World Journal of Fish and Marine Sciences 2 (2): 93-98, 2010
ISSN 2078-4589

Feed Utilization and Biochemical Characteristics of *Clarias gariepinus* (Burchell, 1822) Fingerlings Fed Diets Containing Fish Oil and Vegetable Oils as Total Replacements

Akeem O. Sotolu

Department of Forestry Wildlife and Fisheries,
Nasarawa State University, Keffi, Shabu-Lafia Campus, Nigeria

Abstract: The effects of dietary vegetable lipid sources on the growth performance and haematology of African catfish, *Clarias gariepinus* (initial mean weight 6.37±0.24g) were examined in a 10 weeks feeding trial in an attempt to eliminate the expensive fish oil in the preparation of fish diets. Twenty fish were allotted for each treatment tanks in triplicates groups at random and were fed five isonitrogenous and isocaloric diets of fish oil-based diet (Control), benni seed oil-based diet (BS-oil), groundnut oil based-diet (GN-oil), soybean oil-based diet (SB-oil) and palm oil-based diet (P-oil) as diets 1-5, respectively. Results showed that feed consumption, weight gain and survival rates of fish were generally high as no significant difference was found in the specific growth rate among treatments. There were some marginal differences recorded in the protein efficiency ratio and feed conversion ratio of the control diet and P-oil but they were superior to others with BS-oil having the least quality. Fish carcass protein and lipids were significantly different among all treatments but the control and P-oil had marginally different values followed by SB-oil and the least being fish fed dietary BS-oil. Fish haemoglobin was marginally different in all treatments except diet 2 (BS-oil) while diet 5 (P-oil) had highest value of cholesterol (228 g/dl) and, diet 1 (control) had the least (202 g/dl). Blood protein ranged between 3.87-4.22 g/dl with significant differences among the treatments of which value was highest in diet 4 (SB-oil) and least in diet 2 (BS-oil). It could be concluded from the present study that, vegetable oil sources including palm oil, soybean oil and groundnut oil can be utilized by catfish as the sole lipid source in fish diet with negligible impact on growth performance while the utilization of benni seed oil should be limited for efficient feed utilization by fish and ensure good food fish quality.

Key words: *Clarias gariepinus* % Fish oil % Vegetable oils % Fish diets % Haematology

INTRODUCTION

Lipids (fats) are high-energy nutrients that can be utilized to partially spare (substitute for) protein in aquaculture feeds. Lipids supply about twice the energy as proteins and carbohydrates. Lipids typically comprise about 15% of fish diets, supply essential fatty acids (EFA) and serve as transporters for fat-soluble vitamins. According to Jobling [1], cost-effective, practical aquaculture feeds can be produced using vegetable oil in the absence of fish oil with no resulting or apparent loss in fish growth. Hence, there is a growing demand to substitute fish oil with less expensive lipids-rich plant sources [2] and in this respect, pulses and oilseed meals have economic potentials [3, 4]. The use of vegetable oils such as soybean oil that contains very high levels of linoleic acid has been found useful in fish production whereas high levels of this fatty acid exhibited a sparing effect for energy [5]. Although grain legumes have been widely used as protein source in aquaculture feeds production [6], much have not been done about utilizing oilseeds and their by-products as major source of dietary lipid/fat within aquaculture feeds production for warmwater omnivorous fish species such as catfish (*Clarias gariepinus*). Beside this, few studies have been conducted on the use of oilseed meals such as benniseed (sesame) meal and cottonseed meal in warmwater fish nutrition [7] in partial replacement of fish oil, there is the need to intensively conduct researches on the utilization of vegetable oil as a total replacement of fish oil in aquafeed production. *Clarias gariepinus* is a major fish species for aquaculture in African and it has also been introduced in Europe and Asia. It is cultured for its omnivorous feeding habit, high growth rate and its resistance to handling and stress [8].

Corresponding Author: Akeem O. Sotolu, Department of Forestry Wildlife and Fisheries, Nasarawa State University, Keffi, Shabu-Lafia Campus, Nigeria

This study was carried out to evaluate the nutritive potential of various mechanically-extracted oil from plants-soybean meal, groundnut cake, benni seed and oil palm as replacement for fish oil in the diets of *Clarias gariepinus* fingerlings.

