Nigerian Journal of Fisheries and Aquaculture 3(1&2): 62 – 67, 2015

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Available online: http://www.unimaid.edu.ng
ISSN-2350-1537

Changes in Lipid Profile and Kidney Function of African Catfish C*larias gariepinus* (Burchell, 1822) Fed Different Lipid Resources

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Received July 22, 2015 Accepted August 30, 2015

ABSTRACT

The study was conducted to assess some lipid parameters and kidney function of African catfish *Clarias gariepinus* (4.50± 0.01g), fed six isonitrogenous and isocaloric diets containing different lipid resources. The sources of dietary lipid were fish oil (Control diet), coconut oil diet (CCO), olive oil diet (OLOD), crude palm oil diet (PMOD), sunflower oil diet (SFOD) and sesame oil diet (SSOD) incorporated at the 7 % level. Feeding trials were conducted in a floating hapa ($1m^3$) system for 12 weeks. Results showed that different lipid sources in diets significantly ($p < 0.05$) increased the levels of total cholesterol, triglycerides and low density lipoprotein (LDL) cholesterol in all treated groups when compared with the initial levels. Significantly ($p<0.05$) higher value of high density lipoprotein (HDL) cholesterol was observed in the group fed OLOD when compared with the control. For the atherogenic indices, significant ($p < 0.05$) increase in HDL-cholesterol/Total cholesterol ratio was observed while LDL-cholesterol/HDL-cholesterol and log (TG/HDLCH) ratios significantly ($p < 0.05$) decreased in the OLOD group. Kidney function parameters: serum protein, albumin and globulin increased significantly in PMO group, whereas the level of albumin-globulin ratios were insignificant ($p > 0.05$) in all groups. Inferences from this study support direct use of olive and crude palm oils as a total replacement for fish oil in catfish feed production. These findings may be of clinical importance to individuals at risk of cardiovascular disease for proper dietary planning.

Key words: *Clarias gariepinus*, fish oil, plant oil, substitution, lipid profile, kidney function

INTRODUCTION

Aquaculture feed accounts for more than 50% cost of intensive aquaculture operations (NRC, 1993). The major concern in the industry is the fact that the major ingredients (fish meal and fish oil) are scarce and expensive. The issues around the use of fish meal and fish oil in compound aquaculture diets are wide-ranging and complex (FIN, 2006). One of the main areas of contention is the presumption that although aquaculture production is expected to continue its rapid rise in the foreseeable future, catches from small pelagic fisheries, which are the source of fish meal and oil are expected to remain static, or even decrease due to major drop in supply during the El Niño events of 1998 – 2004 (FAO, 2013). It has been acknowledged that these fisheries often follow a boom and bust cycle, which is dictated more by climate (Anon, 2007). Fears have been raised that this trend may have disastrous consequences for the ecosystem, fuelling concerns that aquaculture may not be a net contributor to world fish supplies, but instead, adding more pressure on wild fisheries (Allan, 2004). This then becomes a prelude in looking for a comparatively cheap and available source of the ingredient for fish feed production. There have been considerable research efforts to find suitable, cost-effective, non-conventional and terrestrial alternative ingredients which can totally or partially replace fish meal in aqua-feeds (Ufodike *et al.*, 2012; Effiong *et al.*, 2014). Presently, the most urgent problem to be solved in the aqua - feed industry relates to fish oil replacement. This study was carried out to assess the effects of total replacement of fish oil with different plant-based oils on some lipid parameters and kidney function of catfish and justify these effects on the healthy condition of the end product.

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MATERIALS AND METHODS

Experimental design

The experimental setup composed of an outdoor concrete tank (8m x 5m x 1.65m) situated at the Vika Farms Limited, Mbak Etoi, Uyo, Akwa Ibom State, Nigeria. The farm is located at geographical coordinates of Latitude 5° 3' 0" North and Longitude 7° 56' 0" East. This tank was equipped with both inlet and outlet facilities and a 5,000 l capacity overhead tank served as a water reservoir. The experimental design was made up of a module consisting of 8.5m x 6.5m bamboo raft with sixteen 1.5m x 1.5m apartments fittable with sixteen 1m x 1m x 1m hapas constructed to fit on the concrete tank as described by Otubusin (2000).

