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GROWTH AND HAEMATOLOGICAL RESPONSES OF *CLARIAS GARIEPINUS* JUVENILES FED DIETS CONTAINING VARYING DIGESTIBLE LIPIDS OF PLANT ORIGIN

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ABSTRACT: *This study was conducted to evaluate the growth and hematological responses of Clarias gariepinus juveniles fed diets containing different digestible lipids of plant origin. One hundred and eighty (180) juveniles (4.78±0.37g) were stocked using four treatments in three replicates. The experiment lasted for 10 weeks. Fish were fed at 5% body weight with four isonitrogenous diets (40% crude protein), with control diet without lipid supplement (D_1). Diets (D_2-D_4) contained Soya oil, palm kernel oil and groundnut oil respectively. Weight gain (WG), feed conversion ratio (FCR), protein efficiency ratio (PER) and specific growth rate (SGR) showed significant difference ($p<0.05$) among treatments. However, the highest WG was recorded in D_4 (10.69±0.97g) and lowest in fish fed D_1 (9.91±0.35g). FCR ranged between 1.69±0.17 in D_2 and 1.52±0.67 in D_4 respectively. Protein utilization showed no significant difference ($P>0.05$) in all treatments. There were significant differences ($P<0.05$) among hematological parameters analyzed such as PCV, WBC, RBC, Hb, MCHC, MCH, MCV. The highest cholesterol level was recorded in fish fed D_4 (1.67±0.81), while the lowest value was recorded in D_1 (1.10±0.80). Triglyceride was highest in D_3 (1.40±0.45) while the lowest value was recorded in the control D_1 (1.20±0.45) with no lipid inclusion. There was no significant difference ($P>0.05$) in the HDL and LDL value in all treatments. Hence, all hematological indices fall in the required range for Clarias gariepinus.*
KEYWORDS: growth, haematological responses, clarias gariepinus, juveniles, digestible lipids, plant origin.

INTRODUCTION

Food is a major requirement for all living organisms including fish for growth, reproduction and body maintenance (Al-Ogaily *et al*, 1996). In fish culture systems, the importance of feed cannot be over emphasized, since feed is the most expensive input in terms of cost in fish production. Nutritional requirement of fish is necessary in order to formulate an economical and nutritionally balanced diet for the fish (Solomon *et al.* 2012). To sustain fish under culture, supplementary diet must be provided to complement natural feeds supply (Karapan Agbottidis, 2002). Feed stuffs used in aquaculture to provide basic nutrients such as protein, carbohydrate, minerals, water, vitamins and lipids are expensive because of their competitive uses by man and other animals (Dunham *et al*., 2001). However, Carbohydrates (starch and sugars) are the most economical and inexpensive sources of energy for fish diets. Although not essential due to little energy requirement in fish, it is included to reduce feed cost and for their binding activity during feed manufacturing. Dietary starches are useful in the extrusion manufacture of floating feeds. Proteins are formed by linkage of individual amino acids. Protein on the other hand is the most expensive part of a fish feed which makes it important to accurately determine the protein requirements for each species and size of cultured fish. Vitamins are organic compounds necessary in the diet for normal fish growth and health. They often are not

synthesized by fish, and must be supplied in the diet, while Minerals are inorganic elements necessary in the diets for normal body functions.

Worldwide, natural vegetable or plant oil sources and fat are increasingly becoming important in nutrition and commercial feed production because of possession of high dietary energy, essential fatty acids, biofuels, anti-oxidants and raw-material for the manufacture of industrial products. (Okullo *et al*., 2010). Previous research have focused attention on the use of oil seeds such as groundnut oil, benniseed (sesame), shea butter oil, cotton seeds and palm oil as suitable substitutes in the diet of warm water fish species (Legendre *et al*., 1995; Ng *et al*., 2000; Ng *et al*., 2003; Ochang *et al*., 2007; Yusuf *et al* 2009; Aderolu and Akinremi, 2009; Solomon et al., 2012) and reported positive result.

Lipids are highly digestible source of concentrated energy and contain about 2.25 times as much energy as equivalent amount of carbohydrates (Robinson *et al*., 2001) and proteins (Sotolu, 2010). Lipids comprise about 15% fish diet and supply essential fatty acid (EFA) as well as serves as transport for fat soluble vitamins (Lim *et al*., 2001). It can be utilized to spare protein in aquaculture feeds (Craig, 2009). The protein sparing effect of lipids has been shown to be effective in several fish species (Solomon *et al* 2012). Lipids serve as important source of dietary energy for all fish. (Solomon *et al.*,2012). Studies have shown that providing energy using dietary lipids in fish diets minimizes the use of protein which is more expensive as energy source (Solomon *et al.,* 2012). The use of vegetable oil is cost effective in fish diets since fish oil is costly due to its high demand for both human and livestock's need (Adebayo, 2017). Although *Clarias gariepinus* can utilize carbohydrates efficiently, lipids are considered as important energy sources in catfish diets (Steffens, 1996). Carbohydrates improve the pelleting quality and nutrients value of diets while lipids play important physiological roles in providing energy, essential fatty acids and fat soluble nutrients for normal growth and development in fish (Lovell, 1998)

Although, increasing dietary lipids can lead to excessive fat deposition in the liver which can affect the health of fish and reduce market quality (Craig, 2009).Feed composition affects its utilization by fish and consequently the growth of fish (Adebayo, 2017). Diets containing high levels of lipids may affect fish growth negatively. It results to an imbalance of digestible energy to protein ratio in diets which may reduce feed consumption and poor utilization of feed stuff (Solomon *et al* 2012). On the other hand, fat-deficient diets may result in growth retardation and physiological disorders (De-Silva and Anderson, 1998). It is therefore important to get the proper lipid-energy ratio in diets for fish.

