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Nutrition and Health Status of African Catfish Fed Yellow Corn Waste Meal

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Abstract
A ten week feeding trial was conducted to investigate the growth performance, haematology and histology of African catfish (*Clarias gariepinus)* fed varying inclusion levels of yellow corn waste meal. A total of one hundred and eighty fingerlings were allotted to six diets with varying concentrations of yellow corn waste meal (0, 10, 20, 30, 40, and 50%). At the end of the feeding trial the growth performance were determined: The mean weight gain (MWG), average daily weight gain (ADWG), percentage daily weight gain (PDWG), specific growth rate (SGR), average feed intake (AFI), feed conversion ratio (FCR), protein intake (PI), protein efficiency ratio (PER), were significantly different ($p>0.05$). Highest MWG(13.29g), ADWG(6.19g), PWG(192.33%), SGR(1.54%/day, PER(1.57) and least FCR (1.59) were recorded in treatment 4 and the least MWG, ADWG,PWG,SGR (5.47g, 0.08g 79.05, 0.84) respectively and highest FCR(3.10)were observed in treatment 6. Hematological parameters such as packed cell volume (PCV), haemoglobin (HB), Red blood cell (RBC), white blood cell (WBC), mean corpuscular volume (MCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) recorded were all significantly ($P<0.05$) different.The highest PCV (37.60, 38.70, 38.30%) and RBC (2.74, 2.98, 3.05) were recorded in treatments 3, 4 and 6 respectively. The highest HB, WBC and lymphocyte count, (13.50g/dl, 154.20 and 59.08) respectively were recorded in treatment 6 respectively. Although, highest MCV (145.90fl) was recorded in treatment 3. The highest MCH (60.80, 63.63,) MCHC (53.80, 57.50) and Platelets (54.00,53.00) were recorded in treatment 1 and 2 respectively. The haematology results therefore, revealed that higher levels of YCWM in the diet of African cat fish did not degenerate to any disease in the blood Cellular rupture, aggregation of inflammatory cells, vacuolar degeneration in the hepatocyte, focal areas of necrosis and rupture of blood sinusoids that resulted in hemorrhage were characterized. Furthermore, histological examination of liver tissue revealed in plate E shows only a slight difference when compared with the liver tissue of the fish fed control diet in plate A, although little degeneration and presence of melanomacrophage. The histological result suggests that not more than 40% YCGM should be substituted with maize grain under the conditions tested in this study.Therefore, it can be concluded that maize can be replaced with YCWM at 40% inclusion levels in the diet of African catfish (*Clarias gariepinus*) without any deleterious effect.
Keywords: Maize, nutrition, haematology, histology and African cat fish

1. Introduction

Globally, aquaculture is considered to be the fastest growing sector than all other animal food producing sectors, with an average annual global growth rate of 8.8% per year since 1970, compare to only 1.2% for capture fisheries (FAO,2007) Aquaculture is been relied on as a source of food and income. African catfish (*Clarias gariepinus)* is widely known as the leading cultured fish in Nigeria due to some high quality characteristics possessed by the fish such as: high growth rate reaching market size of 1kgg in 5-6 month under intensive management conditions (Olaleye, 2005). African catfish is an important commercially valued fish for the Nigerian fishing industry and has been identified to contribute immensely to fish production in Nigeria (Ita, 1980). Also, it contributed 32% of the total production (Ayinla, 2007).

Feed is one of the major input in aquaculture production , however, it is quite unfortunate that fish feed technology is poorly developed particularly in Africa and other developing countries of the world therefore High cost of fish feed was observed as one of the problems hampering aqua cultural development in Nigeria (Gabriel *et al* 2007). Fish feed account for at least 60% of the total cost of production therefore this has motivated the research for local, cheap and wastes as alternative feed ingredients for *Clarias gariepinus* to reduce the cost of production without compromising the quality. Maize is a predominant crop of the world, about 30 percent of world production is used for direct human consumption and 70 percent as animal feed.

Corn waste meal is a by-product of the manufacture of maize starch by wet milling process (RFA, 2008). Corn waste meal is known to contain high level of gluten that is rich in protein feed, containing about 65%c.p (DM), used as a source of protein, energy and pigment for fish and other Livestock. Corn waste meal is particularly rich in yellow xanthophylls (between 200 and 500mg/kg DM) used for pigmentation (Blair, 2008; Combra, 2001). Therefore, this study investigate the level at which Yellow corn waste meal could replace maize in the diet of African catfish without deleterious effect.

2. .Materials and Method

2.1 Experimental Site

The study was conducted at the fishery unit of Ladoke Akintola University of Technology Teaching and Research farm, Ogbomoso, Oyo state.

2.2 Experimental Fish and Management

A total of one hundred and eighty (180) Clarias gariepinus fingerlings were procured from a reputable fish farm in Ogbomoso, Oyo state, Nigeria. The fingerlings were acclimatized for two (2) weeks in circular plastic tanks (70litres) and fed 2mm floating feed before the commencement of the experiment. After which they were fed 3% body weight of the experimental diets.

2.3 Collection and Processing of Yellow Corn Waste Meal

Yellow corn waste meal was collected as waste from pap vendors in Ogbomoso metropolis and it was sundried to a constant dry weight, after which it was grounded to powder and packed in an air tight nylons.

2.4 Experimental Diets

Six experimental diets were formulated using the following feed ingredients: yellow waste meal, wheat offal, soya bean mean, groundnut cake meal, fish meal, bone meal, mineral premix, salt and oyster shell. Yellow corn waste meal was included at different levels (0%, 10%, 20%, 30%, 40%, 50%) into the diets. The feed were made into pellets with the use of pelleting machine and sundried for three days to reduce the moisture content and to prevent deterioration. The feeds were packed and stored for use.