MATERIALS AND METHODS

Preparation of Experimental Diets and Experimental Procedures: Mechanically-extracted oils from soybean seed, cotton seed, benni seed and palm oil and fish oil (cod liver oil) were used to formulate five isonitrogenous (40% Crude protein) and isocaloric (3500 kcal/kg) diets for catfish fingerlings. The control diet (Diet 1) contained cod liver oil as the fish oil source which was replaced with each vegetable oil at the same level in four other separate diets for diets 2-5; Benni seed oil, Ground nut oil, Soya oil and Palm oil respectively. All the five diets are represented as 1 (Control), 2 (BS-oil), 3 (GN-oil), 4 (SB-oil) and 5 (P-oil). Total of 300 *Clarias gariepinus* fingerlings (average weight of 6.37±0.24g) was randomly distributed into the five treatments in triplicates concrete tanks of 2.0x2.0x1.5m. All diets were chemically analyzed for crude protein, crude fibre, crude fat/lipid, ash, moisture, nitrogen free-extract and calorific value using the methods of AOAC [9] gross energy was determined by bomb calorimetry using an adiabatic Gallenkamp calorimeter (Model OC-5182). Each diet was fed to experimental fish in triplicate tanks to apparent satiation twice daily (09:00 h and 17:00 h) for 70 days. Individual fish in each tank were weighed at the start and every 14 days to monitor growth response and feed utilization. Water quality parameters which include dissolved oxygen, pH and ammonia were kept within the range of 6.7-6.9 (mg/l), 7.2-7.8 and 0.16-0.18 (mg/l), respectively and were considered favourable in fish culture tanks according to Boyd [10].

Determination of Fish Growth and Performance and Analysis Carcass Composition: Fish growth and performance and nutrient utilization were determined according to the methods of Jobling[1] for fish Mean weight gain (MWG), Specific growth rate (SGR), Protein efficiency ratio (PER), Feed conversion Ratio (FCR), Protein intake (PI) and fish Survival rates (SR %). Fish carcass was analyzed for crude protein, lipid and ash using the methods of AOAC [9] in all treatments at the end of the feeding trial.

Haematological Study: Blood samples were collected into heparinised bottles through the caudal peduncle of fish from each treatment. The capillary tubes were micro-centrifuged and relative packed cell volume (PCV) of the red blood cell was measured to determine the percentage haematocrit value [11]. Other haematological indices assessed are haemoglobin, percentage plasma protein and cholesterol.

Statistical Analysis: The experiment consisted of a completely randomized design with three replicates for each five dietary treatments. Statistical analysis of the data included the one-way analysis of variance (ANOVA) using the SPSS version 10.0 for windows on PC (Statistical Graphics Corp, US). Significant mean differences were separated at 5% using the methods of Steel *et al*. [12] whereas appropriate and values are expressed as means ± SE.

RESULTS

The proximate compositions of the experimental diets are presented in Table 1. Growth response, feed and protein utilization efficiency by catfish are as shown in Table 2, which reveals that the best overall weight gain was obtained in fish fed with SB-oil based-diet and the least weight gain was recorded in fish fed diet 2 (BS-oil).

No significant differences was recorded in weight gain and growth response by fish fed the entire lipid-based feeds as SGR ranged between 0.64 – 0.65 (%/day). There are significant variations ($p<0.05$) in the feed intake pattern among treatments which was ranged between 22.87g in diet 3 (GN-oil) and 23.85g in diet 2 (BS-oil). Feed utilization indices also varied significantly ($p<0.05$) among treatments (Table 2). Fish fed diet 4 had the best PER and FCR among all the treatments while fish fed diet 2 had the least PER and inferior FCR. However, growth response and feed utilization was similar in fish fed diet 1 (Control) and fish fed diet 3 (GN-oil). Fish survival rates was generally high in all dietary treatments whereas values ranged between 93.33% in SB-oil and 98.33% in both control diet and GN-oil based diet fed fish. Mortality rate was therefore non-differential among treatments.