Clarias gariepinus (African catfish) is one of the most important fish species cultured in Nigeria. The Juveniles of this fish are widely produced in Nigeria (FAO, 2003). The species has shown considerable potential for use in intensive aquaculture because of its omnivorous feeding habit which allows them to feed on wide range of food materials, for example general supplemental feeds are obtained from Agricultural by-products (e.g. oil cakes, brans etc.) industrial residues (e.g. brewers wastes) animal by-products (e.g. blood meal, maggot meal etc.) and wastes (e.g. poultry droppings etc.). The most commonly practiced feed supplementation is the dispensation of ground feedstuff such as cereals brans and domestic left-over/kitchen waste to feed fish. Though these are known to enhance growth they may not be complete or balanced. Fishes fed on incomplete feeds will suffer deficiency diseases or symptoms attributable to lack of ingredients. Balanced/complete diets are formulated by combination of different essential nutrients in different proportions (Protein, Carbohydrate, lipids, Vitamins. Minerals) (De-Silva and Anderson, 1998).

Complete count of blood indices and plasma chemistry profile in haematology are important diagnostic tool for monitoring health status, detecting illness and following the progress of disease and response to therapy most especially, response to treatment after a feeding trial in fishes (Clauss, *et al* 2008).

Anti-oxidants is used in general sense to refer to any type of chemical agent which inhibits attack by oxygen or ozone (Emmanuel *et al.*, 2008). Most digestible lipids in feeds tend to encounter the problem of rancidity. This is a natural process of decomposition of fat by either hydrolysis or oxidation. The process of degradation converts fatty acids esters of oils into free fatty acids. This gives rise to an unpleasant odour and taste in food. These lipids degrade to the point of becoming either unpalatable or unhealthy to ingest (Saeed and Howell, 2002).

This research is designed to evaluate the growth performance of *Clarias gariepinus* juveniles fed with all-plant digestible lipids, and the effect on the hematology of the fish. The amount of non-carbohydrate energy source in fish diet is one of the factors influencing carbohydrate inclusion in feed formulation. Non-carbohydrate energy source such as plant source digestible lipids may be utilized as an energy source in fish diets where the carbohydrates energy ingredients such as maize are not readily available. From the nutritional point of view the use of protein as energy source is costly. It seems worthwhile to supply the required energy as possible as lipids rather than protein, and by reducing the proportion of protein in the diet. The reduction in the dietary protein requirement by increasing the level of dietary non protein energy is called protein sparing effect. The optimum level of dietary protein can be reduced with the inclusion of higher lipid in diets. However, the type and level of lipid in the diet are important factors to consider thereby avoiding undesirable high lipid inclusion in the fish diets, hence, the relevance of this paper which will be achieved with the objectives of determining the response of *Clarias gariepinus* juvenile raised on different digestible lipids from plant sources, supplemented with anti-oxidant on growth and haematological indices.

MATERIALS AND METHODS

Experimental procedure

The experimental study was conducted at the Department of Fisheries and Aquaculture management research farm under the Faculty of Agricultural sciences, Ekiti State University, Ado Ekiti, Ekiti State, Nigeria. Prior to the commencement of the experiment, 180 juveniles of *Clarias gariepinus* juveniles of average initial mean weight of 4.82±0.28 were procured from Kay Fish Farm in Ado-Ekiti, the fish juveniles were acclimatized in transparent plastics for a period of two weeks at the experimental site. During acclimatization, the fish were fed with 1.5mm Durante feed. The fish was randomly stocked at the rate of 15 per tank in three replicates according to the number of diets including the control. The experiment lasted for 10 weeks.

Experimental Diets

The dietary ingredients for the experiment include fishmeal, soybean meal, maize, vitamin Premix, mineral premix, salt and vitamin E (antioxidant). Four different diets were compounded, each containing at least one plant-source digestible lipid except the control, the various digestible lipids for each treatment includes; groundnut oil, soy oil and palm kernel oil. The gross composition of the experimental diets is shown in Table 1. All the diets contain the same proportion of feed ingredients except that each diet contains different plant-source oils. The diets were all isonitrogenous (40%CP). In preparing the diet the two protein sources was included in the ratio of 2:1. Dry ingredients were ground to a powdery form to aid assimilation by fish using a gasolin driven grinding machine in Ado Ekiti. The diets were thoroughly mixed with each digestible lipid, Vitamin E antioxidant was added to

the feed at 400ppm i.e. 400mg/kg. The dough was pelleted using a locally fabricated pelleting machine with a 2.0mm die. Diets were immediately sun dried and later broken mechanically into small sizes and packed in a

INGREDIENTS	DIETS			
	D1	D2	D3	D4
FISH MEAL(FM)	28.39	18.39	18.39	18.39
SOY BEAN MEAL	36.77	36.77	36.77	36.77
YELLOW CORN	30.34	30.34	30.34	30.34
GROUNDNUT OIL	--------	10	-------	-------
PALM KERNEL OIL	--------	-------	10	-------
SOY OIL	--------	------	------	10
VITAMIN PREMIX	2	2	2	2
MINERAL PREMIX	2	2	2	2
SALT	0.5	0.5	0.5	0.5
TOTAL	100	100	100	100

labelled air tight containers. Each diet was formulated to last for three (3) months to maintain good quality.

