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Some Physiological Responses of the Catfish, *Clarias Gariepinus* (Burchell 1822) Fed Cassava (*Manihot Esculenta*) Peel and *Leucaena Leucocephala* Leaf Meal

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ABSTRACT

This study examined the physiological responses (hematology and enzyme characteristics) of *Clarias gariepinus* juveniles (mean weight $29.69 \pm 0.91\text{g}$) fed diets with varying levels of fermented cassava (*Manihot esculenta*) peel and *Leucaena leucocephala* leaf meal (CPLM), for a period of 10 weeks in the laboratory. Seven iso-caloric and iso-nitrogenous diets were formulated containing 0%, 20%, 30%, 40%, 50%, 60% and 70% CPLM maize replacements tagged diets D₀; D₂₀; D₃₀; D₄₀; D₅₀; D₆₀ and D₇₀ respectively.

The results showed that the final weight gain, DWG, PWG, FCR and PER of the fish fed diets diet D₀, D₂₀, D₃₀, D₄₀, D₅₀ were not significantly different ($P > 0.05$) from one another, but were significantly higher ($P < 0.05$) than those of the fish fed diets D₆₀. The SGR and survival were not significantly different ($P > 0.05$) from one another. The white blood cell (WBC) and lymphocytes ranged between $7.35\text{-}8.14 \times 10^3 \text{ mm}^{-3}$ and 63.00-72.00% respectively.

Keywords: proximate, disorders, glucanase, amylase, anti-nutrients, haematology.

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This study examined the physiological responses (hematology and enzyme characteristics) of *Clarias gariepinus* juveniles (mean weight 29.69 ± 0.91g) fed diets with varying levels of fermented cassava (*Manihot esculenta*) peel and *Leucaena leucocephala* leaf meal (CPLM), for a period of 10 weeks in the laboratory. Seven iso-caloric and iso-nitrogenous diets were formulated containing 0%, 20%, 30%, 40%, 50%, 60% and 70% CPLM maize replacements tagged diets D₀; D₂₀; D₃₀; D₄₀; D₅₀; D₆₀ and D₇₀ respectively.

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farmers especially in resource poor regions of the world can take advantage of this ingredient as a replacement for more expensive maize when formulating feed for fish in aquaculture.

Keywords: proximate, disorders, glucanase, amylase, anti-nutrients, haematology.

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I. INTRODUCTION

Feed is one of the major inputs in aquaculture production and fish feed technology is one of aquaculture least developed sectors of aquaculture, particularly in Africa and other developing countries of the world. FAO (1993) have emphasized the utmost importance of using local feed resources as the key driving force to increase the productivity of fish. High cost of fish feed was observed as one of the problems hampering aquaculture development in Nigeria (Adewumi, 2015). Expensive feeds will marginalize or even nullify the profitability of fish farming thereby incapacitating the expansion of farms to increase production resulting in the scarcity of the commodity (fish) and eventually high cost of the few available ones to the disadvantage of the consumers (Adikwu, 1992).

Cassava peel as a cheap carbohydrate source is capable of supplying adequate calories to *Clarias gariepinus* fingerlings/juvenile with improved

protein value, through fermentation with biomass from organic sources (Ijaiya, 2001). The starch in cassava is highly digestible when compared to that of maize due to the high content of amylopectin (Talthawan et al., 2002). However, cassava peel, as an energy component of the test diets contains some hydrogen cyanide (HCN) derivatives that have been shown to be toxic to livestock (McDonald et al., 1995) and therefore limits the use of cassava peels in the raw state, as feedstuff.

Phytate, found in cassava products binds with phosphorus in diets and render it non bio-available to any animal that is non-ruminant. Besides, phytate has also been reported to form complexes with proteins at both low and high pH values. These complex formations alter the protein structure, which may result in decreased protein solubility, enzymatic activity, and proteolytic digestibility. In order to prevent goitrogenetic and other neuropathological effect on animals, it will be necessary to process the peels before consumption.

