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Growth performance and nutrient digestibility of cockerels fed diets containing varying levels of water hyacinth [*Eichhornia crassipes* (Martius) Solms-Laubach] meal supplemented with exogenous enzymes

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Abstract

A six weeks' feeding trial was conducted on 288 two-weeks'-old Black Harco cockerel chicks to evaluate their growth performance when fed diets containing water hyacinth (Eichhornia crassipes) meal (WHM) at 0, 100, and 200 g//kg dietary inclusion levels, with no exogenous enzymes supplementation (Diet 1, Diet 2 and Diet 3 respectively) and then with exogenous enzymes (Maxigrain®) supplementation (Diet 4, Diet 5 and Diet 6 respectively); as a replacement for wheat offal (WO). The birds were randomly allocated to the six dietary treatments, with three replicates per diet and 16 chicks per replicate, and fed ad-libitum for six weeks. At the end of the feeding trial, three birds per replicate were randomly selected, removed from the floor and placed in metabolism cages for digestibility studies. They were kept in the cages for three days to enable them adjust adequately to the conditions in the cages, followed by faecal collection that lasted for four days. Results show that there were no significant (P>0.05) differences in initial body weight, final body weight, average body weight gain, total body weight gain, total feed intake, feed conversion ratio and protein efficiency ratio between birds fed 0, 10 and 20 % dietary inclusion levels of WHM. There were no significant (P>0.05) enzyme and water hyacinth level interactions for these parameters, indicating that exogenous enzymes addition did not significantly (P>0.05) affect feed intake, body weight gain and feed conversion ratio in cockerels fed WHM diets. Crude fibre digestibility decreased significantly (P<0.05) as the dietary WHM increased, indicating decreased utilization; while the exogenous enzymes addition increased the digestibility of the nutrients. It is therefore concluded that based on growth performance parameters, WHM can effectively replace WO 100 % in the diets of cockerels without exogenous enzymes addition; however, better nutrient digestibility are obtained when the WHM-based diets are treated with exogenous enzymes..

Key words: Water hyacinth meal, cockerels, exogenous enzymes, growth performance, nutrient digestibility.

Introduction

Poultry farmers in some parts of the world usually prefer cockerel farming due to low cost of day-old chicks; besides, cockerels require less floor space and feed and there is higher price for cockerel meat than that of broiler meat. It is also believed that cockerels are less susceptible to diseases in comparison to broilers (Sil *et al., 2002*).

Water hyacinth is a free floating perennial aquatic plant of *Eichhornia* genus in the *Pontederiaceae* family. It is native to tropical and sub-tropical South America, and is one of the fastest growing plants known; and are produced primarily by way of runners or stolons that form daughter plants. It grows profusely as a noxious aquatic weed, forming dense mats that can spread across water surface eventually choking an entire water body, if allowed to proliferate. It is the most invasive aquatic weed species known and have become a terror and a menace in many tropical and subtropical countries of the world, including Nigeria. Many international conferences and symposia have been held on its complete eradication and control, but not much success have been achieved practically; the weed continue to spread at an alarming rate. In fact, the presence of water hyacinth disrupts all life in the water (Center *et al.*, 1999), causing high evaporation rate and loss of water. Shoeb and Singh (2000) reported that under favourable conditions, water hyacinth

can achieve a growth rate of 17.5 metric tons per hectare per day.

It is estimated that about70-75 % of the cost of production is incurred in the procurement of feed and feed ingredients for poultry (Idowu *et al.*, 2005). To minimize this, there is an urgent need for animal scientists and feed nutritionists to address the high cost incurred on feeds and feed ingredients by sourcing for non-conventional feed ingredients that are cheaper and nutritive, and can replace the conventional ones Fortunately, water hyacinth plant, though a weed, has high nutritive values similar to high quality forage (Dung, 2001). According to Malik *et al.* (2014), water hyacinth meal (WHM) when compared to wheat offal (WO) has a higher CF content (21 % versus 11 %), lower CP content (14 % versus 16 %), higher ash content (24 % versus 6 %) and comparable ether extract (5 % versus 4 %) and metabolizable energy content (1901 Kcal/kg versus 1845 Kcal/kg). The challenge therefore is converting a weed of nuisance value in to a valuable feed resource for poultry, as a non-conventional feed ingredient.

Several exogenous enzymes have been used by different workers in nutrient utilization and retention studies for different categories of farm animals, especially when fed fibrous feedstuffs.