Experimental diets preparation

Six isonitrogenous (41% CP) diets were prepared using fishmeal, soybean meal, groundnut cake and corn flour as main ingredients. In Diet 1 (Control), fish oil served as the lipid source. In Diets 2 to 6, coconut oil (CCOD), olive oil (OLOD), palm oil (PMO), sunflower oil (SFOD) and sesame oil (SSOD) respectively were used as a total replacement for fish oil. The various oils were incorporated at 7% of the diet. All ingredients were procured at the same time to avoid variations associated with batch differences. They were carefully weighed out, mixed, made into pellets using the 2mm meat mincer, air-dried and labelled separately according to diets.

Fingerling rearing

Each floating hapa was randomly stocked with *Clarias gariepinus* (mean initial weight of 4.5±0.01g) at 20 fish per rearing system. Experimental diets were fed to triplicate groups of fish at 5% of their body weight. This amount was divided into three equal portions and fed at 08:00, 13:00 and 18:00hrs, respectively over a period of twelve weeks.

Determination of biochemical parameters

The concentrations of total cholesterol (TC), Triglyceride (TG), HDL- cholesterol and LDL-cholesterol were determined by enzymatic colorimetric test described by Fossati and Prencipe (1982). While the total protein level in serum was determined by the biuret method as described by Henry *et al*. (1974), using a commercial clinical investigation kit (Fortress Diagnostic Analysis, United Kingdom). All biochemical analyses were carried out in Biochemistry Laboratory, University of Uyo, Nigeria.

Economic analysis of experimental diets

Profit index (PI) and incidence of costs (IC) models were used to estimate the economic benefits of the diets: PI= Value of fish (N) / Cost of feed (N)**;** IC= Cost of feed (N) / Weight (kg) of fish produced.

Statistical analysis

Data collected were subjected to descriptive statistics involving mean and standard error and the New Duncan Multiple Range Test was used to rank the means using Statistical Package for Social Sciences (SPSS) 19.0, 2010 version.

RESULTS

The influence of different oils on lipoprotein cholesterol values were significant ($p < 0.05$) higher in all experimental groups when compared with the initial levels (Table 1). The best TC (3.36mmol/l), TG (1.37mmol/l), HDH (1.01mmol/l) and LDL (2.14mmol/l) were recorded in fish fed OLO diet.

The results of the kidney function indices showed that fish fed PMO diet had the highest total protein (5.42mmol/L), albumin (2.98mmol/L) and globulin (2.06mmol/L), while those fed the control diet had the least of these values (Table 2). It might be mentioned here that immune bodies are associated with the globulins. However, insignificantly ($p > 0.05$) high albumin-globulin ratios were observed in all treated groups.

Table 1: Serum lipid profile of *Clarias gariepinus* fed diets in which different Plant-based oils replaced fish oil shown alongside initial levels

Indices	**Initial**	**Treated fish**					
		Control	**CCOD**	**OLOD**	**PMOD**	**SFOD**	**SSOD**
TC [1]	3.30[a]	3.60±0.05[b]	3.87±0.05[d]	3.36±0.02[a]	3.97±0.02[e]	3.52±0.03[b]	3.76±0.05[c]
TG [2]	1.07[a]	1.15±0.01[a]	1.27±0.02[ab]	1.37±0.01[b]	1.27±0.01[ab]	1.28±0.07[ab]	1.12±0.10[a]
HDL[3]	0.68[a]	0.77±0.02[ab]	0.83±0.01[b]	1.01±0.01[d]	0.84±0.02[cd]	0.95±0.02[bc]	0.71±0.06[a]
LDL[4]	2.08[a]	2.31±0.04[ab]	2.44±0.07[b]	2.14±0.03[a]	2.45±0.00[b]	2.21±0.05[a]	2.31±0.08[ab]

Value are means of three determinations ± standard error; means in the same row with the same superscript were not significantly different ($p > 0.05$). Where**:** [1]total cholesterol (mmol/l); [2]triglyceride (mmol/l); [3]high density lipoprotein (mmol/l); [4]low density lipoprotein (mmol/l).