Table 1: Gross composition of the experimental diets

Parameters	Diet 1 (10%)	Diet 2 (10%)	Diet 3 (20%)	Diet 4 (30%)	Diet 5 (40%)	Diet 6 (50%)
Yellow Maize	19.97	17.97	15.98	13.98	11.98	9.98
Wheal Offal	9.98	9.98	9.98	9.98	9.98	9.98
Groundnut cake	16.65	16.65	16.65	16.65	16.65	16.65
Fish Meal	33.30	33.30	33.30	33.30	33.30	33.30
Yellow Gluten Meal	-	2.00	3.99	5.99	7.99	9.99
Soybean Meal	16.65	16.65	16.65	16.65	16.65	16.65
Bone Meal	1.40	1.40	1.40	1.40	1.40	1.40
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin premix	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.05	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100	100
Crude protein	40.00	40.05	40.10	40.15	40.20	40.25

2.5 Experimental Procedure

After acclimatization period, one hundred and fifty (150) African catfish fingerlings were randomly selected and assigned to six dietary groups at the rate of fifteen(15) fish per treatment in a completely randomized design. Each treatment was replicated twice .The fish were weighed to obtain t initial weight and subsequent weighing was carried out every 14days and the feeding rate was adjusted accordingly. The waste and uneaten feeds were siphoned off daily to clean tank and the water was replaced completely with aerated clean water every week.

The fish were fed experimental diets twice daily morning (8.00hrs) and evening(17.00hrs) for the period of ten weeks (70 days) and the weight changes were taken using a digital weighing scale.

2.6 Blood Collection

At the end of the feeding trial blood samples were collected from the fish (by cutting the caudal peduncle with a sharp blade) into a Ethylene Diamine Tetracetric Acid (EDTA) bottles and they were taken to the laboratory for the haematology test.

2.7 Data Collection

Data collected were weight gain (WG) and feed intake and other parameters such as mean weight gain (MWG),percentage mean weight gain(PMWG), average daily weight gain (ADWG), specific growth rate (SGR), average feed intake (AFI),feed conversion ratio (FCR) and protein efficiency ratio (PER) were calculated as follows:

Weight gain (WG)

$WG = W_2 - W_1$

Where: W_2 = final weight gain; W_1= initial weight gain
Mean weight gain (MWG): MWG = $W_2 - W_1$ / by no of fishes
Where: W_2 = final weight gain; W_1= initial weight gain
Percentage mean weight gain (PMWG): PMWG= MWG X 100/ initial weight
Average daily weight gain (ADWG): MWG/ no of days
Specific growth rate (SGR): SGR= log final body weight – log initial body weight/no of days X 100
Average Feed Intake (AFI): AFI= feed intake / no of days
Feed Conversion Ratio (FCR): FCR= Average Feed Intake (g)/ Mean weight gain (g)

The following haematological parameters were determined: Packed cell volume (PCV), White blood cell (WBC), Red blood cell (RBC), Haemoglobin concentration (HB), Mean corpuscular volume (MCV), Mean corpuscular Haemoglobin (MCH), Mean corpuscular Haemoglobin concentration (MCHC).

Packed Cell Volume (PCV)

Packed cell volume describes the volume that is occupied by a cell pellet after centrifugation. The haemotocrit body was filled three quarters with blood and the end sealed with crystal seal, the tube was then centrifuge in a micro-haemotocrit centrifuge for 5minutes at 200g. The PCV was determined using haemotocrit method (Dacie and Lewis, 1991).

White Blood Cell (WBC)

White blood cell was determined by making a bulk dilution of 1:20 and in a situation where the white blood cell are so numerous , 1:200 dilution is made using Turb's fluid. A counting chamber was prepared and fills by capillary attraction. It was allowed to settle and then observed under the microscope of x10 object. i.e. small squares 1mm x 1mm squares (four large corner squares).

Red Blood Cell (RBC)

The blood of fish was diluted in improved new baver pipette with formal centrifuge at 1:200. The pipette blood was introduced into a neubaner counting chamber and red blood cells counted under a microscope (Meyer *et al*., 1992).

Haemoglobin Concentration (Hb)

The Haemoglobin was determined using cyammethaenoglobin method; 0.02ml of blood was added to 5mls of reagent. After 30 minutes, the optical density was read calorimetrically at 540mm. The grams of haemoglobin per 100ml of blood were obtained from the calibration curve (Robert, 1978).

Mean Corpuscular Haemoglobin (MCH)

The haemoglobin content of a single red blood cell was calculated below as stated by Meyer *et al* (1992).
MCH=Haemoglobin (Hb) / Erythrocyte count X 100

Mean Corpuscular Haemoglobin Concentration (MCHC)

The mean corpuscular haemoglobin concentration was calculated below as stated by Meyer *etal*., (1992).
MCH= Haemoglobin concentration (g/100ml) / Packed cell volume (%) x 100

2.7 Chemical Analysis

The test ingredient, experimental diets and the fish carcass were analyzed for proximate composition using the method of A.O.A.C,(2000).

2.8 Statistical Analysis:

All data collected were subjected to one way Analysis of Variance (ANOVA) using Completely Randomized Design, SAS, 2000 package, and means were separated using Duncan Multiple Range Test (Duncan, 1955) of the same package

3. Results

The proximate composition of yellow corn waste meal is as shown in table 2 that revealed the crude protein (CP) content 11.53%. The CP content of the waste is higher than other chemical composition such as fats, fiber, and ash obtained with the following values of 1.61%, 7.77% and 0.64% respectively. It has shown that the composition could be tolerated by fish without adverse effects