They have been used to increase the availability of nutrients by retarding the adverse effects of anti-nutritional factors present in feed components (Munir and Maqsood, 2013). Enzymes are added to animal ration with the goal of increasing its digestibility, removing anti-nutritional factors and improving nutrient availability; and a large number of carbohydrases, proteases, phytases and lipases are used for this purpose (McCleary, 2001). Therefore, the objective of this research study is to evaluate the growth performance and nutrient digestibility of cockerels fed diets containing varying levels of WHM (as a replacement for wheat offal) supplemented with exogenous enzymes at the chick phase.

Table 1 : Proximate composition of water hyacinth meal (WHM)

Parameter	Composition (g/kg)
Dry matter	949.00
Crude protein	144.10
Crude fibre	213.30
Ether extract	30.00
Ash	231.10
Nitrogen free extract	330.50

Materials and Methods

Preparation of Water Hyacinth Meal

Water hyacinth meal (WHM) was prepared using the procedure of Malik *et al.* (2014). Whole plants of water hyacinth were collected from the surface of the River Niger by hand and using local canoes at Nkukuso village, near Bida, in Lavun Local Government Area of Niger State. The harvested green plants were sun-dried for a few days at the river bank until they were properly dried. Foreign extraneous materials such as leather wastes, empty tin containers, iron materials and dried weeds were manually removed. They were then packaged in polythene sacks and transported to the Animal Production Laboratory of the Federal University of Technology, Minna, for further processing. In the lab, they were oven dried at a temperature of 80 °C for between 18 to 24 hours to a moisture content of less than 10 %. The dried samples were then milled with an attrition mill and sieved using a 2 mm sieve to obtain the water hyacinth meal (WHM); which was stored in plastic containers with tight-fitting lids until needed for use in formulating the experimental diets. Table 1 gives the proximate composition of the WHM.

Experimental Location

This Research Study was carried out at the Poultry Unit of the Animal Production Teaching and Research Farm, Federal University of Technology, 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° 37' North and Longitude 6° 33' East. Its mean annual rainfall is 1300 mm, taken from an exceptionally long record of 50 years. Temperature rarely falls below 22 °C; the peaks are 40 °C (February – March) and 35 °C (November – December). The rainy season starts in April and lasts between 190 and 200 days (2009-2013 Postgraduate School Prospectus, Federal University of Technology, Minna).

Experimental Diets

The experimental diets were formulated as follows: Diet 1, 2 and 3 contained 0, 100 and 200 g/kg dietary inclusion levels of WHM (replacing 0, 50 and 100 % wheat offal respectively) with no exogenous enzymes (Maxigrain®) added; while

Diet 4, 5 and 6 contained 0, 100 and 200 g/kg dietary inclusion levels of WHM (replacing 0, 50 and 100 % wheat offal respectively) with Maxigrain® added at the rate of 100 g per tonne of the mixed feed. Other feed ingredients used were purchased from Minna Central Market and from other feed ingredients depots within Minna metropolis. Table 2 shows the gross composition of the experimental diets (g/kg diet).

Experimental Animals and their Management

A total of 288 day-old *Black Harco* cockerels were obtained from Minna branch depot of Avian Specialties Limited, Ibadan. Before the arrival of the birds, the deep litter house was thoroughly washed and disinfected and the floor was covered with wood shaving up to 10 cm depth. Drinkers and feeders were set in place in the pens and sources of heat provided using stove and coal pot. The deep litter house was then covered with polythene sheets which provided adequate brooding environment for the birds (ambient temperature was about 32 °C). On the arrival of the chicks, the birds were unboxed and counted; and antibiotics, multivitamins, vitamin C and glucose were administered in their drinking water as anti-stress and source of energy to stimulate feed consumption. The birds were then fed with a commercial pullet chick mash for two weeks, after which they were weighed, before being introduced to the six different experimental diets. 48 birds were randomly selected and allotted to each treatment: with 16 birds per replicate and three replicates per treatment. They were fed for six weeks. During the course of the experiment, clean drinking water and fresh feed were supplied to the birds *ad libitum*. A standard vaccination programme was administered to the birds from day old till the end of the brooding period to ensure that the birds were immunized against major poultry diseases. Records of feeds intake, body weight gain, and left over feed were taken.

Table 2: Composition of the experimental diets (g/kg)