Table 1: Gross composition of experimental diets fed to *Clarias gariepinus* (%)

Fish were fed to satiation twice daily in two equal installments between 08:00 -10:00 and 16:00 – 18:00 for 70 days while the weights of the experimental fish were measured bi-weekly to calculate their response using Electronic scale (kerro blc20001). Water was monitored closely and changed every other day to allow freshness and to maintain good water quality for the period experiment lasted. Left over feed was siphoned out on daily basis to reduce water pollution. $_{P}$H values of the water during feeding were measured directly by electronic $_{P}$H meter by dipping the electrode into each tanks. Dissolved oxygen was measured using a standardized YSI Do meter (YSI model). Temperature was measured using thermometer calibrated from $0^{o}C$ – $110^{o}C$ on daily basis. This was done by gently immersing the thermometer into the water at vertical position and left for about 2-5 minutes. It was quickly moved near the surface of the water and read.

Growth and nutrient utilization parameters

Growth performance and feed conversion were measured in terms of final individual fish weight, Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), and Net Protein Utilization (NPU). Growth response was calculated;

Growth and nutrient utilization parameters

$$\textbf{SGR (\%)} = \frac{(\text{Log } W_t - \text{Log } W_i) \times 100}{\frac{T}{1}}$$

Where W_t is the final weight of the fish at time (t), W_i is initial weight of the fish at time 0, and T is the culture period in days.

FCR (%) = Total dry feed fed (g) / Total weight gain (g)

PER (%) = Net weight gain (g) / Amount of protein fed (g)

NPU (%) = Protein gain × 100 / Protein consumed (AOAC, 2005)

Chemical analysis

Samples of the experimental diets, fish carcass (before and after the experiment) in all the treatments were analyzed for proximate composition parameters namely: moisture content, crude protein, crude fat, crude fiber, ash, and carbohydrate according to the method of AOAC (2005).

Statistical analysis

Data obtained (Mean Weight Gain, SGR, FCR, PER, and NPU) from the feeding trial and haematological result obtained were subjected to one way Analysis of variance (ANOVA) using SPSS. Differences in significant means were separated using Duncan Multiple Range Test at 5% level of probability.

Haematological Analysis

5-10ml blood samples were collected from cardiac puncture using 2ml disposable heparinized syringe treated with EDTA as anti-coagulant.

Blood cell count

Haematocytometer was used in blood cell count. The blood diluting fluid was prepared as Svobodova *et al.* (1991). The blood cells were counted on the counting chamber of haemocytomter with the aid of compound microscope:

RBC= No of cells counted ×3×10×200 ($10^6 mm^3$)

Haemoglobin estimation:

Haemoglobinometer was used for haemoglobin estimation based on acid haematin method (SAHLI).

Packed cell volume (PCV):

The packed cell volume was measured after placing sealed micro-haematocrit tube in a centrifuge at 10,500 rpm using micro-haemtocrit reader and expressed as percentage.

Erythrocyte sedimentation rate (ESR):

ESR was determined the procedures of Svobodova *et al* (1991). The volume of ESR with the given time interval is the difference between 100% and the percentage part presented by the corpuscle volume.

Mean corpuscular volume (MCV):

MCV was calculated from the haematocrit value (PCV, % and the Erythrocyte count (Er mm^3)

Mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular haemoglobin (MCH):

MCHC and MCH were calculated according to the formulae given by Dacie and Lewis (2001).

To calculate the MCHC, expressed as gram of haemoglobin per 100ml packed cell

$$\textbf{MCHC} = \frac{\text{Haemoglobin (g/100ml)} \times 100}{\text{Haematocrit (\%)}}$$

To calculate the MCV, expressed in femtolitres (fl or 10-15L)

$$\textbf{MCV} = \frac{\text{Haemocrit (\%)} \times 10}{\text{RBC count (millions/L blood)}}$$

To calculate the MCH, expressed in pictograms (pg)

$$\textbf{MCH} = \frac{\text{Haemoglobin (g/100ml)} \times 10}{\text{RBC count (millions/L blood)}}$$

Cholesterol and triglyceride test:
Cholesterol and Triglycerides was also determined using enzymatic colometric test.

RESULTS

Proximate composition of experimental diets

The proximate composition of Experimental diets fed to *C. gariepinus* juveniles are presented in Table 2. Moisture content of the experimental diets ranged between 6.35% in D1 and 8.14% in D3.The Lipid content ranged between 11.93% in D1 and 20.71% in D2 while the ash content ranged between 6.20% in D4 and D3 (7.20%). Protein content was within the formulated 40% CP diets, and ranged between approximately 40.38% in D4 to 40.86% in D3. Crude fibre value was highest in D2 (2.24%) and lowest in D1 (4.12%).

Table 2: **Proximate composition of experimental diets (%)**

Parameters	**Diets**			
	D1	**D2**	**D3**	**D4**
Moisture	6.35	7.54	8.14	7.62
Ash	6.50	7.20	7.30	6.90
Crude fibre	4.12	2.83	2.24	3.37
Crude Protein	41.65	41.36	40.86	40.38
Lipid content	12.93	19.51	18.10	19.09
NFE	28.55	21.24	23.36	22.64
TOTAL	100	100	100	100

NFE, Nitrogen Free Extract

Water Quality Parameters

Water quality parameters in the experimental tanks during the experimental period are presented in Table 3. The values observed were within the tolerant range of *C. gariepinus*. The ^{P}H was between 6.5 -7.8; Dissolved Oxygen ranged between 5.60mg/l – 6.54mg/l and Temperature 25^0C – 26^0C.