Table 2: Kidney function parameters of *Clarias gariepinus* fed diets in which different plant-based oils replaced fish oil shown alongside initial levels

Indices	**Initial**	**Treated fish**					
		Control	**CCOD**	**OLOD**	**PMOD**	**SFOD**	**SSOD**
TP[5]	2.54[a]	2.97±0.03[a]	3.85±0.44[c]	3.56±0.38[bc]	5.42±0.32[d]	3.02±0.29[b]	3.23±0.22[b]
A[6]	1.40[a]	1.63±0.01[a]	2.11±0.24[c]	1.96±0.21[bc]	2.98±0.18[d]	1.66±0.16[b]	1.78±0.1[b]
G[7]	0.97[a]	1.13±0.01[a]	1.46±0.17[c]	1.35±0.14[bc]	2.06±0.12[d]	1.15±0.11[b]	1.23±0.09[b]
A/G ratio	1.44	1.44±0.25	1.44±0.52	1.45±0.19	1.44±0.66	1.44±0.35	1.44±0.72

Value are means of three determinations ± standard error; means in the same row with the same superscript were not significantly different ($p > 0.05$). Where**:** [5]total protein (mmol/l); [6]albumin (mmol/l); [7]globulin (mmol/l).

Economic evaluation of the experimental diets revealed that Control diet had the least ($p < 0.05$) profit index as well as the poorest economic conversion ratio (Table 3). While PMOD had the best profit index and CCOD the best economic conversion ratio.

Table 3: Economic evaluation of experimental diets

Indices	**Control**	**Treated Fish**				
		CCOD	**OLOD**	**PMOD**	**SFOD**	**SSOD**
FFW[1]	213.2±1.14[b]	188±1.37[a]	209.2±1.85[b]	236.6±3.7[c]	203±2.9[b]	171.7±1.3[a]
QFP[2]	4194.4±93[c]	3697.5±72[b]	4115.9±104[c]	4672.8±25[d]	3998.7±113[c]	3434.7±25[a]
PI[3]	15.16±0.1[a]	27.97±0.1[e]	23.33±0.2[b]	27.42±0.5[de]	25.32±0.5[c]	26.71±0.1[a]
VOF[4]	2,097.18±46[c]	1,848.77±36[b]	2,057.95±52[c]	2,336.4±12[d]	1,999.34±56[c]	1717.33±12[a]
ECR[5]	11.02±0.14[d]	6.04±0.28[a]	7.18±0.09[c]	6.11±0.00[a]	6.57±0.1[b]	6.49±0.00[b]

Value are means of three determinations ± standard error; *means in the same row with the same superscript were not significantly different ($p > 0.05$). Where: [1]Fish final weight (g); [2]quantity of fish produced (g); [3]profit index; [4]value of fish (N); [5]economic conversion ratio.

The results of atherogenic risk predictor indices revealed that significant ($p < 0.05$) increase in HDL-cholesterol/total cholesterol ratio was observed in fish fed OLOD (Fig. 1).
On the contrary, the lowest level of LDL-cholesterol /HDL- cholesterol was recorded in OLOD (Figure 2). While the values of log (triacylglycerol/HDL-cholesterol) were insignificant ($p>0.05$) in the Control, CCOD, PMOD and SSOD (Figure 3).

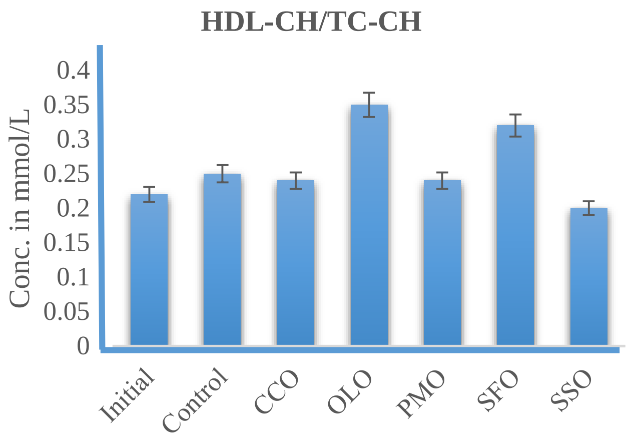

Figure 1: Mean values of serum atherogenic risk predictor indices (HDL-CH/TC-CH) of different oil resources on catfish.

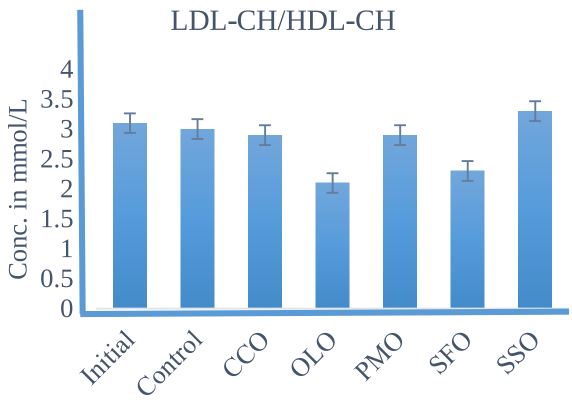

Figure 2: Mean values of serum atherogenic risk predictor indices (LDL-CH/HDL-CH) of different oil resources on catfish.