	Without enzymes			With enzymes		
WO replacement	**0%**	**50%**	**100%**	**0%**	**50%**	**100%**
Ingredients (g/kg)	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**	**Diet 6**
Maize	453.90	453.90	453.90	453.90	453.90	453.90
Groundnut cake	251.10	251.10	251.10	251.10	251.10	251.10
Wheat offal (WO)	200.00	100.00	0.00	200.00	100.00	0.00
Water hyacinth meal	0.00	00.00	200.00	0.00	100.00	200.00
Fish meal	20.00	20.00	20.00	20.00	20.00	20.00
Palm oil	10.00	10.00	10.00	10.00	10.00	10.00
Lysine	5.00	5.00	5.00	5.00	5.00	5.00
Methionine	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	45.00	45.00	45.00	45.00	45.00	45.00
Limestone	5.00	5.00	5.00	5.00	5.00	5.00
*Premix	2.50	2.50	2.50	2.50	2.50	2.50
Salt	2.50	2.50	2.50	2.50	2.50	2.50
Determined Analysis						
Dry matter	893.00	901.00	902.00	905.00	879.90	899.00
Crude protein	196.00	200.00	206.50	206.50	206.50	203.00
Crude fibre	60.00	86.70	93.30	60.00	80.00	86.70
Ether extract	160.00	155.00	145.00	165.00	165.00	160.00
Ash	105.00	100.00	126.70	100.00	100.00	111.50
Nitrogen free extracts	372.00	359.30	330.50	373.50	328.40	337.80

*Each 2.5 kg of premix is made of the following: Vitamin D_3, 10,000,000.00 IU; Vitamin E, 2,000,000.00 IU; Vitamin K_2, 23,000.00 mg; Vitamin K_3, 2,000.00 mg; Vitamin B_1, 1800.00 mg; Vitamin B_2, 5,500.00 mg; Niacin, 27,500.00 mg; Panthothenic acid, 7,500.00 mg; Vitamin B_6, 3,000.00 mg; Vitamin B_{12}, 15.00 mg; Folic acid, 750.00 mg; Biotin, 60.00 mg; Choride, 300,000 mg; Cobalt, 200.00 mg; Copper, 3,000.00 mg; Iodine, 1,000.00 mg; Iron, 20,000.00 mg; Manganese, 40,000.00 mg; Selenium, 200.00 mg; Zinc, 30,000.00 mg; Antioxidant, 1,250.00 mg.

Parameters Determined

The following parameters were determined using the procedures of Adesida *et al*. (2010). **Average feed intake** was obtained by subtracting the quantity of the left-over (uneaten) feed from the quantity of feed supplied to the birds per day. **Weekly body weight gain** was determined by subtracting the body weight of the birds in the preceding week from the body weight of the birds in the following week. **Feed conversion ratio (FCR)** was obtained by dividing the average feed intake per bird per week by the average body weight gain per bird per week for each treatment while protein efficiency ratio (PER) was determined by dividing the body weight gain by the birds by their protein intake.

Digestibility Studies

At the end of the six weeks' feeding trial, three birds per replicate and a total of nine birds per treatment, were randomly selected, removed from the floor and placed in metabolism cages for three days, for them to adjust to the conditions in the cages. Measured quantities of fresh feed were then given to the birds daily, while the droppings were collected 24 hours later (and for four days) using aluminum foils, based on the total collection method. Collected droppings were then oven-dried at 80 ^{0}C for 24 hours to get a constant weight. The oven dried faeces were then packaged in polythene bags and stored in plastic containers in a deep freezer until needed for analysis. Apparent digestibility of nutrients (ADN) was calculated using the formula described by Isikwenu *et al*. (2010) thus:

$$ADN = \frac{(\text{Nutrient intake}) - (\text{Nutrient in faeces voided}) \times 100}{\text{Nutrient intake}}$$

Total digestible nutrient (TDN) was calculated using the formula given by Church and Pond (1988) thus:

TDN = Digestible crude protein + Digestible NFE + 2.25 x Digestible ether extract

Chemical Analysis

The proximate composition of the water hyacinth meal (WHM), the experimental diets and the collected faecal droppings were determined using the procedures of AOAC (1990).

Statistical Analysis

Data obtained from this research study was subjected to a one-way analysis of variance (ANOVA) based on a 2 x 3 factorial model using the Statistical Analysis Software (SAS, 2000, Version 6). Where means were significant, they were separated using the Duncan Multiple Range Test (Duncan, 1955).

Results and Discussion

There were no significant ($P>0.05$) differences in initial body weight (IBW), final body weight (FBW), total body weight gain (TBWG), average body weight gain (ABWG), total feed intake (TFI), feed conversion ratio (FCR) and protein efficiency ratio (PER) between enzyme-supplemented and non-supplemented diets; and between 0, 100 and 200 g/kg dietary inclusion levels of WHM (Table 3). This result does not quite agree with the findings of Alam *et. al*. (2003) who reported that cockerels fed on enzymatic diets had a tendency to convert feed more efficiently to live weight than those without enzyme supplementation. However, according to an earlier study by Malik *et al*. (2014), the crude fibre component of WHM is made up of 24.60 % cellulose, 26.08 % hemicellulose and 12.86 % lignin; and has NDF and ADF values of 63.54 and 37.46 % respectively. Each gramme of Maxigrain® contains 10, 000 IU cellulase, 200 IU β-glucanase, 10, 000 IU xylanase and 2, 500 FTU phytase. This enzyme composition may not be very effective in degrading the high cellulose (24.60 %), high hemicellulose (26.08 %) and high lignin (12.86 %) fibre component of WHM at high dietary inclusion levels of WHM (100 and 200 g/kg diet) in cockerel diets, hence the non-significant difference in growth performance among the birds fed those diets.