The parameters observed on growth performance and nutrients utilization of African catfish (*Clarias gariepinus)* fingerlings fed varying levels (0,10, 20, 30, 40 %, and 50%) of yellow corn waste meal is as shown in table 3. The final weight gain (FWG), were not significantly different ($p>0.05$) in treatment 5 and 6 while treatments 1, 2, 3 and 4 were significantly different ($p<0.05$). The highest FWG 20.20g was recorded in treatment 4 while the least value of 12.31g was recorded in diet 6. The mean weight gain (MWG),were not significantly different in treatments 4 and 5 while treatments 1, 2, 3 and 6 were significantly different. The highest value of 13.29g was recorded in teatment 4 and the least value of 5.52g was recorded in treatment 5. The Average daily weight gain (ADWG), were not significantly different in all the treatments ($p>0.05$). The highest value of 0.19g was recorded in diet 4 while the least value of 0.08g was recorded in diets 5 and 6. The

percentage mean weight gain (PMWG), were significantly different in all diets ($p<0.05$). The highest value of 192.33g was recorded in diet 4 while the least value of 76.0g in diet 6. The specific growth ratio (SGR), were not significantly different ($p>0.05$) in diets 1, 2, 3 and 4 while they were significantly different ($p<0.05$) in diets 5 and 6. The highest of value 1.54g was recorded in diet 4 while the least value of 0.84g recorded in both diet 5 and 6. The Average feed intake (AFI), were not significantly different in all the diets ($p>0.05$), the highest value of 23.02g was recorded in diet 3 while the least value of 15.37g was recorded in diet 5. The Feed conversion ratio (FCR), were not significantly different in diets 2, 3 and 4 ($p>0.05$) while there were significant difference ($p<0.05$) in diets 1, 5 and 6. The highest value of 3.10g was recorded in diet 6 while the least value of 1.59g was recorded in diet 3. The protein intake (PI), were not significantly different in all the diets ($p>0.05$). The highest value of 9.20g was recorded in diet 3 while the least value of 6.15g was recorded in diet 5. The protein efficiency ratio (PER), were not significantly different in diets 2, 3 and 4 ($p>0.05$) while they were significantly different ($p>0.05$) in diets 1, 5 and 6. The highest value of 1.57g was recorded in diet 4 while the least value of 0.01 was recorded in diet 6.

The parameters observed on carcass composition at the beginning and at the end of the experimental trial were shown in table 5.

The haematology studies of the fish fed yellow corn gluten meal were shown in table 6. PCV, HB, RBC, WBC, MCV, MCH, MCHC, PLT, lymphocytes were significant ($P<0.05$).

PCV ranged from 1.93% in fish fed 0% to 38.30% in fish fed 50%. However, fish fed 20%, 30%, and 50% YCGM recorded the highest PCV (37.60%, 38.70%, 38.30%) respectively. Also, fish fed 0%, 10%, 40% recorded the least PCV (1.93%, 3.30%, and 2.57%).

Haemoglobin ranged from 1.40g/L to 13.80g/L in fish fed 0%, and 50%. Fish fed 50% recorded the highest HB content (13.80g/L) and the least HB contents (1.40g/L, 1.90g/L, 1.60g/L) were recorded in fish fed 0%, 10% and 40% YCGM respectively.

RBC ranged from 0.23 in fish fed 0% to 3.05 in 50%. Fish fed 20%, 30%, and 50% recorded the highest RBC count ($2.74 \times 10^{12}/_{L}$, $2.98 \times 10^{12}/_{L}$, and$3.05\times 10^{12}/_{L}$), while fish fed 0%, 10%, and 40% YCGM recorded the least RBC count($0.23 \times 10^{12}/_{L}$, $0.30 \times 10^{12}/_{L}$, and $0.25 \times 10^{12}/_{L}$).The least WBC($8.80 \times 10^{9}/_{L}$,$9.80 \times 10^{9}/_{L}$,$11.27 \times 10^{9}/_{L}$) was observed in fish fed 40%,0%, and10% respectivelywhile the highest value ($154.20 \times 10^{9}/_{L}$) was recorded in fish fed 50% YCWM.

Fish fed 20% YCGM had the highest MCV (145.90fL), while fish fed 10% had the least MCV (112.OOfL).

The highest value of MCH (64.67pg,63.63pg,60.80pg) was found in fish fed 40%, 10%, and 0% respectively, while the least value(43.50pg,42.60pg,45.23pg) was found in fish fed 20%, 30%, and 50%YCGM respectively.

Fish fed 20%, 30% and 50% YCGM had least MCHC (34.30g/L, 32.80g/L, and 36.00g/L) compared to Fish fed 10%, 40% and 0% YCGM that had highest MCHC (57.50g/L, 55.10g/L and 53.80g/L).

The highest platelets count ($54.00\times 10^{9}/_{L}$, $53.00\times 10^{9}/_{L}$) was recorded in fish fed 0%, 10% YCGM and. the least platelet count ($29.00\times 10^{9}/_{L}$) was recorded in fish fed 30%.

Fish fed 50% YCGM recorded the highest lymphocyte count(59.08%) and Fish fed 40% recorded the least lymphocyte count (12.10%).

Histology

The photo micrographic of the histopathology investigation of excised liver tissues of African catfish (*clarias gariepinus*) fed varying inclusion levels of yellow corn gluten meal (0%, 10%, 20%, 30%, 40%, and 50%) were presented in the plate A-F respectively. The alterations were observed in the liver tissues.