Studies on the use of cassava meal in fish feed indicate that cassava can replace the conventional energy feed ingredients such as maize, broken rice and sorghum, which are commonly used in animal diet in most parts of Africa (Akinfala and Tewe, 2001). Cassava has been successfully used to replace maize in *Clarias gariepinus* fingerlings (Abu et al., 2010; Olukunle, 2006). Inclusion of whole cassava root meal in the diet of fish enhanced growth and survival. Though cassava is high in carbohydrate content, it is however low in protein content (Tewe and Egbunike, 2007) and has a very high crude fibre. Therefore, the need to fortify the peel with protein is necessary. *Glyricidia sepium* leaves have been chosen in this study to boost its protein value.

Hematological parameters are good indicators of physiological status of animals and have been found useful for disease prognosis and for therapeutic and feed stress monitoring (Togun et al., 2009; Aro and Akinmoegun (2012).

Hematological constituents reflect the physiological responsiveness of the animal to its internal and external environments which include

feeding. Hematological values could serve as baseline information for comparisons of nutrient deficiency. Haematological components of blood are also valuable in monitoring feed toxicity especially with feed constituents that affect the formation of blood in culture fisheries (Oyawoye and Ogunkunle, 1998). Animals with good blood composition are likely to show good performance (Isaac et al., 2013).

In view of the above, the present research was set up with the objective of determining the optimum replacement level of maize meal by fermented cassava peel meal (CPLM) and the effects on growth, haematology and digestive enzymes of *Clarias gariepinus*.

II. MATERIALS AND METHODS

2.1 Procurement of Materials

The study was carried out at the Animal House of the Department of Zoology and Environmental Biology, Ekiti State University (EKSU), Ado Ekiti, Ekiti State, Nigeria. Fresh cassava peels (2kg) were obtained from Aba Ebira, Iworoko Ekiti, Ekiti State, and fresh *Leucaena leucocephala* leaves (1kg) were harvested from the Department of Plant Science, EKSU, Ado-Ekiti. Fresh poultry dropping (1kg) was collected from a poultry farm in Iworoko Ekiti. A total of healthy, one hundred and eighty (180) samples of juvenile *C. gariepinus* (av. weight $29.69 \pm 0.91g$) were obtained from Mr. Olatunji's farm, Ibadan, Oyo State and transported, in an aerated container, to the Animal House of the Dept. of Zoology and Environmental Biology, EKSU, Ado-Ekiti.

2.2 Ingredients and Diet Preparation

Two kg of fresh cassava peel wastes collected were cut into small pieces of about 2cm² sizes. These were exposed to the sun for about 5hours, to wilt. The leucaena leaves were added to poultry droppings and mixed together with the cassava peels. These were packed into black polyvinyl bag, tied and left to ferment for 21 days. After 21 days, the mixture was spread out and sundried for four days after which it was milled, with a hammer mill, into powdery form, tagged fermented cassava peel meal (CPLM). The other feed

ingredients; maize, soya beans, 78% Danish fishmeal, ground nut oil, salt, fish premix, lysine and rice bran, were obtained from Metrovet Venture, Ado Ekiti. They were all in milled form, ready for use in feed formulation.

A 2g sample of the CPLM was taken to the lab for proximate analysis (moisture content, crude protein, ash, fibre, fat and carbohydrate) at the Central Science Laboratory of Federal University of Technology, Akure, Ondo state. Based on the crude protein content of the CPLM, seven diets containing different levels of the CPLM replacement for maize (0%, 20%, 30%, 40%, 50%, 60% and 70%) tagged D0, D20, D30, D40, D50, D60 and D70 respectively, were prepared, using Pearson's method (Table 1).