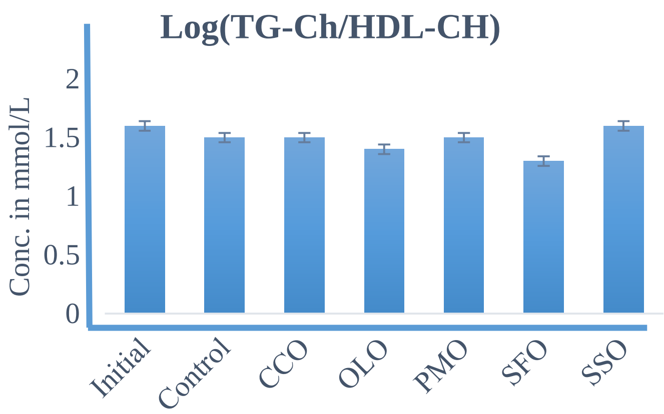

Figure 3: Mean values of serum atherogenic risk predictor indices Log (TG-CH/HDL-CH) of different oil resources on catfish.

DISCUSSION

Studies have revealed that substantial use of vegetable oils as energy sources in fish diets yield positive growth responses in fish (Effiong *et al*., 2014). The results obtained in this study have shown that plant-based oil sources could be used as an excellent nutrient base in catfish feed manufacture. All the experimental diets were adequately consumed by fish and fish showed no sign of stress. This may imply that there were no palatability problem and feed were adequately utilized. This report is similar to the observation of Aderolu and Akinyemi (2009) in the utilization of coconut and peanut oil diets and Sotolu (2010) in the utilization of sesame seed and palm oil diets by *Clarias gariepinus.* Ochang *et al*. (2007) earlier showed that vegetable oils can replace fish oil up to 12.5% inclusion level in catfish diets without feed intake associated problems. The 7% inclusion levels of the various oils used in the present study appeared to be within acceptable limits that ensures balances in lipid components for normal catfish growth (NRC, 1993).

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, increases in LDL-cholesterol level has been associated with atherosclerosis, heart-attack, stroke, peripheral vascular disease (Crowwell and Otvos, 2004). In this study, significant reduction in the level of LDL-cholesterol in the group fed OLO diet (Figure 2) signified a decreased risk of cardiovascular disease. Also low value of log (TG/HDL-cholesterol) (Figure 3) indicated a decreased risk of vascular disease, since the high androgenic index of log TG/HDL-cholesterol had been positively correlated with cardiovascular disease (Igwe *et al*., 2007). Generally, the values of LDL-cholesterol/HDL-cholesterol ratio less than 2.3 and HDL-cholesterol/Total cholesterol greater than 0.2 in all treated groups were desirable and non-anthogenic (Crowwell and Otvos, 2004).

Serum proteins play key roles in maintaining osmotic pressure and viscosity of the blood. Of particular interest is the correlation of the albumin-globulin ratio, which low levels have been linked to nephrosis in fishes (Sandnes *et al.*, 1988). The report further established that serum albumin plays a predominating role in exerting osmotic pressure of proteins. Different kinds of fish vary sharply in the total serum proteins and in the distribution of the various fractions. The Elasmobranchii, for instance, are known to use urea, which is present in their blood in very large amounts to maintain the osmotic pressure of their blood approximately equal to that of their environment. In teleosts (such as catfish), it has become a matter of interest to determine whether lipid type has any influence upon the concentration and distribution of their serum proteins. The data presented in this study revealed that the concentrations of serum proteins were in normal range (Table 2) which, indicated that the animals were apparently healthy throughout the experimental period (Sandnes *et al.*, 1988).

The economic evaluation of experimental diets showed that cost of feed was minimized by replacing fish oil with CCO, OLO, PMO, SFO and SSO in catfish diets (Table 3). This assertion is buttressed by the relative similar profit index (PI) obtained from using the various plant oil diets. The trend of the results indicated that though any of the five plant-based oils could be used in the production of catfish feed, olive oil appeared to be the healthiest oil and is recommended for use in aqua-feed industry.

Conclusion

The health and nutritional benefits that can be derived from consuming plant oils have been recognized in many parts of the world. The authors hereby recommends the use of crude palm and olive oils as a total replacement for fish oil in catfish feed production.

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