The liver of the fish fed control diets as shown in PLATE A has a continuous mass of hepatic cells, hepatocyte (H) and blood sinusoids (BS), the cords of hepatocyte and blood sinusoid are well arranged around the central vein (CV). The hepatocytes are in normal size, polygonal in shape with centrally located nuclei, the sinusoids are seen as communicating channels occupied by blood cell. The liver section of the fish after being fed 10% of yellow corn gluten meal revealed a patchy degeneration (D) around the parenchyma cells which was observed from the connective tissues, signs of congestion was also noticed around the blood sinusoids(BS), and melanomacrophage was also recorded in PLATE B. Changes that occurred is also reflected in liver of fish fed 20% of yellow corn gluten meal as shown in PLATE C, which revealed that the blood sinusoids (BS) were congested and also increase in the connective tissue which was demonstrated moving towards the central vein(CV), ruptured (R) hepatocyte was observed and necrosis (N) on the cell. Melano-macrophage (M), degeneration (D) and ruptured (R) hepatocyte and necrosis were recorded in the fish liver fed 30% of yellow corn gluten meal, also central vein (CV) was present and blood sinusoid (BS) were well formed as shown in PLATE D. In the liver of fish fed 40% of yellow corn gluten meal, less damage occurred, well generated blood sinusoid (BS) and central vein (CV), also little degeneration (D) in the hepatocyte and necrosis of some cells as shown in PLATE E. There was absence of nucleus, well generated blood sinusoids (BS) and hepatocyte (H),

presence of central vein (CV), melano-macrophage and parenchyma cells are not well formed, in liver of fish fed 50% of yellow corn gluten meal revealed in PLATE F.

Table: 2 Chemical Analysis Of The Test Ingredient (Yellow Corn Waste Meal)

Parameter	Percentage weight
Dry matter	85.73
Moisture	14.27
Crude protein	11.53
Crude Fiber	7.77
Fat	1.61
Ash	0.64

Table 3. Growth Performance and Nutrient Utilization Parameter of *Clarias gariepinus* Fingerlings Fed Varying Replacement Levels of Yellow Corn Waste Meal.

PARAMETERS	Treatments						SEM
	1	2	3	4	5	6	
IWG (g)	6.880	6.890	6.870	6.910	6.880	6.920	0.015
FWG (g)	13.880^{d}	18.150^{c}	19.800^{b}	20.200^{a}	12.400^{e}	12.390^{e}	0.811
MWG (g)	7.000^{d}	11.260^{c}	12.930^{b}	13.290^{a}	5.520^{e}	5.470^{e}	0.811
ADWG (g/day)	0.100^{a}	0.160^{a}	0.180^{a}	0.190^{a}	0.080^{a}	0.080^{a}	0.019
PMWG (%)	101.740^{e}	163.430^{d}	188.210^{b}	192.330^{a}	179.650^{c}	76.050^{f}	10.896
SGR(%/day)	1.000^{c}	1.390^{b}	1.510^{ab}	1.540^{a}	0.840^{d}	0.840^{d}	0.075
AFI(g)	15.880^{e}	19.400^{c}	23.020^{a}	21.100^{b}	15.370^{f}	16.950^{d}	0.679
FCR(g)	2.270^{c}	1.720^{de}	1.780^{d}	1.590^{e}	2.800^{b}	3.100^{a}	0.139
PI (%)	6.350^{e}	7.760^{c}	9.200^{a}	8.440^{b}	6.150^{f}	6.780^{d}	0.271
PER(g)	1.100^{c}	1.450^{ab}	1.410^{b}	1.570^{a}	0.890^{d}	0.010^{e}	0.129

a, b, c and d Mean within the same row with different superscripts differ significantly $p<0.05$
IWG-initial weight gain, FWG- final weight gain
MWG-mean weight gain, ADWG- average daily weight gain
PMWG-percentage mean weight gain, AFI- average feed intake
SGR-specific growth rate, FCR-feed conversion ratio
PI-protein intake, PER –protein efficiency ratio
SEM –standard error mean.

Table 4 Chemical Composition of Experimental Diets Fed to *Clarias gariepinus* Fingerlings

Components	Diet 1	Diet 2	Diet 3	Diet4	Diet 5	Diet 6	SEM
Dry matter	88.82^{b}	92.04^{a}	92.46^{a}	91.06^{a}	91.52^{a}	91.74^{a}	0.22
CP	40.00^{c}	40.05^{c}	40.10^{bc}	40.15^{b}	40.20^{a}	40.25^{a}	0.57
Ash	10.01^{c}	14.01^{b}	15.13^{ab}	14.80^{ab}	15.24^{ab}	15.50^{a}	0.25
EE	6.50	6.50	5.90	6.40	6.70	6.70	0.15
CF	3.40	3.53	3.30	3.20	3.32	3.40	0.73

Table 5 Carcass Composition of African Catfish *Clarias gariepinus* at the beginning and t he end of the Feeding Trials.

Parameters	Initial	T1	T2	T3	T3	T4	T5	SEM
Dry matter	90.11	90.07	89.69	90.09	89.77^{a}	89.76^{a}	89.66^{a}	0.19
CP	52.15^{d}	45.85^{f}	59.50^{a}	54.86^{c}	56.40^{b}	50.06^{e}	53.86^{c}	0.49
Ash	13.38^{ab}	14.11^{a}	13.16^{ab}	12.10^{b}	14.10^{a}	14.06^{a}	12.70^{ab}	0.21
E.E	5.60^{b}	7.86^{a}	7.86^{a}	7.80^{a}	7.70^{a}	8.10^{a}	8.10^{a}	0.19
C.F	3.30^{a}	0.06^{b}	0.06^{b}	0.06^{b}	0.05^{b}	0.05^{b}	0.06^{b}	0.12

a,b ,c and d. Mean within the same row with different superscripts differ significantly $p<0.05$
SEM : Stansdard Error of Mean

Table 6. Haematology of Africancatfish (*Clarias Gariepinus*) Fed Varying Levels of Yellow Corn Wastemeal.