Table 3: **Range values for physico-chemical parameters during the experimental period**

Treatments	T^{O}C	pH	DO (mg/l)
D1	25±0.50	7.0±0.15	5.9±0.05
D2	25±0.60	7.0±0.00	5.8±0.09
D3	25±0.70	7.0±0.15	5.7±0.03
D4	25±0.00	7.0±0.30	5.7±0.05

Key: T^{O}C= Temperature, DO= Dissolved Oxygen

Growth parameters of *Clarias gariepinus* fed with different experimental diets

From the result in table 4, there was no significant difference (P>0.05) in the Initial Body Weight in all treatments. Treatment fed D1 and D2 also showed no significant difference (P>0.05) in Weight Gain. Treatment fed D3 and D4 also showed no significant difference (P>0.05) but D1 and D2 (9.91±0.35and 9.93±0.70 respectively) showed significant difference (P<0.05) compared D3 and D4 (10.43±0.82and 10.69±0.97 respectively). Feed conversion ratio showed a significant difference (P<0.05) in the treatments which value was highest in treatment fed D2 (1.69±0.17) and lowest in treatment fed D4 (1.52±0.67). D4 and D3 shared a close FCR margin which is not significantly different (P>0.05) from each other. Protein Efficiency Ratio showed no significant difference (P>0.05) in all treatment fed diets, the highest value was recorded in D4 (0.43±0.88) and lowest in treatment fed D1 (0.40±0.50). The specific growth rate value was significantly different in all treatments (P<0.05) except in D3 and D4 which are not significantly different (P>0.05) where the highest SGR value (1.70±0.46 and 1.70±0.70) was recorded and the lowest value was recorded in D2.

Table 4**: Growth parameters of *Clarias gariepinus* fed diets with different experimental diets**

Parameters	Diets			
	D1	**D2**	**D3**	**D4**
IBW	4.40±0.33	4.78±0.37	4.58±0.41	4.65±0.46
FBW	14.31±0.28^{c}	14.71±0.34^{b}	14.98±0.59^{b}	15.35±0.92^{a}
WG	9.91±0.35^{b}	9.93±0.70^{b}	10.43±0.82^{a}	10.69±0.97^{a}
FCR	1.56±0.43^{b}	1.69±0.17^{a}	1.54±0.50^{c}	1.52±0.67^{c}
PER	0.40±0.50^{a}	0.40±0.59^{a}	0.41±0.37^{a}	0.43±0.88^{a}
SGR	1.69±0.45^{b}	1.61±0.59^{c}	1.70±0.46^{a}	1.70±0.70^{a}

IBW, Initial Body Weight; FBW, Final Body Weight; WG, Weight Gained; FCR, Feed Conversion Ratio; PER, Protein Efficiency Ratio; SGR, Specific Growth Ratio.
**Different alphabets in the same row show significance difference at p<0.05

Carcass composition of experimental fish before and after feeding trial

The initial and final whole body composition of experimental fish is presented in Table 5. Moisture content was not significantly different (P>0.05) in all treatments. Compared to the initial value which was 6.26±0.11, it was observed that fish fed D3 had the highest moisture content (6.43±0.15) which was closely followed by fish fed D1 (6.33±0.12) while the lowest value was observed in fish fed D2 (6.18±0.04). However, D4 recorded the highest Crude protein (63.52±1.35) while the lowest in fish

fed D3 (61.48±0.13). The Ether Extract was recorded with the highest value in treatment fed D4 (6.99±0.04) and lowest in treatment fed D1 (4.89±0.46). Ash content was significantly different all treatments (P>0.05) with value which ranged 6.16±0.20 in D3 and 5.81±0.06 in D1 which is slightly higher than the initial value before feeding trial.

Table 5: **Carcass composition of experimental fish before and after feeding trial (%)**

Parameters	**CP%**	**EE%**	**CF%**	**%NFE**	**%Ash**	**%Moisture content.**
Initial	59.05±0.49^{d}	5.29^{c}±0.12^{c}	0.03±0.01	23.86±0.47^{a}	5.49±0.01^{e}	6.28±0.11
D1	61.99±0.16^{b}	4.89±0.46^{c}	0.03±0.01	20.96±0.11^{b}	5.81±0.06^{c}	6.33±0.12
D2	61.47±0.12^{c}	5.91±0.04^{b}	0.06±0.01	20.40±0.36^{c}	5.72±0.21^{d}	5.96±0.04
D3	61.48±0.13^{c}	6.30±0.35^{b}	0.06±0.04	19.62±0.09^{d}	6.16±0.20^{a}	6.43±0.15
D4	63.52±1.35^{a}	6.99±0.04^{a}	0.06±0.04	18.37±0.17^{d}	5.89±0.07^{b}	6.18±0.04

CP, Crude protein; EE, Ether extract, CF, Crude Fibre, NFE, Nitrogen Free Extract;
**Different alphabets in the same row show significance difference at p<0.05

Haematological parameters of *Clarias gariepinus* fed diets containing different levels of all-plant digestible lipids.

Table 6 shows there was significant difference (P<0.05) observed for all haematological parameters analyzed across the treatment fed diets. The highest cholesterol level was recorded in fish fed D4 (1.67±0.81), while the lowest value was recorded in the treatment control D1 (1.10±0.80). Triglyceride was highest in D3 with palm kennel oil inclusion (1.40±0.45) while the lowest value was recorded in the control D1 (1.20±0.45) with no lipid inclusion. There was significant difference (P<0.05) in the HDL and LDL value in all treatments.