Table 3 presents the body proximate composition of experimental fish after the 70-day feeding trial. Dietary lipid-based feedings significantly affected fish carcass compositions. Values of all parameters assessed; dry matter, crude protein, crude lipids and ash were all significantly different ($p<0.05$) among treatments. Fish carcass protein and lipids were only marginally different between the control diet fed fish and diet 5 (P-oil) and the same trend was exhibited by fish fed diets 2 and 4 for values of crude protein and lipids respectively. Similarly, the feeding of the fish with diets containing different lipid sources brought about significant changes ($p<0.05$) in

Table 1: Gross and proximate composition (g/kg dry matter) of experimental diets

	Experimental Diets				
Nutrient Parameters	1 (Control)	2 (BS oil)	3 (GN oil)	4 (SB oil)	5 (P oil)
Gross composition					
Fish meal	23.15	23.15	23.15	23.15	23.15
Blood meal	36.78	36.78	36.78	36.78	36.78
Dried brewers' grain	10.36	10.36	10.36	10.36	10.36
Yellow maize	16.57	16.57	16.57	16.57	16.57
Fish oil (Cod liver)	9.00	-	-	-	-
Benni seed oil	-	9.00	-	-	-
Groundnut oil	-	-	9.00	-	-
Soya oil	-	-	-	9.00	-
Palm oil	-	-	-	-	9.00
Fish premix [1]	1.00	1.00	1.00	1.00	1.00
Bone meal	1.50	1.50	1.50	1.50	1.50
Methionine + Lysine	2.00	2.00	2.00	2.00	2.00
Proximate composition (%)					
Crude protein	40.22	40.10	40.74	40.36	40.63
Crude lipid	13.74	13.28	14.08	13.79	13.76
Crude fibre	5.21	4.66	5.27	5.63	5.40
Ash	12.16	11.83	11.80	12.02	12.16
NFE [2]	28.67	30.13	28.11	28.20	29.02
Gross energy (Kcal/kg)	3498.40	3513.53	3518.30	3506.70	3510.44

[1]Fish pre-mix. Colborne Dawes Nutrition Ltd., UK. g/kg diet: vitamin A, 1600 IU; vitamin D, 2400 IU; vitamin E, 160 mg; vitamin K, 16 mg; thiamin, 36 mg; riboflavin, 48 mg; pyridoxine, 24 mg; niacin, 288 mg; panthotenic acid, 96 mg; folic acid, 8 mg; biotin, 1.3 mg; cyanocobalamin, 48 mg; ascorbic acid, 720 mg; choline chloride, 320 mg; calcium 5.2 g; cobalt, 3.2 mg; iodine, 4.8 mg; copper, 8 mg; iron, 32 mg; manganese, 76 mg; zinc, 160 mg; Endox (antioxidant) 200 mg.

[2]NFE: Nitrogen Free Extract

Table 2: Growth response and feed utilization by C. gariepinus fed different dietary lipids for 70 days

	Experimental Diets				
Indices	1 (Control)	2 (BS-oil)	3 (GN-oil)	4 (SB-oil)	5 (P-oil)
Initial weight (g)	6.37±0.24	6.31±0.24	6.48±0.24	6.26±0.24	6.37±0.24
Weight gain(g)	18.26±0.62[a]	17.98±0.70[a]	18.05±0.53[a]	18.97±0.32[a]	18.25±0.10[a]
Feed intake (g)	23.26±1.21[a]	23.85±1.03[a]	22.87±1.30[b]	23.25±0.84[a]	23.30±1.05[a]
SGR (%/day)	0.65±0.01[a]	0.65±0.06[a]	0.64±0.10[a]	0.65±0.02[a]	0.65±0.03[a]
PER	0.79±0.13[b]	0.75±0.11[c]	0.79±0.10[b]	0.82±0.12[a]	0.78±0.08[b]
FCR	1.27±0.03[b]	1.33±0.04[a]	1.27±0.01[b]	1.23±0.04[c]	1.28±0.0b[a]
Survival rate (%)	98.33	95.00	98.33	93.33	96.67

Mean values on the same row with different superscripts are significantly different (p<0.05)

Table 3: Fish carcass composition after 70-day feeding trial

Parameters (%)	1 (Control)	2 (BS-oil)	3 (GN-oil)	4 (SB-oil)	5 (P-oil)
Dry matter	84.18±2.17[a]	82.51±1.52[c]	83.88±2.26[b]	84.16±1.83[a]	84.23±1.08[a]
Crude protein	67.15±3.27[a]	66.05±2.24[b]	66.17±1.24[b]	66.19±1.02[b]	67.12±0.15[a]
Crude lipid	10.84±1.10[a]	11.89±0.73[c]	12.50±0.63[d]	11.96±0.76[c]	11.03±1.07[a]
Ash	0.56±0.11[a]	0.48±0.16[b]	0.33±0.18[c]	0.31±0.11[c]	0.57±0.13[b]

Mean values on the same row with different superscripts are significantly different (p<0.05).