PARAMETER	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
PCV (%)	1.93^{b}	3.30^{b}	37.60^{a}	38.70^{a}	2.57^{b}	38.30^{a}	4.33
HB (g/dl)	1.40^{c}	1.90^{c}	12.57^{b}	12.70^{b}	1.60^{c}	13.80^{a}	1.39
RBC (x10^{6}ul)	0.23^{b}	0.30^{b}	2.74^{a}	2.98^{a}	0.25^{b}	3.05^{a}	0.35
WBC (ul)	9.80^{d}	11.27^{d}	144.77^{c}	150.30^{b}	8.80^{d}	154.20^{a}	16.97
MCV (fl)	114.20^{cd}	112.00^{d}	145.90^{a}	129.87^{b}	116.80^{c}	126.10^{b}	2.85
MCH (pg)	60.80^{a}	63.63^{a}	43.50^{b}	42.60^{b}	64.67^{a}	45.23^{b}	2.40
MCHC(gm/100m)	53.80^{a}	57.50^{a}	34.30^{b}	32.80^{b}	55.10^{a}	36.00^{b}	2.62
PLATELETS	54.00^{a}	53.00^{a}	44.00^{c}	29.00^{d}	47.00^{bc}	49.00^{b}	2.06
LYMPHOCYTES	54.00^{ab}	53.80bc	50.50^{c}	57.80^{ab}	12.10^{d}	59.08^{a}	3.97

a, b, c, d means the superscript on the same row are significantly different (P<0.05)
WBC – White Blood Cell, HGB – Haemoglobin, RCB – Red Blood Cell,PCV – Packed Cell Volume, MCV – Mean Corpuscular Volume, MCH – Mean Corpuscular Haemoglobin, MCHC – Mean Corpuscular Haemoglobin Concentration, SEM – Standard Error Mean, T – Treatment.

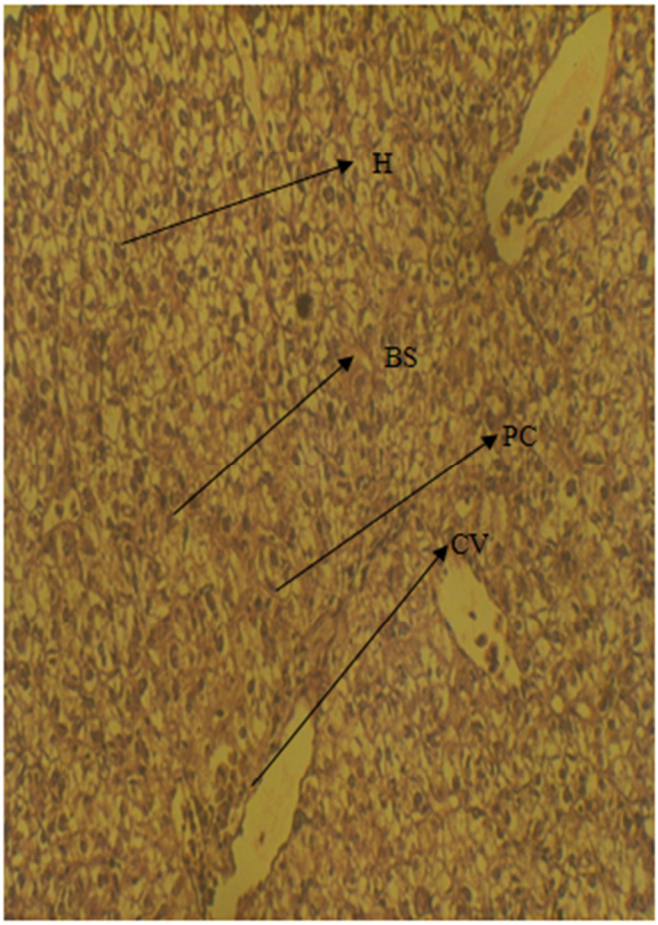

PLATE A: A section of the liver tissue of African catfish (*Clarias gariepinus*) fed control diet (0%) Mgx400
CV-(central vein), H-(hepatocyte), BS- (blood sinusoid), PC- parenchyma cells

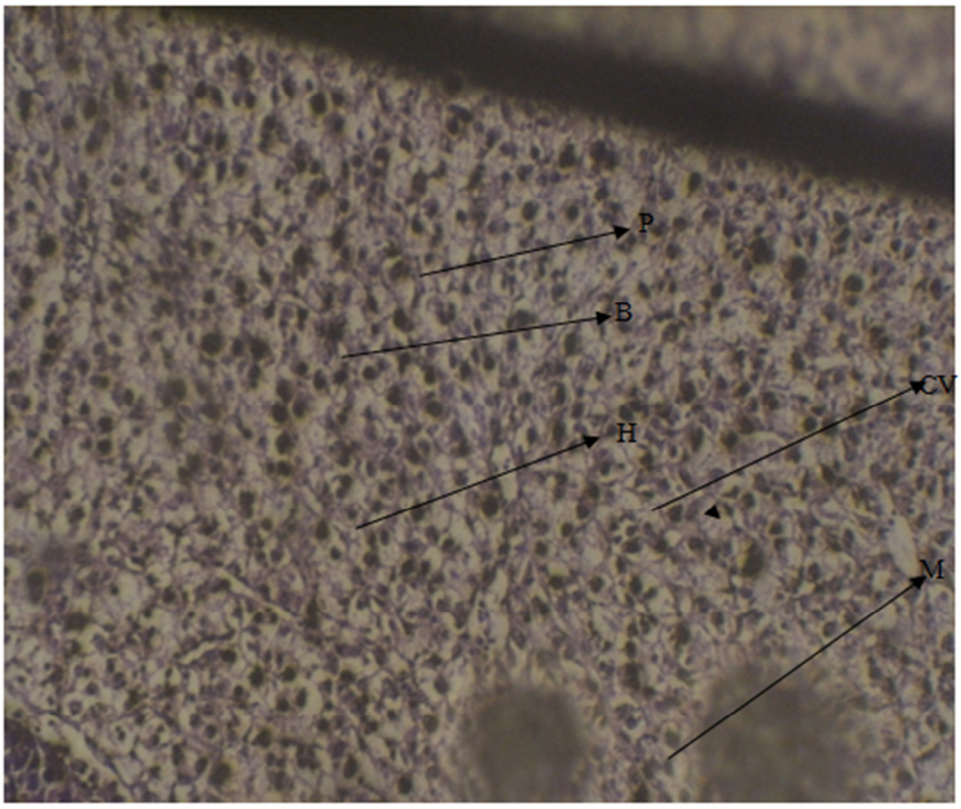

PLATE B: Section of the liver tissue of African catfish (*Clarias gariepinus*) fingerlings fed 10% of yellow corn waste meal (Magx400)
CV- (central vein), H- (hepatocyte), BS-(blood sinusoid), PC –(parenchyma cells), M-(melano-macrophage).