In terms of nutrient digestibility, crude fibre and nitrogen free extracts were better utilized by cockerels fed the enzyme-supplemented diets than those fed diets without enzyme supplementation; while total digestible nutrient (TDN) was significantly ($P<0.05$) higher for birds fed diets with 0 g/kg WHM than birds fed the 100 and 200 g/kg WHM diets. This may be due to the fact that exogenous enzymes supplement the digestive enzymes of monogastric animals by aiding the breakdown of non-starch polysaccharides, protein and anti-nutritional factors thereby increasing their nutritional value by making available the nutrients to the birds (Chot, 2006; Giraldo *et al*., 2008). According to Buchanan *et al*. (2007), exogenous enzymes hydrolyze non-starch polysaccharides (NSPs)

Table 3: Main effects of exogenous enzymes supplementation and feeding graded levels of water hyacinth meal on the growth performance of cockerels

Treatment	IBW (g)	FBW (g)	TBWG (g)	ABWG (g)	TFI (g)	AFI (g)	FCR	PER
ENZYME (E)								
0	31.94	491.31	459.36	8.21	1922.00	34.32[a]	4.29	1.19
1	31.59	479.98	448.39	8.00	2073.00	37.02[b]	4.67	1.54
SEM	0.55	23.56	23.97	0.43	106.13	1.89	0.42	0.45
LOS (0.05)	NS	NS	NS	NS	NS	*	NS	NS
HYACINTH (H)								
0%	32.81	508.93	476.12	8.51	1969.30	35.17	4.26	1.22
10%	31.25	484.07	452.82	8.08	1968.30	35.15	4.38	1.17
20%	31.25	463.94	432.69	7.73	2054.90	36.69	4.79	1.72
SEM	0.67	28.85	29.35	0.52	129.95	2.32	0.61	0.55
LOS (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
INTERACTION								
E X H	NS	NS	NS	NS	NS	NS	NS	NS

[a b] Means in the same column with different superscripts were significantly ($p<0.05$) different

IBW (g/bird) = Initial body weight.
FBW (g/bird) = Final body weight.
TBWG (g/bird) = Total body weight gain
ABWG (g/bird/day) = Average body weight gain.
TFI (g/bird) =Total feed intake
AFI (g/bird) = Average feed intake.
FCR = Feed conversion ratio.
PER = Protein efficiency ratio
SEM = Standard error of means
LOS = Level of significance
NS = Not significantly different

Table 4: Main effects of exogenous enzymes supplementation and feeding graded levels of water hyacinth meal on the nutrient digestibility of cockerels (%)

Treatment	Dry matter	Crude Protein	Crude Fibre	Ether Extract	Ash	NFE	TDN
ENZYME (E)							
0	88.93	87.09	69.94[b]	96.01	90.16[a]	87.13[b]	81.42[b]
1	89.27	86.88	86.67[a]	96.71	80.70[b]	95.57[a]	86.52[a]
SEM	1.27	1.71	4.38	0.45	2.23	0.81	0.73
LOS (0.05)	NS	NS	*	NS	*	*	*
HYACINTH (H)							
0%	89.67	86.76	75.14	96.09	90.24	90.69	86.42[a]
10%	88.62	85.81	77.36	96.21	82.15	91.14	83.34[b]
20%	89.02	88.40	82.41	96.79	83.91	92.23	82.16[b]
SEM	1.55	2.10	5.37	0.56	2.73	0.99	0.89
LOS (0.05)	NS	NS	NS	NS	NS	NS	*
INTERACTION							
E X H	NS	NS	NS	NS	NS	NS	*

[a b] Means in the same column with different superscripts were significantly ($p<0.05$) different

SEM = Standard error of the means LOS = Level of significance NS = not significantly different
NFE = Nitrogen free extracts TDN = Total digestible nutrient

which might be potentially used by the animal, increasing the usage of feed energy, therefore increasing the digestibility of all nutrients.

Recommendations

It is therefore recommended that based on growth performance parameters, WHM can be included up to 200 g/kg in the diet of cockerels at the starter phase (effectively replacing wheat offal 100 % in the diets of cockerels) without exogenous enzymes addition. However, better nutrient digestibilities are obtained when the WHM-based diets are treated with exogenous enzymes from Maxigrain®.

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