Table 4: Haematological indices of C. gariepinus fed different dietary vegetable oils

Haematological Indices	1 (Control)	2 (BS-oil)	3 (GN-oil)	4 (SB-oil)	5 (P-oil)
Hb (g/dl)	14.04±1.17[a]	13.81±1.12[b]	13.97±1.07[a]	13.96±1.02[a]	14.01±1.15[a]
PCV (%)	44.28±0.78[a]	42.05±1.24[c]	43.73±1.24[b]	43.87±0.65[b]	44.15±0.41[a]
ESR (mm/h)	11.21±1.41[c]	11.19±0.12[c]	12.00±0.30[a]	11.82±0.26[b]	11.76±0.37[b]
Protein (g/dl)	4.06±0.24[b]	3.87±0.12[c]	3.93±0.31[c]	4.22±0.41[a]	4.10±0.06[b]
Cholesterol g/dl)	202±3.24[c]	217±5.06[b]	226±4.01[a]	219±2.39[b]	228±0.08[a]

Mean values on the same row with different superscripts are significantly different (p<0.05).

the heamatology and blood chemistry of the experimental fish (Table 4). Values of haemoglobin (Hb) and PCV decreased from that of the control diet in all vegetable oil fed fish. ESR and blood protein were also significantly ($p<0.05$) affected by treatment while cholesterol values were not affected by treatments with values ranging between 203 (g/dl) in diet 2 and 211 (g/dl) in diet 4.

DISCUSSION

Use of plant lipid sources in the production of aquafeed has been a welcome development for the development of the aquaculture industry over decades. Recent studies have revealed that substantial use of vegetable oils as energy sources in fish diets have yielded positive growth response in fish [13, 14]. The results gathered from this study have demonstrated that all the vegetable oil sources used are of good nutrient composition as all diets formulated were adequately consumed and SGR was marginally different among treatments including control. This observation could imply that there was no palatability problem and that their utilizations were adequate, which is similar to that of Aderolu and Akinremi, [15] in the utilization of coconut oil and peanut oil in catfish diet. Ng [16] and Ochang *et al*.[17] in earlier studies have shown that vegetable oil can replace fish oil up to 12.5% inclusion level in catfish diets without feed intake associated problems. The 9% inclusion levels of the various oils used in the present study appear to be within acceptable limits that ensures balances in fatty acids components of the feeds [18]. This result may however, be responsible for the high level performance of fish under all treatments which is in line with the reports of Fitzsimmons *et al*. [19] and Lim *et al.* [20] and were probably responsible for overall high survival rates, which was higher than values (85%) recorded for sharpsnout sea bream fed graded levels of dietary soybean oil diets in another study by Piedecausa *et al.* [4]. Marginally superior feed utilization efficiency (PER and FCR) exhibited by fish fed control diet compared to other diets could be as a result of its superior fatty acid composition as vegetable oils are known to lack EPA and DHA [21]. It could be that high quality dietary fatty acid is capable of sparing protein component of the diet for conversion into energy just like Regost *et al*. [22] who reported that increased dietary oil in fish feed is capable of sparing protein for energy expenses. Other studies have revealed that the use of linseed, soybean and various palm oil products do not significantly affect growth performance and feed utilization of tilapia [23, 24]. Consequently, fish carcass quality was similar for control diet and fish fed palm oil, especially in terms of crude protein and lipid value and closely related to the values of other vegetable sources except for few differences. This observation is similar to those made on other fish species, including Atlantic salmon [25, 26], turbot [27] and European sea bass [28]. Fish carcass protein and lipids were generally high in all treatments, but were highest in fish fed control diet with marginal differences from fish fed diet 5. It was however, reported that the use of vegetable oils (lacking in EPA and DHA) in fish feeds will decrease the concentrations of beneficial omega-3 HUFA in fish fillets destined for human consumption [29] and this has become a major concern to human nutritionist in recent years. In the light of this, a good fish oil substitute such as linseed oil (rich in 18:3 n-3) and palm oil (rich in monoenes) are superior alternatives compared to other vegetable oils for use in replacing fish oils in aquafeed. This may be the reason for closely related values shown by fish fed cod liver oil (Control) and fish fed palm oil (Diet 5) which remained uncompromised. The results of the fish haematology in most cases related directly with the results of fish carcass composition. Haematocrits showed that Haemoglobin (Hb) and packed cell volume (PCV) were best in control and fish fed palm oil closely followed by those fed diets containing GN-oil and SB-oil. Fish fed benni seed oil (BS) performed least in the feed utilization efficiency with relatively least values for fish carcass quality and probably resulted in the corresponding poor haematology characteristics of the fish. Surprisingly, blood protein was highest in fish fed diet containing SB-oil while the least cholesterol in fish fed the control diet may be as a result of the superior composition of its fatty acids but all values were still within the normal ranges of haematology described for *Clarias gariepinus* by Joshi *et al.* [30].