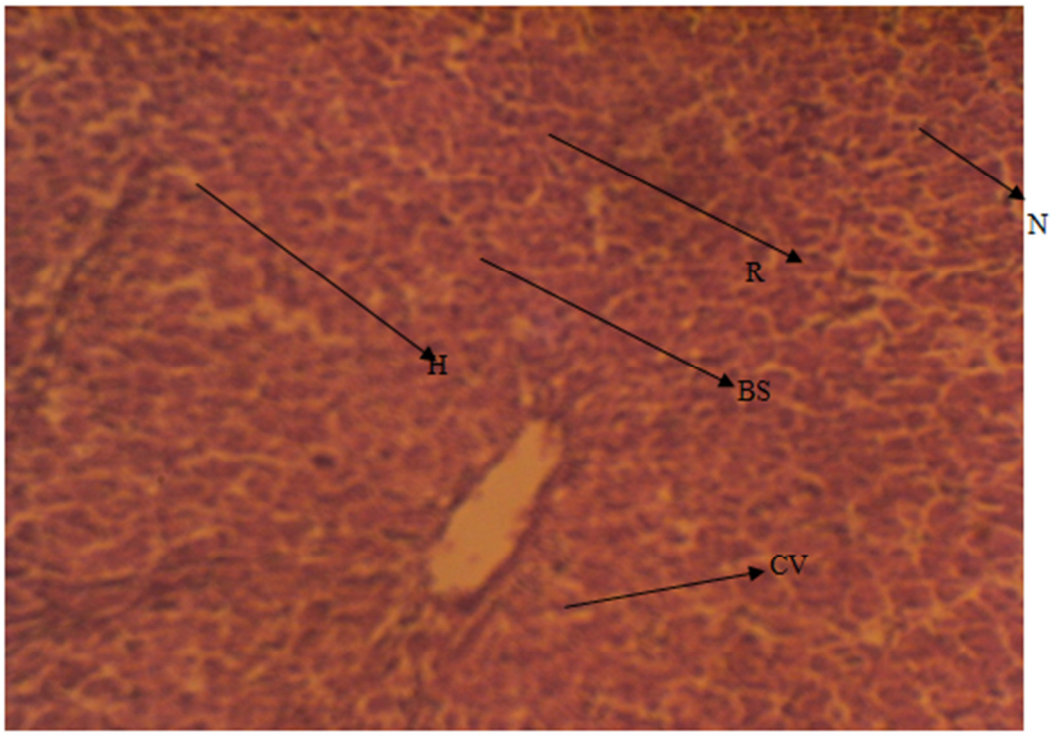

PLATE C: Section of the liver tissue African catfish (*Clarias gariepinus*) fingerlings fed 20% of yellow corn waste meal (Mag x 400)
CV- (central vein), H- (hepatocyte), BS-(blood sinusoid), R-(ruptured cells), N- (necrosis)

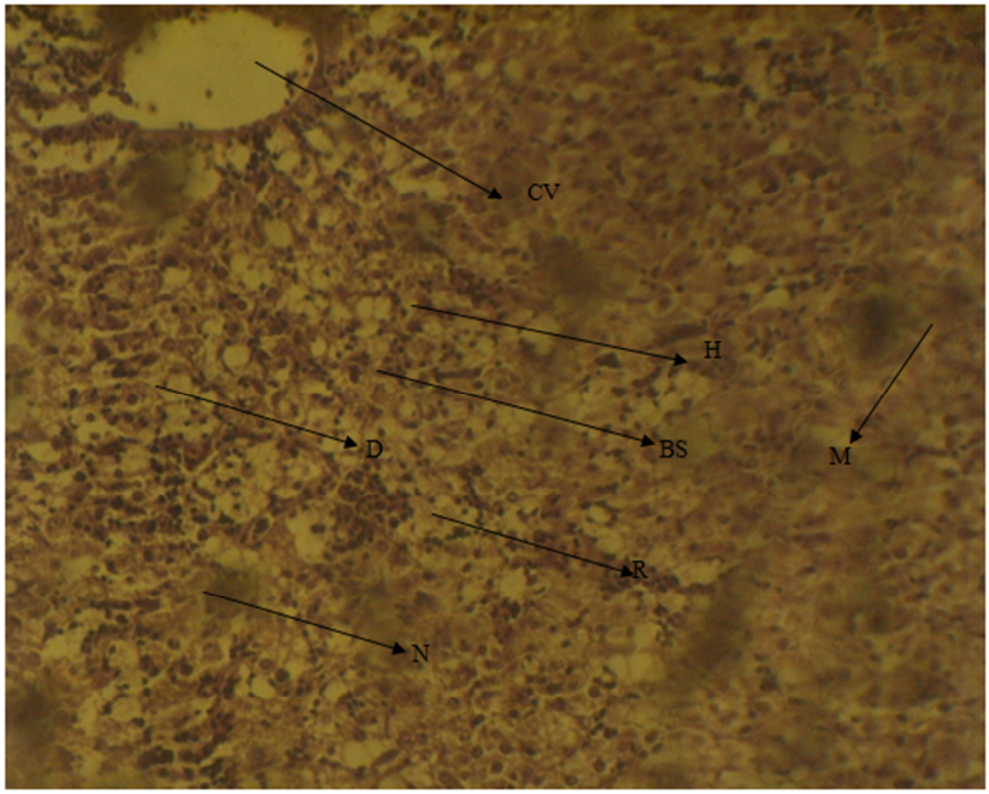

PLATE D: Section of the liver tissue of African cat fish (*Clarias gariepinus*) fingerlings fed 30% of yellow corn waste meal (Magx400)
CV- (central vein), H- (hepatocyte), BS-(blood sinusoid), R-(ruptured cells), N-(necrosis), D-(degeneration), M-(melano-macrophage.)