Table 6**: Haematological parameters of *Clarias gariepinus* fed diets containing different plant based digestible lipids.**

Blood Parameters of Experimental treatments (Diets)	**D1**	**D2**	**D3**	**D4**
HB(g dl^{-1})	11.53±0.003^{d}	11.05±0.018^{b}	11.52±0.020^{a}	10.03±0.006^{c}
PCV (%)	34±0.069^{b}	32±0.006^{d}	31±0.007^{c}	30±0.099^{a}
RBC(x10^{6}/µl)	3.47±0.021^{b}	3.6±0.007^{d}	2.9±0.200^{c}	2.8±.624^{a}
MCV(fl)	98.67±0.224^{a}	89±0.181^{b}	106±0.082^{c}	107±0.081^{d}
MCH(pg)	33.42±0.122^{d}	30.74±0.196^{c}	39.62±0.487^{a}	36.04±0.433^{b}
MCHC(g l^{-1})	34.01±0.229^{c}	34.57±0.865^{a}	37.2±0.624^{b}	33.51±0.209^{d}
WBC(x10^{3}/µl)	3.1±0.059^{c}	3.62±0.032^{d}	3.5±0.099^{b}	3.69±0.209^{a}
TCH(Mmol/L**)**	1.10±0.80^{c}	1.52±0.80^{b}	1.66±0.80^{a}	1.67±0.81^{a}
TRI(Mmol/L**)**	1.20±0.45^{c}	1.33±0.45^{b}	1.40±0.45^{a}	1.39±0.45^{a}
HDL(Mmol/L**)**	0.13±0.80^{a}	0.16±0.80^{a}	0.15±0.80^{a}	0.14±0.80^{a}
LDL(Mmol/L**)**	0.40±0.38^{c}	0.46±0.38^{c}	0.32±0.38^{c}	0.35±0.38^{c}

Key: PCV (Packed cell volume); WBC (white blood cell); RBC (red blood cell); Hb (haemoglobin); MCHC (mean corpuscular haemoglobin concentration); MCH (mean corpuscular haemoglobin); MCV (mean corpuscular volume), TCH (total cholesterol), TRI-triglycerides, HDL (high density lipoprotein), LDL (low density lipoprotein), Mmol/L (mini mole per litre)×88.5 ≡ mg/dl.
**Different alphabets in the same row show significance difference at $p<0.05$

DISCUSSION

Use of plant lipid sources in the production of aqua-feed has been a welcome development for the development of the aquaculture industry over decades (Sotolu 2010). Recent studies have revealed that substantial use of vegetable oils as energy sources in fish diets have yielded positive growth response in fish (Babalola and Adebayo 2007; Aderolu and Akinremi 2009).

The result of this study indicates that the juveniles of *Clarias gariepinus* fed the four lipid based diets responded well to the diets in terms of growth and feed utilization as there was no significant difference ($P>0.05$) in all growth parameters measured across the experimental diets. This result is similar to the result reported by Sotolu (2010) for *Clarias gariepi*nus fed fish oil, sesame seed oil, groundnut oil, soybean oil and palm oil based diets, where all diets formulated were adequately consumed and SGR was marginally different among the treatments. This agrees with the reported work of Al-owefeir and Belal (1996), that diet fed *Oreochromis niloticus* containing groundnut oil were comparable in weight gain to those fed palm oil diet and palm oil could replace Soya bean oil in the same vein without negatively effecting fish growth and body composition. Rosenlund *et al*., 2001 and Bell *et al*., 2002.

The improvement in feed conversion ratio FCR with increasing high lipid level in both ingredients tested is in agreement with other studies (Einen and Roem 1997; Weatherup *et al*. 1997; Pie *et al*. 2004). The decrease in protein efficiency ratio PER with increasing high lipid level in both ingredients tested agreed with earlier studies, Peres and Oliva-Teles (1999) did not observe any protein sparing effect of lipid when they fed European *Zea bass* on graded levels of dietary lipid. It could also be inferred that the level of oil being tested is not enough to cause any protein sparing effect. Increased

PER could probably be that increased lipid level spared dietary protein conversion into energy (Chou and Shiau, 1996). Lim *et al.* (2001) explained that there is a definite influence of a non-protein source of energy (lipid or carbohydrate) on the nitrogen retention and that dietary lipid may also influence the growth performance and protein utilization.

The proximate composition of the experimental diets is shown in Table 2. The protein content in different diets varied according to their original formulation. The level of lipid, NFE and crude fibre contents in different diets also varied due to variation in amount of ingredients included in diets for keeping the protein and energy contents at desired levels. Water quality parameter values were within the optimum recommended range for culture of *Clarias gariepinus* (Ajani *et al*., 2011).

Fish haematology is gaining increasing importance in fish culture because of its importance in monitoring the health status of fish (Hrubec *et al,*. 2000). Haematological characteristics of most fish have been studied with the aim of establishing normal value range and any deviation from it may indicate a disturbance in the physiological process (Rainza-paiva *et al*., 2000).