2.3 Experimental Set Up

The fish were acclimatized for 2 weeks in plastic aquarium tanks, supplied with clean water and fed with conventional commercial fish feed twice daily (8.00am - 9.00am) and (6.00-7.00pm), in order to adapt to the environmental condition before the commencement of the study. After 2 weeks of acclimatization, the fish were fed with the test diets for eight (8) weeks in each plastic bowls. Eighteen bowls were randomly allocated in triplicates, to six treatment diets, and the fish were randomly distributed into the bowls, at a stocking density of 15 juveniles per bowl. Feeding was carried out twice daily. The left-over feeds and faeces were siphoned off promptly and dead fish were promptly removed to prevent contamination.

Table 1: Composition of Experimental Diets (100-1dry Matter Basis) With Varying Inclusion Levels of Fermented Cassava Peel Meals (CPLM).

Ingredient	Diet						
	D0	D20	D30	D40	D50	D60	D70
Fish Meal	28	28	28	28	28	28	28
CPLM	0	3	6	9	12	15	18
Maize	30	27	24	21	18	15	12
Soybeans	19	19	19	19	19	19	19
Rice bran	20	20	20	20	20	20	20
Oil	1	1	1	1	1	1	1
Salt	1	1	1	1	1	1	1
Vit. premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lysine	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Methionine	0.2	0.2	0.2	0.2	0.2	0.2	0.2

2.3 Collection of Blood Samples

Blood samples of a set of three fish were collected at the beginning of the feeding trial (week 0) and at the end of trial (week 8) from each set in each bowl. This blood sample was withdrawn from the caudal peduncle, following the procedure described by Stockopf (1993), Joshi et al. (2000a) and Dienne and Olumuji (2014). Two ml of the blood sample from each fish was collected with 2ml syringe and needle and put in ethylenediamine tetra-acetic acid (EDTA) bottle. The samples were taken to the laboratory for hematological analysis which involves

measurement of erythrocyte values: Haemoglobin (Hb), estimated by cyanomethemoglobin method, red blood cells (RBC) and white blood cell (WBC) counted by Neubauer's improved haemocytometer, using Hyem's and Turks solution as a diluting fluid respectively. The absolute erythrocyte indices [mean corpuscular haemoglobin concentration (MCHC); mean corpuscular haemoglobin (MCH) and mean cell volume (MCV)] were calculated respectively using standard formula described by Dacie and Lewis (2001) as follows;

- $MCHC (\%) = \frac{Hb \times 10}{PCV}$
- $MCH (pg) = \frac{Hb \times 10}{RBC}$
- $MCV (fl) = \frac{PCV \times 10}{RBC}$

2.4 Crude Enzyme Preparation

Ten experimental fish from each sample collection were slaughtered and the gut regions of the fish were pooled, homogenized in an ice cold 20mM phosphate buffer pH 7.0 and the homogenates were centrifuged at 1200 rpm for 30 minutes at 40C. The supernatants were used as crude enzyme extracts without further purification. Benedict's qualitative reagents were used for the qualitative assay of glycosidases (carbohydrases) following the methods used by Fagbenro et al., (2005) and Olatunde et al. (1988). Glycosidases (maltase, cellulase, gluconase) were assayed in a reaction mixture containing 2.0 ml of phosphate buffer (pH 7.0), 0.4 ml of 1 % of substrate and 0.2 ml of the enzyme extract. The test and control samples were incubated for one hour in a water bath at 370C. Hydrolysis of polysaccharides and non-reducing disaccharides were determined in terms of the appearance of reducing properties using Benedict's reagents. An aliquot of 5.0 ml of the alkaline copper reagent of Benedict was added to 1.0 ml of the reaction mixture and heated for 30 minutes in a water bath at 1000C. The appearance of brick red to cream yellow precipitate was taken as an index of positive

reaction. Quantitative assays were conducted using the dinitrosalicylate (DNS) methods described by Plummer (1978). Each reaction mixture comprised 0.4 ml of 1% substrate, 0.2 ml phosphate buffer (pH 7.0), 1.6 ml of alkaline 3, 5-dinitrosalicylic acid reagent (DNSA) and 0.2 ml of the enzyme extract. The reaction mixtures for test and control samples were heated for 30 minutes in a water bath at 100C. Each of the mixtures was made to 4.0 ml by diluting with 1.6 ml distilled water. The amount of reducing sugars produced on enzymatic reaction was estimated colorimetrically and the absorbance read at 550 nm on a spectrophotometer.