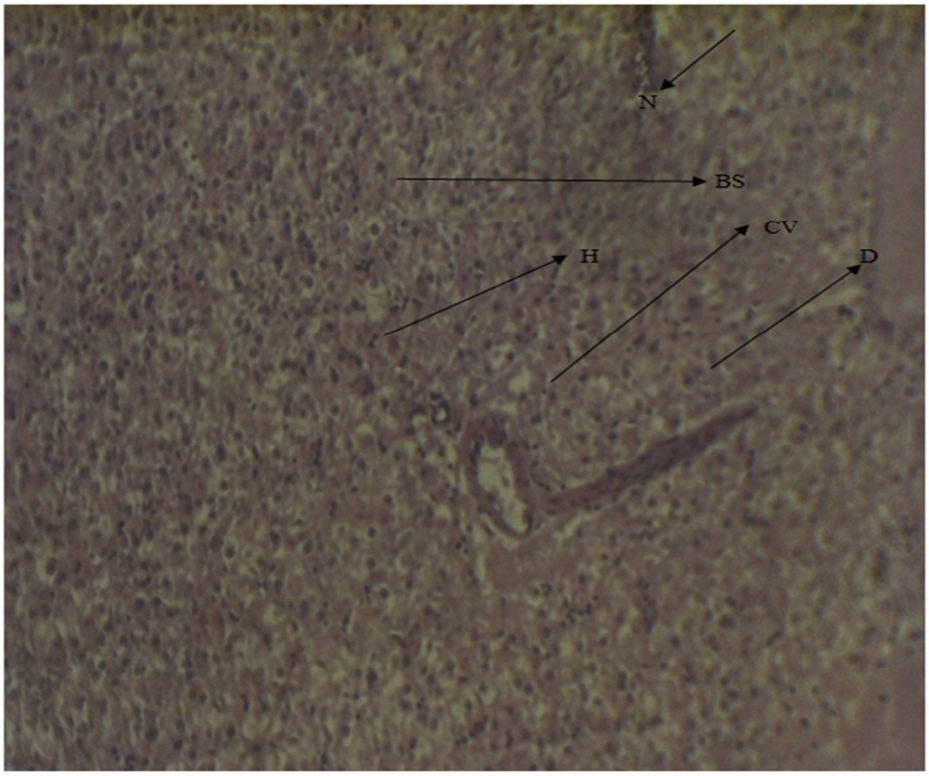

PLATE E: Section of the liver tissue of African catfish (*clarias gariepinus*) fingerlings fed 40% of yellow corn waste meal (Mag x 400)
CV- (central vein), H- (hepatocyte), BS-(blood sinusoid), N-(necrosis), D-(degeneration)

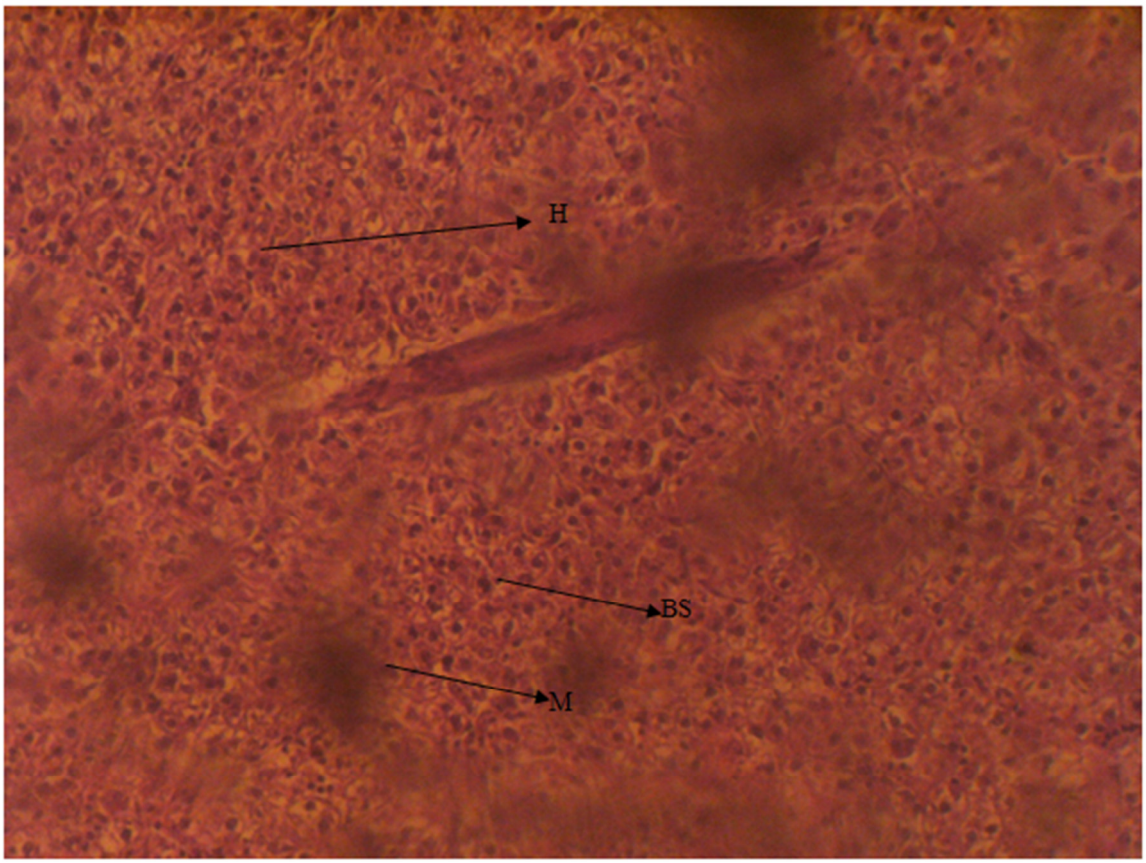

PLATE F: Section of the liver tissue of African catfish (*Clarias gariepinus*) fingerlings fed 50% of yellow corn waste meal (Mag x 400)
CV- (central vein), H- (hepatocyte), BS- (blood sinusoid), M-(melano-macrophage).

