2.36[b]
20 %	112.78[c]	540.45	4.89[a]
SEM	0.02	44.03	0.02
LS	*	NS	*
Interaction	*	NS	*

NS = Not significant, * = significant at 5 % α-level, ** = significant at 5 % α-level
SEM = standard error of means