. The values obtained in this experiment for both the PCV and Hb were within the normal ranges recommended for *Clarias gariepinus* (Sunmonu, 2008 and Adedeji and Agbede, 2009). The Haemaglobin values are much higher than those obtained by Subhadra *et al*. (2006) for the largemouth bass with diets containing canola oil, chicken oil and menhaden fish oil, which ranged between 3.7-3.9g dl. All the values recorded in this study were within the acceptable range of a healthy juvenile catfish (Oyelese *et al*., 1999). The RBC count which ranged between 2.8 – 3.42 x10^6/mm3 is slightly above the range of (2.3 - 2.9 x 10^6) and (1.5 x 106/mm3) described for catfish Adeyemo *et al*. (2003). The value obtained was below the value of 3.50 ± 0.35 x 106/µl reported when ethanoic extracts of *Garcinia kola* seeds were fed to *Clarias gariepinus* broodstock by Dada and Ikuerowo (2009). The haemoglobin concentration ranged between 10.03-11.53g/dl. These values were slightly above the highest value of 9.60g/100ml recorded by Omitoyin (2007) for African catfish juvenile fed poultry litter and 10.62g/100ml reported by Osuigwe *et al*. (2005) who fed *Clarias gariepinus* with Jackbean meal based diets but in agreement with findings of Adeyemo *et al.* (2003). The packed cell volume (PVC) was highest in the control group (34%) while the least value of 38.0% was recorded in catfish group fed Tigernut at 75% dietary inclusion (P>0.05). These values were above 36.0% reported by Adeyemo *et al.* (2003). Nevertheless, the mean cell haemoglobin concentration (MCHC) reported in this study which ranged between 33-37% is similar to the value of 33.97% recorded by Adeyemo *et al* (2003) for African catfish This may be due to age of the fishes that greatly influence value of blood profile and haematological indices.

Cholesterol is the most important sterol occurring in animal fats. It is equally distributed between plasma and red blood cells, but in adrenal cortex, it occurs in the esterified form. The cholesterol occurs as white or faintly yellow almost odorless granules. A rise in cholesterol typically accompanies the inflammatory response and it serves to protect the nerve and brain against exposure to fat-soluble toxins and heavy metals. A triglyceride (TG, triacylglycerol, or TAG, triacylglyceride) is an ester derived from glycerol and three fatty acids. Triglycerides are blood lipids that helps enable the bidirectional transference of adipose fat and blood glucose from the liver. There are many triglycerides: depending on the oil source, some are highly unsaturated, some less. Triglycerides are formed by combining glycerol with three molecules of fatty acid. Triglycerides, as major components of Very Low Density Lipo-Protein (VLDL) and chylomicrons, play an important role in metabolism, as energy sources and transporters of dietary fat. The increase in plasma triglycerides is likely due to a decrease in lipoprotein lipase activity (key enzyme in triglyceride hydrolysis). A significant increase in liver

triglyceride level was also observed; this increase was attributed to increased triglyceride synthesis. Lipid stores represent major energy reserves in fish, and during sexual maturation they are mobilized and directed from previously stored tissue to gonads, in order to sustain their development (Yanik *et al* 2005). Lipoproteins function in fish for lipid transport (Babin and Vernier, 1989).

The transport of lipids and other lipid-soluble components from the intestine to peripheral tissues is predominantly mediated by lipoproteins (Babin and Vernier, 1989). Lipoproteins are classified according to their density into: chylomicrons, Very Low Density Lipoprotein (VLDL), low density lipoprotein (LDL), high density lipoprotein (HDL). In fish, it is not yet clearly understood, which route the chylomicrons and VLDL take from the enterocytes (Turchini *et al*., 2009). LDL-cholesterol transport cholesterol to the arteries where they can be retained in arterial proteoglycans leading to formation of plaques. Thus, increase in LDL-cholesterol level has been associated with atherosclerosis, heart-attack, stroke, peripheral vascular disease (Turchini *et al*., 2009). The results obtained shows that values recorded for cholesterol, triglycerides, low density lipoprotein and high density lipoprotein falls in the normal range described by the National heart, lung, and blood institute of consumed sea food; 200-239 mg/dL(cholesterol), Triglycerides(150 to 199 mg/dL (1.7 to 2.2 mmol/L), 76-129mg/DL (LDL), Less than 40 mg/Dl (HDL). The cholesterol values recorded in this experiment are below the values obtained by Aderolu and Akinremi (2009) who reported the dietary effects of coconut oil and peanut oil on biochemical characteristics of *Clarias gariepinus* juvenile.

CONCLUSION AND RECOMMENDATION

Lipid is an important source of dietary energy for fish which have limited ability to utilize dietary carbohydrate for energy. Hence, as demonstrated in the present study the inclusion of plant based lipids sources is suitable for formulation of *Clarias gariepinus* diets. When all the required essential nutrients are available in the diet, *Clarias gariepinus* will grow and survive well regardless of the lipid source without any problem to the fish growth and health.

REFERENCES

Aderolu, Z.A. and Akinremi, O.A. (2009). Dietary effects of coconut oil and peanut oil in improving biochemical characteristics of *Clarias gariepinus* juvenile. *Turkish Journal of Fish. AndAqua.Sciences,* 9: 105-110.

Adebayo I.A. (2017) Growth Responses of Hybrid Catfish (*Heteroclarias)* Juveniles fed all plant: protein diets supplemented with L-lysine and L-methionine. J Fisheries Livest Prod 5: 219 doi: 10.4172/2332-2608.1000219

Adedeji, O and and Agbede O. K. (2009) Effect of Diazinon on blood parameters in the African Catfish (Clarias gariepinus. *African Journal of Biotechnology*. 8:3940-3946.

Aderolu, A. Z. and Akinremi, O. A. (2009). Dietary effects of coconut oil and peanut oil in improving biochemical characteristics of *Clarias gariepinus* juvenile. Turkish Journal of Fisheries and Aquatic Science. 9(1):105-110.