2.5 Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA). Comparisons among diets means were carried out by Duncan Multiple Range Test (Duncan 1955) at a significant level of 0.05. All computation was performed using statistical package SPSS 15.0 (SPSS Inc., Chicago, IL, U.S.A).

III. RESULTS

Table 1 shows the percentage composition of the fermented and unfermented cassava peel meals respectively, while Table 2 shows the proximate compositions of the seven diets formulated for the feeding trial. The crude protein content of the diet ranged between 39.32 and 43.06%, crude lipid, 4.40-5.44% and crude fibre, 4.96-8.44%.

Table 1: The Proximate Composition (G/100g DM*) of Cassava Peels Used in Formulating the Experimental Diets

Parameter	Composition	
	Unfermented	Fermented
Crude protein	5.3	11.4
Lipid	1.2	3.5
Ash	5.9	6.3
Crude Fibre	20.9	7.1
Moisture	5.2	5.7
Carbohydrate	61.5	66.0

DM = dry matter

Table 2: The Proximate Composition of the Experimental Diets Fed to *C. Gariepinus*, During the Period of Study

INGREDIENTS	DIETS						
	Do	D20	D30	D40	D50	D60	D70
Crude protein	40.24	43.06	41.56	40.79	39.77	39.78	39.32
Moisture	9.96	7.31	8.13	7.76	7.08	7.13	8.25
Ether extract	5.17	5.08	5.41	5.44	4.55	4.57	4.40
Crude fiber	4.96	5.85	6.82	6.91	7.02	7.65	8.44
Ash	5.78	5.67	5.32	5.34	5.72	5.89	6.91
Nitrogen Free extract	33.89	33.03	32.76	33.76	35.86	34.98	32.68

NFE, Nitrogen free extract

Table 3 shows the hematological composition of fish fed with varying fermented cassava peel meal-based diet during the experiment. The Packed cell volume (PCV) results showed that the fish fed the control and D20 had increase in PCV values (32.00% and 30.00% respectively) when compared with the initial value. These values were not statistically significant ($p > 0.05$) from one another. The fish fed diets D30 to D60 showed a decrease in the PCV. White blood cells (WBC) result showed that fishes fed D30 to D60 had higher values than fishes fed control and D20 diets. The highest value of $8.02 \times 10^3 \text{ mm}^3$ was recorded in fish fed diet D70.

The red blood cell (RBC) showed a decrease as fermented cassava peel meal increased in the diet. The fish fed control diet and D20 recorded values of $3.60 \times 10^3 \text{ mm}^{-3}$ and $3.20 \times 10^3 \text{ mm}^{-3}$ respectively and were not significantly different ($P > 0.05$) from one another, but were significantly different from fish fed diet D30 to D60.

Hemoglobin (Hb) decreased in fishes fed diet containing D20 to D60. The fish fed the control diet and D20 recorded values of 9.20 g/100 ml and 9.00 g/100 ml respectively. These values showed a significant ($P < 0.05$) difference from fishes fed diet containing D30 to D60.

Lymphocyte (LYMPH) count showed an increase as the level of CPLM increased in the diet. The highest value of 70.00% was recorded in fish fed diet D60 and D70 and the least value of 63.00% was recorded in fish fed the control diet. The highest value (30.77%) for MCHC was recorded in fish fed diet D30 and the lowest value (28.75%) was obtained in fish fed the control diet. The results obtained for MCH and MCV showed that the fishes fed diet D50 had the highest values of 47.00 pg and 160.00 fl for MCH and MCV respectively and the least values of 25.56 pg and 88.89 fl were recorded for MCH and MCV in fish fed D20 diet.