The present study showed that all vegetable oil sources tested can be utilized by catfish as the sole lipid source in fish diet with negligible impact on growth performance in total replacement of fish oil except benni seed oil. The oil of benni seed should therefore not be used for total replacement of fish oils as it may likely affect the quality of the fish produced.

REFERENCES

1. Jobling, M., 1983. A short review and critique of methodology used in fish growth and nutrition studies. Journal of Fish Biology, 23: 686-703.

2. New, M.B. and U.N. Wijkstrom, 2002. Use of fishmeal and fish oil in aquafeeds: Further thoughts on the fishmeal trap. F.A.O fisheries circular 2002; No. 975. Rome: Food and Agriculture Organization of the United Nations.
3. Allan, G., 1998. Fishmeal replacement in aquaculture feeds: Sub-program administration. Final report to Fisheries Research and Development Corporation. New South Wales Fisheries Final Report Series, No. 7: 74.
4. Piedecausa, M.A., M.J. Mazon, B. Garcia-Garcia, and M.D. Hernandez, 2007. Effects of total replacement of fish oil by vegetable oils in the diets of Sharpsnout seabream (*Diplodus puntazzo*), Aquaculture, doi:10.1016/j.aquaculture.2006.09.39.
5. Santiago, C.B. and O.F. Reyes, 1993. Effects of dietary lipid source on reproductive performance and tissue lipid levels of Nile tilapia *Oreochromis niloticus* (Linnaeus) broodstock. J. Appl. Ichthyol., 9: 33-40.
6. Sotolu, A.O. and E.O. Faturoti, 2008. Digestibility and Nutritional Values of Differently processed *Leucaena leucocephala* (Lam De Wit) Seed Meals in the Diet of African Catfish (*Clarias gariepinus*). Middle-East Journal of Scientific. Researches, 3: 190-199.
7. Lim, C. and W. Dominy, 1989. American Soybean Association. Utilization of plant proteins by warm water fish. USDA-ARS, Tropical Aquaculture Research Unit; the Oceanic Institute, Hawaii.
8. Fagbenro, O.A. and S.J. Davies, 2001. Use of soybean flour (dehulled, solvent-extracted soybean) as fishmeal substitute in practical diets for African catfish, *Clarias gariepinus* (Burchell, 1822): growth, feed utilization and digestibility. J. Appl. Ichthyol., 17: 64-69. DOI. 10.1046/j.1439-0426.2001.00252.x.
9. AOAC. (Association of Official Analytical Chemists), 1990. Official Method of Analysis. 17th Edition, Washington D.C. U.S.A: 1298.
10. Boyd, C.E., 1990. Water quality in ponds for aquaculture. Alabama agricultural experimental station. Aurburn University, Alabama, pp: 483.
11. Dalcie, J.V. and S.N. Lewis, 2001. Practical Haematology. 9th Edition. Edinburg, Churchill Livingstone, London: 633.
12. Steel, R.G., J.H. Torrie and D.A. Dickey, 1997. Principles and Procedures of Statistics, A Biometric Approach, 3rd edition. McGraw-Hill Companies Inc., New York, USA: 121.
13. Pei, Z., S. Xie, W. Lei, X. Zhu and Y. Yang, 2004. Comparative study on the effect of dietary lipids level on growth and feed utilization for gibel carp (*Carassius auratus gibelio*) and Chinese longsnout catfish (*Leiocassius longirostris* Gunther). Aquaculture Nutr., 10: 209-216.
14. Babalola, T.O. and M.A. Adebayo, 2007. Effects of dietary lipid on levels of growth performance and feed utilization by *Heterobranchus longifilis* fingerlings. Journal of Fisheries International, 2(1): 60-64.
15. Aderolu, Z.A. and O.A. Akinremi, 2009. Dietary effects of coconut oil and peanut oil in improving biochemical characteristics of *Clarias gariepinus* juvenile. Turkish Journal of Fish. and Aqua. Sciences, 9: 105-110.
16. Ng, W.K., 2004. Palm oil in salmonid feeds. Aqua Feeds: Formulation and Beyond, 1: 7-9.
17. Ochang, S.N., O.A. Fagbenro and O.T. Adebayo, 2007. Growth performance, body composition, haematology and product quality of the African Catfish (*Clarias gariepinus*) fed diets with palm oil. Pakistan Journal of Nutrition, 6(5): 452-459.
18. NRC (National Research Council), 1993. Nutrient Requirements of Fish. National Academy Press, Washington, DC, pp: 114.
19. Fitzsimmons, K., G. Dickenson, C. Brand and J. Davis, 1997. Effects of reducing dietary lipid levels on growth and body composition of hybrid tilapia in an intensive recirculating-water system. Progressive Fish Culturist, 59: 293-296.
20. Lim, P.K., P.L. Boey and W.K. Ng, 2001. Dietary palm oil level affects growth performance, protein retention and tissue Vitamins E concentration of African catfish, *Clarias gariepinus*. Aquaculture, 202: 101-112.
21. Kaushik, S.J., 2004. Fish oil replacement in aquafeeds. Aqua Feeds: Formulation and Beyond, 1: 3-6.
22. Regost, C., J. Arzel, M. Cardinal, J. Robin, M. Laroche and S.J. Kaushik, 2001. Dietary lipid level, hepatic lipogenesis and flesh quality in Turbot (*Psetta maxima*). Aquaculture, 193(3-4): 291-309.
23. Gaber, M.M.A., 1996. Effect of oil source on growth, feed conversion and body composition of Nile tilapia (*Oreochromis niloticus*). Annals of Agricultural Science, 34: 1549-1562.
24. Ng, W.K., P.K. Lim and H. Sidek, 2001. The influence of a dietary lipid source on growth, muscle fatty acid composition and erythrocyte osmotic fragility of hybrid tilapia. Fish Physio. Biochem., 25: 301-310.