4. Discussion

4.1Chemical composition of yellow corn waste meal and experimental diets

The potential of feedstuff such as yellow corn waste meal can be evaluated mainly on the basis of its proximate composition, . The chemical composition of yellow corn waste meal in the present study revealed that the crude protein (CP) content was 11.53%. This value is higher than the value 6.00% to 7.00% reported by (leeson *et al.,* 2005), this is contrary to Gerpacio and Castilo (1979) who revealed the CP content as 8.30%. Crude fiber 1% according to leeson et al., 2005, and 3.80% for Gerpacio and Castilo (1979 The Experimental diets were shown in table 4 and observed to be isonitrogenous. And the Ether Extract were also the same among the treatments, meaning that they are isocaloric in nature.

4.2 Growth performance

Many researchers have extensively investigated the use of alternative energy sources to substitute maize grain in fish feed and also recommended waste meal levels of 20-25% (Alexs et al 1985) and even 40% (Morales 1993) in the diet for rainbow trout. The imbalance in protein composition observed(amino acid level) when corn waste meal is added to the diet may be as a result of its deficiency in lysine.

Furthermore, in relation to the present study, a decrease in growth rate was observed in the fish fed 40% of the corn waste meal upward. High fiber content in yellow corn waste meal may be responsible for the decrease in growth performance of the African cat fish fed yellow corn waste meal test diets

4.3 Haematology

From the haematology results of this study, it was recorded that fish fed 20% YCWM falls within the normal range (37%) of PCV, according to Adedeji et al., (2000).

HB has higher value compared with the normal value (10.62g/100ml) recorded by Osigwe *et al.,* who fed *Clarias gariepinus* with jack bean meal based diets but in agreement with findings of Adeyemo *et al.,* (1989) considered decreases in haemoglobin content as a contribution to haemodilution.

Fish fed 20% and 30% YCWM falls within the normal range (2.3-2.9 x10^6 u) of RBC describe for Catfish by Gabriel *et al.,* (2004). The reduced erythrocytes count revealed the possibility of haemolytic anaemia as stated

by Kelly (1974) due to toxic factors, infections, nutritional deficiency and metabolic disease.

There is marked increase in WBC count across the treatment compare with normal value (6.6 x 10^3u) recommended by Adedeji *e*t al., (2000). Increase in total WBC (leucocytosis) may be attributed to increase in production of leucocytes in the Haemotopoietic tissues in the kidney and perhaps the spleen.

Jain (1986) stated that the value of MCV can be used to determine the size of the cells. Although, the fish in all the six treatments recorded higher MCV (size of cells), compared with the normal range of MCV (37fL) stated by Adedeji *et al.,* (2000), and this showed that all the blood cells increases in size than normal. The increase in MCV may be attributed to the swelling of the erythrocytes resulting in macrocytic anaemia (RBC are larger than normal).

MCHC is a good indicator of RBC swelling (Wepener et al., 1992). Fish fed 50% YCWM falls within the normal range (37%) of MCHC, recommended by Adedeji *et al.*, (2000). The MCHC, which is the ratio of blood haemoglobin concentration as opposed to the haematocrit, is not influenced by the blood but can be interpreted incorrectly when new cells with a different haemoglobin concentration are released into blood circulation (soivio and Nikimmaa, 1981).

4.4 Histology

Histopathology alteration has been increasingly recognized as a valuable tool for the assessment of the impact of environmental pollutants on fishes (Heath, 1995; Teh *et al*., 1997). The liver is the vital organ for detoxification; the exposure alterations in the liver are associated with degenerated morphological changes (Arellano *et al.,* 1999), the changes in the liver were more evident in animals fed varying inclusion levels than the control.

The study exhibited severe damage in liver tissue of *Clarias gariepinus* including necrosis and decrease in cell number. In the present study, the liver cells borders disappeared and central vein becomes smaller as the test ingredient increases. It was observed that lesser damages occurred in the liver tissue of catfish fingerlings fed 40% of test ingredients as shown inplate E. Slight difference is observed when compared with normal (untreated) liver. Melano-macrophages are groupings of cells containing pigments that are generally found inside liver, kidney and spleen of fish, and in this study it was observed in PLATE B, PLATE D and PLATE F, which was as a result of inflammatory lesion as they may also develop with chronic inflammatory lesion, it increases in size and frequency in condition of liable biomarkers for water quality in terms of both deoxygenation and chemical pollution.

However these changes can be correlated to the altered behavioral responses and this study supports the observed histopathological lesions of liver tissues. Thus, yellow corn waste meal affects the physiologyl and histopathology of cat fish. In the present study, areas of necrosis and rupture in hepatocytes located in the liver tissues of fish fed higher levels of corn waste, are due to possible irreversible effects on fish health due to nutritional imbalances (Mosconi-Bac, 1990).

5. Conclusion

Highest performance was recorded in treatment 4, although, the haematology, revealed that higher levels of YCWM in the diet of African cat fish did not degenerate to any disease in the blood and histological result suggests that not more than 40% YCGM should be substituted with yellow corn waste meal in this study. Therefore, it can be concluded that maize can be replaced with YCWM at 40% inclusion levels in the diet of African catfish (*Clarias gariepinus*) without any deleterious effect

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