Table 4: Hematological Composition of *Clarias Gariepinus* Juveniles Fed With Varying Levels of Fermented Cassava Peel Meal-Based Diet

Parameter	Do	D20	D30	D40	D50	D60	D70
PCV %	27.80 ^b	32.00 ^a	30.00 ^a	27.00 ^b	27.50 ^{ab}	24.00 ^c	24.00 ^c
WBC (10^3 mm^{-3})	7.20 ^c	7.45 ^{bc}	7.50 ^{bc}	7.60 ^b	7.60 ^b	8.00 ^a	8.02 ^a
RBC (10^6 mm^{-3})	2.80 ^b	3.60 ^a	3.20 ^a	2.00 ^b	1.90 ^b	1.70 ^b	1.50 ^{bc}
Hb (g/100ml)	8.00 ^b	9.20 ^a	9.00 ^a	8.10 ^b	8.00 ^b	7.00 ^c	7.05 ^b
LYMPH (%)	60.00 ^c	63.00 ^b	63.02 ^a	64.00 ^a	64.05 ^b	70.00 ^a	70.00 ^a
MCHC (%)	28.78 ^{ab}	28.75 ^{ab}	29.00 ^a	29.02 ^a	29.00 ^a	30.17 ^a	30.38 ^a
MCH (pg)	28.57 ^{cd}	25.56 ^d	28.13 ^{cd}	40.50 ^b	42.11 ^b	36.84 ^c	47.00 ^a
MCV (fl)	100.00 ^c	88.89 ^d	93.75 ^d	93.00 ^b	92.84 ^b	133.33 ^b	160.00 ^a

Figures on the same row having the same superscript are not significantly different ($p > 0.05$).

PVC = Packed cell volume; WBC = white blood cell; RBC = red blood cell; Hb = hemoglobin; LYMP = lymphocyte; MCHC=mean corpuscular hemoglobin concentration; MCH = mean

corpuseular hemoglobin; MCV=mean corpuseular volume.

Digestive enzyme assays in the gut of *Clarias gariepinus* (Table 3) indicated significant difference ($P < 0.05$) between the gut amylase activity of the fish fed the control diet and the other dietary treatments, with D60 showing the least activity. Sucrase activity increased with increase in CPLM level, while maltase activity was

not significantly different ($P = 0.05$) from one another. The glucanase activity of the fish fed the various diets was not significantly different ($P > 0.05$) from one another, but lower than the initial value. Cellulase activity decreased at lower CPLM level while there was no significant difference ($P > 0.05$) at higher level of CPLM inclusion.

Table 5: Sugar Degrading Enzyme Activity From the Gut (G) of Catfish (*Clarias Gariepinus*)

Diet	Amylase	Sucrase	Maltase	Glucanase	Cellulase
Initial	36.64 ^b	4.51 ^b	4.23 ^b	4.23 ^b	1.83 ^b
Do	70.47 ^a	7.26 ^a	4.82 ^b	4.64 ^a	2.92 ^a
D20	66.95 ^a	5.17 ^c	5.07 ^a	4.65 ^a	2.58 ^a
D30	42.58 ^a	12.47 ^a	4.59 ^a	4.19 ^a	1.76 ^{ab}
D40	41.58 ^a	10.86 ^a	4.52 ^a	4.19 ^a	2.04 ^{ab}
D50	37.53 ^a	14.29 ^a	4.86 ^{ab}	3.34 ^a	1.56 ^{ab}
D60	36.57 ^b	14.22 ^a	4.77 ^{ac}	1.01 ^a	1.00 ^{bc}
D70	33.54 ^b	15.12 ^a	5.01 ^{ac}	1.32 ^a	1.57 ^{bc}