Adeyemo, O., Agbede, S.A., Olaniyan, A.O., Shoaga, O.A. (2003) The haematological response of *Clarias gariepinus* to change in acclimation temperature. Afri. J. of Biomed. Res.;6:105-108

Ajani**,** E. K. (2011): Toxic effects of propanil on *Oreochromis niloticus* (Linn Trewavas 1983) fingerlings. *Nigerian Journal of Rural Extension and Development* 4: 65 – 70.

Al-Ogaily, S. M., Al-Asgah, N. A. and Ali A., (1996).Effect of feeding different grain sources on the growth performance and body composition of Tilapia,*Oreochromis niloticus* (L) *Aquaculture research.* 1298pp

Al-Owafeir, M. A. and Belal, I. E., (1996). Replacing palmoil for Tilapia *Oreochromis niloticus* (L.), feed. *Aquaculture research.* 27:221-224

Babalola, T.O. & Adebayo, M.A. (2007). Effects of dietary lipid level on growth performance and feed utilization of *Heterobranchus longifilis* fingerlings, *Journal of Fisheries International,* 2:60-64. doi: jfish.2007.60.64

Babin, P. J. and Vernier, J. M. (1989). Lipid transport mechanism in fish. *Journal of lipid resources*. 30: 467-489

Bell, J.G., Henderson, R.J., Tocher, D.R., Mc Ghee, F., Dick, J.R., Potter, A., Smullen, R.P. & Sargent, J.R. (2002). Substituting fish oil with crude palm oil in the diet of Atlantic salmon (*Salmo salar*), effects on the muscle fatty acid composition and hepatic acid metabolism. *Journal of Nutrition*. 132: 220-230.

Chou, B.S. & Shiau, S.Y. (1996). Optimal dietary lipid level for growth in juvenile hybrid tilapia *Oreochromis niloticus* X *Oreochromis aureus*. *Aquaculture.* 143: 185-195. doi: 10.1016/0044-8486(96)01266-5

Clauss, T., Dove, A. d. M. and Arnold, J. (2003) Hematologic disorders of fish. *Journal of Vertinary Clinic of North America Exotic Animal Practice.* 11 (3): 445-62

Craig, S. (2009) Understanding Fish Nutrition, Feeds, and Feeding. Virginia Cooperative Extension. Virginia State University. Virginia State, Petersburg

Dada, A. A. and Ikuerowo, M. (2009). Effects of ethanolic extracts of Garcinia kola seeds on growth and haematology of Catfish (*Clarias gariepinus*) broodstock. *African Journal of Agricultural Science.* 4(4):344-347.

De-Silva, S. S. and Anderson, T. A. (1998). Fish Nutrition in Aquaculture. Chapman and Hall, London, UK.

Dunham, R.A., Majumdar, K., Hallerman, E., Bartly, D., Mair, G., Hulata, G., Liu, Z., Pongthan, N., Bakos, J., Penman, D., Gupta, M., Rothlisberg, P. & Hoerstgen-Schwark, G. (2001). Review of the status of aquaculture genetics. In: R. P. Subasinghe P, Bueno MJ, Philips C, Hough SE, McGladdeny & JR Arthur (Eds). Aquaculture in the third millennium. Technical proceeding of the conference on aquaculture in the third millennium, Bangkok, Thailand, 20-25 February, 2000 PP137-166.NACA. Bangkok and FAO, Rome.

Einen, O. & Roem, A.J. (1997). Dietary protein/ energy ratios for Atlantic salmon in relation to fish size, growth, feed utilization and slaughter quality. *Aquaculture Nutrition*, 3: 115-126. doi: 10.1046/j.1365-2095.1997.00084.x

Emmanuel O. Aluyor and Mudiake Oghene Ori-Jesu (2008) the use of antioxidants invegetable oils – A review *African Journal of Biotechnology Vol. 7 (25), pp. 4836-4842,29 December, 2008*

FAO (Food and Agriculture Organization). (2003) The state of food insecurity in the world (Sofi2003)Rome, Italy; 2003.

Hrubec, T.C., Cardinale, J.L. and Smith, S.A. (2000) Hematology and plasma chemistry reference intervals for cultured tilapia (*Oreochromis* hybrid). *Verter. Clin. Path.*, 29: 7-12

Karapan, A. (2002). Studies to optimize poly unsaturated fatty acid composition of tilapia for human consumption in S.E. Asia. *Aquaculture News*.28:6-7.

Legendre, M., Kerdchuan, N., Corraze, G. &Bergot, P. (1995). Larval rearing of an African catfish, *Heterobranchus longifilis* Teleostei, *Clariidae*: effect of dietary lipid son growth, survival and fatty acid composition of fry. *Aquatic Living Resources.* 8: 355-363. doi: 10.1051/alr:1995040

Lim, P.K., Boey, P.L. & Ng, W.K. (2001). Dietary palm oil level effects on growth performance, protein Retention and Tissue Vitamin E Concentration of African catfish *Clarias gariepinus*. *Aquaculture.* 202:101-102. doi: 10.1016/S0044-8486(01)00563-4

Lovell, T. (1998) Nutrition and feeding of fish. Avi Chapman and Hall, London. 267pp.
Ng, W.K. Tee, M.C. & Boey, P.L. (2000). Evaluation of crude palm oil and refined palm oil as dietary lipids in pelletized feeds for a tropical bagrid catfish, *Mystus nemurus* (Cuvier & Valendciennes). *Aquaculture Research*, 31:337-347. doi: 10.1046/j.1365-2109.2000.00437.x

Ng, W.K. Lim, P.K. & Boy, P.L. (2003). Dietary palm oil source affects growth fatty acid composition and muscle X-tocopherol concentration of African catfish (*Clarias gariepinus*). *Aquaculture*. 215:229-243. doi: 10.1016/S0044-8486(02)00067-4