25. Menoyo, D., C.J. Lopez-Bote, J.M. Baustita and A. Obach, 2003. Growth, digestibility and fatty acid utilization in large Atlantic salmon (*Salmo salar* L.) fed varying levels of n-3 and saturated fatty acids. Aquaculture, 225: 295-307.
26. Ng, W.K., Y. Wang and K.H. Yuen, 2004. Replacement of dietary fish oil with palm fatty acid distillate elevates tocopherol and tocotrienol concentrations and increases oxidative stability in the muscles of African catfish, *Clarias gariepinus*. Aquaculture, 233: 423-437.
27. Regost, C., J. Arzel, M. Cardinal, G. Rosenlund and S.J. Kaushik, 2003. Total replacement of fish oil by soybean or linseed oil with a return to fish oil in Turbot (*Psetta maxima*) II. Flesh quality properties. Aquaculture, 220: 737-747.
28. Mourente, G., J.E. Goodand J.G. Bell, 2005. Partial substitution of fish oil with rapeseed, linseed and olive oils in diets for European sea bass (*Dicentrarchus labrax* L.): Effects on flesh fatty acid composition, plasma prostaglandins E2 and F2a, immune function and effectiveness of a fish oil finishing diet. Aquaculture Nutr., 11: 25-40.
29. Wang, Y., K.H. Yuen and W.K. Ng, 2004. Inhibition of lipid peroxidation and distribution of tocopherols and tocotrienols in the tissues of red hybrid tilapia fed a tocotrienol-rich fraction extracted from crude palm oil. Proceedings of the Eleventh International Symposium on Nutrition and Feeding in Fish. Phuket, Thailand, pp: 145.
30. Joshi, P.K., M. Bose and D. Harish, 2002. Changes in certain haematological parameters in Siluroid catfish, *Clarias batrachus* (Linn) exposed to cadmium chloride. Pollution Resources, 21(2): 129-131.