Note: Samples with the same letter in a column are not significantly different at 5% level

IV. DISCUSSION

The potential of a feedstuff such as cassava peel and leaf meal in fish diets can be evaluated on the basis of its proximate chemical composition, which comprises the moisture content, crude protein, crude fibre, crude fat, total ash, carbohydrate and nitrogen free extract. The proximate composition of fermented cassava peel meal in the present investigation revealed that the crude protein content was 28.03%, crude fibre 18.87%, crude fat 2.25%, carbohydrate 48.00 and total ash 6.81%. These values as observed in this study fell within the range obtained by Sotolu, (2010). This confirmed the potential of fermented cassava peel meal as adequate animal feedstuff from nutritional point of view. A trial conducted by Oboh and Akindaunsi (2003) on the fermentation of cassava peels with a consortium of microorganism indicated a significant increase in protein content and digestibility of the microbially treated peels, as against the untreated control. The authors concluded that such fermented cassava by-product could be a good supplement in compounding animal feed.

Antai and Mbongo (1994) observed that fermentation of cassava peels by pure culture of

Saccharomyces cerevisiae could increase its protein content from 2.4% in non-fermented cassava to 14.1% in fermented products. They reported that fermented cassava flour, with *S. cerevisiae*, enhanced the protein level (from 4.4% to 10.9%) and decreased the amount of cyanide content (Oboh and Akindahunsi, 2005).

Noomhorm et al. (1992) reported that the conversion of a part of the starch in cassava root meal to protein by microbes, during the process of solid-state fermentation, has great potential as a means of improving the feed value of cassava root meal. As observed in this work, Adeyemi and Sipe (2004) also reported an improvement in crude protein concentration of cassava root when fermented with rumen filtrate with or without ammonium sulphate as the source of nitrogen.

Adeyemi et al. (2004) obtained a value of 237.8 % increase in the crude protein value of whole cassava root meal fermented with rumen filtrate using caged layer waste as source of nitrogen. Ubalua and Ezeronye (2008) have identified fermentation as one of the less expensive means of increasing the protein quality of cassava and cassava wastes. Dried products from roots, which have been fermented or ensiled to detoxify the

HCN or to increase their protein content, are other ways of root processing (Khajarerern and Khajarerern, 2007).

All the haematological parameters measured in this study were within the recommended physiological ranges reported for *C. gariepinus*. The change in the blood characteristics of *C. gariepinus* caused by stress due to exposure to environmental pollutants, diseases or by pathogens have been studied by a number of workers especially in capture fisheries (Onusiriku and Ufodiike, 2000; Ezeri, 2001; Gabriel et al., 2001).

Blaxhall and Daisley (1973) reported the essence of using haematocrit to detect anaemic condition in fishes. The packed cell volume (PCV) range 24.00 to 32.00% observed in this study is within the range of 20 to 50% reported by Pietse et al. (1981), though, a decrease was observed in the level of PCV as the level of CPLM increased in the diet. Reduction in the concentration of the PCV in the blood usually suggests the presence of toxic factor. The decreasing trend observed in the PCV of this study may be attributed to the presence of remnants of some anti-nutrients, such as some levels of hydrogen cyanide, tannin and mimosine in the fermented cassava peel meal as reported by Oboh and Akindahunsi (2003).

White blood cells (WBC) and lymphocytes results recorded in this study showed an increase as the level of CPLM increased in the diet. White blood cells (WBC) and lymphocytes are the defence cells of the body. Douglas and Jane (2010) demonstrated that the amount has implication in immune responses and the ability of the animal to fight infection. High WBC count is usually associated with microbial infection in the circulatory system (Oyawoye and Ogunkunle, 1998). The value range of 7.20×10^3 to 8.02×10^3 mm⁻³ recorded in this study for WBC was lower compared to 16.13×10^3 to 16.39×10^3 mm⁻³ reported by Sotolu and Faturoti (2009).