Ochang, S.N., Fagbenro, O.A. and Adebayo, O.T. (2007). Influence of dietary palm oil on growth response, carcass composition, haematology and organoleptic properties of juvenile Nile tilapia, *Oreochromis niloticus*. *Pakistan Journal of Nutrition*, 6: 424-429. Available at http://docsdrive.com/pdfs/ansinet/pjn/2007/424-429.pdf

Okullo, J.B.L., Omujar, F., Agea, J.G., Vuzi, P.C., Namutebi, A., Okelle, J.B.A.&Nyanzi, S. A. (2010). Physio-chemical characteristic of shea-butter (*Vitellaria paradoxa*, C.F. Gaertin) oil from shea-districts of Uganda. *African Journal of Food Agriculture, Nutrition and Development* 10:1-15. doi: 10.4314/ajfand.v10i1.51484

Olivia-Teles, A. and Peres, H. (1999). Effect of dietary lipid level on growth performance and feed utilization by European sea bass juvenile (*Dicentarchus labrax*). *Aquaculture*, 179: 325-334. doi: 10.1016/S0044-8486(99)00168-4

Omitoyin, B. O. (2007). Plasma biochemical changes in Clarias gariepinus (Burchell, 1822) fed poultry litter. *Asian Journal of Animal Science*. 1(1):48-52.

Osuigwe, D.I., Obiekezie, A.I. and Onuoha, G. C. ((2005). Some haematological changes in hybrid catfish (*Heterobrachus longifilis x Clarias gariepinus*) fed different dietry levels of raw and boiled Jackbean (*Canavalia ensoformis*) seed meal. *African Journal of Biotechnology*. 4(9):1

Oyelese, O. A., Taiwo, V.O., Ogunsanmi A. O and Faturoti, E. O. (1999). Toxicological effects of processed cassava peels on haematology, serum biochemistry and tissue pathology of Clarias gariepinus fingerlings. Journal of Tropical Veterinarian. 17 : 17-30.

Pie, Z., Xhu X. & Yang, Y. (2004). Comparative Study on the Effect of Dietary Lipid level on Growth and Feed Utilization for Gibel carp (*Carcasius auraatus* Gibelio) and Chinese long snout catfish (*Leiocassius logirostris*, Gunther). *Aquaculture Nutrition*. 10:209-216. doi: 10.1111/j.1365-2095.2004.00291.x

Rainza-Paiva, M.J.T., C.M. Ishikawa, A.A. Dostiras and N.N. Felizando (2000). Haematological analysis of "Chara" *Pseudoplatysoma fasciatum* in captivity. Aqua 2000. Responsible aquaculture in the new millennium:Nice, France. *Aqu. Social Special Pub*. 28:590-592.

Robinson, Z.H., Menghe, H.L. & Manning, B.B. (2001). A practical guide to nutrition, feed and feeding of catfish. MiSSiPPi State University Publication No.1113, 39 pp.

Rosenlund, G., Obach, A., Sandberg, M. G., Standal, H. &Tveit, K. (2001). Effect of alternative lipid sources on long term growth performance and quality of Atlantic salmon (*Salmo salar (*L).). *Aquaculture Research*. 32: 323- 328. doi: 10.1046/j.1355-557x.2001.00025.x

Saeed, S and Howell, N. K. (2002) Effect of lipid oxidation and frozen storage on muscle protein of Atlantic mackerel (Scomber scombrus). *Journal of the Science of Food and Agriculture*. 82 (5):579-586.

Solomon S.G., Ataguba G.A. and Imbur I (2012) growth performance of juvenile *Clarias gariepinus* fed different dietary lipid sources
International Journal of Research in Fisheries and Aquaculture 2012; 2(4): 52-55

Sotolu, A.O. (2010) Feed utilization and biochemical characteristics of *Clarias gariepinus*(Burchell, 1822) fingerlings fed diet containing fish oil and vegetable oil as total replacements. *World Journal of Fish and Marine Sciences*, 2(2): 93-98.

Subhadra, B., Lochmann, R., Rawles, S. and Ruguang C.R. (2006) Effect of dietary lipid source on the growth, tissue composition and haematological parameters of largemouth bass (*Micropterus salmoides*). *Aquaculture*, 255: 210-222.

Sunmonu, T.O. (2008) Haematological response of African catfish (*Clarias gariepinus*) and rat to crude oil exposure. *The Internet Journal of Haematology*

Turchini, G.M., Bente, E.T. and Wing-Keong, N. (2009). Fish oil replacement in finfish nutrition. Wiley online library. Review in Aquaculture. 1:1.

Weatherup, R.N., Mc Cracken, K.J., Foy, R., Rice, D., Mc Kendry, J., Mairs, R.J. & Hoey, R. (1997). The effects of dietary fat content on performance and body composition of farmed rainbow trout (*Oncorhyncus mykiss*). *Aquaculture*, 151: 173- 184. doi: 10.1016/S0044-8486(96)01507-4

Yanik, T, Orhan, E A. and Ilta, A. (2005). Alterations in cholesterol, glucose and triglycerides levels in reproduction of Rainbow trout. Journal of Animal and Veterinary Advances. 8: 34-45.

Yusuf, A.M., Olafadehan, O.A., Obun, C.O., Inuwa, M., Garba, M.H. & Shagwa, S.M. (2009). Nutritional evaluation of Shea butter fat in fattening of Yankassa sheep. *Pakistan Journal of Nutrition*. 8: 1062-1067.