Reduction in the red blood cells was observed as the level of fermented cassava peel meal increased in the diet. The range of RBC (1.50×10^6 to 3.60×10^6 mm⁻³) recorded in this study is fairly

comparable with (1.70×10^6 to 4.00×10^6 mm⁻³) reported by Bhasker and Rao (1990) and lesser than (2.24×10^6 to 2.49×10^6 mm⁻³) reported by Sotolu and Faturoti (2009). The decrease in RBC could probably be due to the high concentration of anti-metabolites in the diet containing more fermented cassava peel meal.

The haemoglobin result showed a decrease as the CPLM increased in the diet. The haemoglobin range (7.00 – 9.20g/100ml) recorded were high and fell within the range (5.6 to 15.8 g/100 ml) reported for *Esox lucius* (Mulcahy, 1970). It also compared well with (8.70 g/100 ml) recorded for *C. gariepinus* (Sowunmi, 2003). These values were also higher than 4.46 g/100 ml reported for *Heterotis niloticus* (Fagbenro et al., 2000). The range of haemoglobin concentration recorded in this study is quite high and can be related to large anaerobic metabolism capacity of *C. gariepinus*. The decrease in the level of haemoglobin as CPLM increased in the diet could imply that diets having higher fermented cassava peel meal had negative effect on the blood.

The mean corpuscular volume (MCV) range (88.89 to 160.00 fl) recorded in this experiment was higher than (79.20 to 105.32fl) reported for *Heteroclaris* by Anyanwu et al. (2011), meanwhile the mean corpuscular haemoglobin concentration (MCHC) range (28.75 to 30.77%) recorded in this study compared fairly well with 30.70% reported for *C. gariepinus* from Asejire dam (Adedeji and Adegbile, 2011).

The MCH results showed that the fish fed diet D50 recorded the highest values. The MCH range (25.56 to 47.00 pg) obtained in this study was higher than the range (20.82 to 26.60 pg) reported for *Heteroclaris* fed *Carica papaya* leaf meal incorporated feed (Anyanwu et al., 2011). In recent years, good management practices have been advocated as effective ways of reducing stress in fish culture (Gabriel et al., 2007).

The enzymes present in the gut of the fish fed experimental diets were lower compared to the initial. The decreasing amylase activities in the fish, as the level of CPLM increases in the diets, can be explained by lower dietary lipid levels. As

reported here, Fountoulaki et al. (2005) also reported that in gilthead sea bream, amylase is affected by dietary fat level. Apata and Ojo (2000) suggested that the decrease in the effect of enzymes in the gut may be due to the change arising from the breaking down of high dietary fibre. *Clarias gariepinus* is physiologically equipped to cope with frequently and irregular meals as its digestive enzymes respond faster to feeding than those of eel (*Anguilla anguilla*) or carp (*Cyprinus carpio*) (Yalcin et al., 2001; Adeyemi et al., 2004).

From the above observations, it is evident that maize substitution with fermented cassava peel meal at a rate of up to 50% in catfish (*C. gariepinus*) fish feed have no adverse toxicological effect on the fish as revealed through the haematological indices and digestive enzyme assay. Essers et al., (1995) documented that 50% replacement of maize with cassava meal in broiler diet showed no depression in growth or unfavourable feed conversion ratio. This was also supported by Olurin et al. (2006) who reported a replacement level of 50% cassava meal for maize without a depressing growth in *Clarias gariepinus*.

V. CONCLUSION

These investigations have revealed that up to 50% substitution rate of fermented cassava peel meal for fishmeal in catfish (*C. gariepinus*) fish feed produces no adverse toxicological effect on the fish as revealed through the haematological and digestive enzyme indices. By fermentation method, fish feed can therefore be produced at relatively cheaper cost by the use of commonly available cassava peels thus increasing the profits to fish farmers.

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