STUDIES ON THE NUTRITION OF BRACKISH WATER CATFISH - CHRYSICHTHYS NIGRODIGITATUS I: PRELIMINARY INVESTIGATIONS ON THE PROBABLE USE OF VEGETABLE OIL IN CATFISH FEEDS.

by

J. E. Igbinosun and
S. O. Talabi
Nigerian Institute of Oceanography & Marine Research,
Lagos.

ABSTRACT

Four groups of brackish water catfish were fed four diets:- N.F. (NIOMR formula 1 feed), A. B. and C. for seven weeks. Feeds N.F., A., B and C. contained 1.21% fish oil + 5.59% vegetable oil; 1.21% fish oil + 7.39% vegetable oil; 1.21% fish oil + 9.09% vegetable oil; 1.21% fish oil + 10.89% vegetable oil respectively. The total amounts of vegetable oil in A., B. and C. included the supplementation of the residual oil in the ingredients with 2%, 4% and 6% respectively with ordinary cooking mixed vegetable oil. Results of feeding trial showed that growth was best in the group fed diets containing 10.89% vegetable oil and least in those containing 9.09% vegetable oil. There seemed to have been a positive correlation between growth rate and hepatic phospholipids, cholesterol, triglycerides and free fatty acids.

INTRODUCTION

Fish farming (aquaculture) has gained more popularity in Nigeria in recent years than it was about a decade ago. Possibly one of the main reasons for this trend could be the increased demand for some fresh and brackish water fish species as compared to the more abundant marine species.

Although tilapia, mullet and catfish are possibly the most common species in the fresh and brackish waters of Southern Nigeria, their large scale production in fish farms is far from being a reality. This slow pace in the development of fish farming in Nigeria is probably not unconnected with the lack of basic knowledge of efficient large scale fish production. Basic data on the nutrient requirements of tropical fresh and brackish water fish species are very vital in compounding balanced pelleted feeds for optimum culture yields. Some of the few fish farms scattered around Nigeria at present rely heavily on imported fish feeds probably formulated for cold water fish species such as rainbow trout. This importation has possibly deterred many people from commercial fish farming. The others who do not import, use inadequate simple components like groundnut cake. Fish feed formulation is still in its embryonic stage in Nigeria. Furthermore, the development is hampered by the fact that most of the working data on fish nutritional requirements are based on temperate fish species. While, for example, there are a lot of references on the lipid and protein requirements of rainbow trout, channel catfish etc, data on tropical fish species are non-existent or scanty. This study has therefore been carried out as the first in a series of investigations that could help in exposing the nutrient requirements of Nigeria's culturable species.

MATERIALS AND METHODS

The composition of the feeds are shown in Table 1. The mixed vegetable oil (E) was the common cooking oil produced by the Vegetable Oil (Nig.) Ltd. - V.O.N. Analysis of the feed ingredients showed that they all contained residual lipids. The individual contribution of the feed ingredients to the total lipid content of each feed is shown in Table 2. Fishmeal was produced at NIOMR plant from miscellaneous fish species. The feed ingredient were mixed and pelleted also at the NIOMR plant to 2mm diameter pellets. Table 3 also shows the proximate composition of the different feeds.

Fourty catfish weighing 75.96 gm were obtained from the NIOMR fish farm - Ikoyi Lagos. They were divided into four groups of 10 fish each and acclimatized for 6 weeks in sea water contained in the laboratory fish tanks each measuring 0.45m x 0.30m x 0.91m During this acclimatization, they were all fed only diet N.F. at rate of 2% of their body weight. The fish in each tank were fed daily and except on weighing days when feeding started after weighing, a 7 hours feeding period 8.30 -15.30 hr. was maintained throughout. Feeding was carried out 4-6 times daily by dropping the pellets randomly a few at a time into the tanks. This was continued on each occasion until the animals ceased ingesting pellets. Any of the daily ration not eaten were accuretly weighed and the weight recorded so that the actual amount consumed by fish in each tank was known.

The fish were weighed weekly. Before all weighing the fish were first transfered to water containing 10ppm of Hypno fish calmer (Jungle Laboratories Corp. Sanford - U.S.A.). Fish became quiescent in about 2 minutes, after which they were collected in a net from which water was allowed to drain for ten seconds and then weighed on tops of a tarred balance. At the end of the 6 weeks, one group continued to be given diet N.F. and the other three groups diets A, B, or C. This feeding trial lasted for seven weeks. All other conditions with regards to weighing frequency, level of feeding etc. were the same as described above.

At the end of the 7 weeks feeding trials, fish for analysis were killed by a blow on the head and necessary organs or tissues neatly excised and stored in the freezer before analysis.

Lipid from the tissues were extracted by the procedure of Bligh and Dyer (1959) in the presence of BHT. Lipid classes were separated by the one dimensional two solvent systems of Freeman & West (1966). For the identification or location of sports on developed plates, the latter was sprayed with a solution of 3% cupric acetate in 8% phosphoric acid; and heated in the oven at 200% for about 30 minutes Quantification of the separated lipid classes was by desitometry employing Quick Scan Jnr. (Helen Laboratories - Beaumont - Texas - U.S.A.). Results were expressed in area per cent. Protein content of tissues was estimated by the Microkjeldal digestion method.

Table 1 Composition of experimental Diets (Wt %).

Ingrdients Diets	N.F.	A	B	C
Palm Kernel Cake	37.0	35.0	33.0	31.0
Fish Meal	25.5	25.5	25.5	25.5
Wheat Offals	37.5	37.5	37.5	37.5
Vegetable Oil (E)	-	2.0	4.0	6.0
Lipid (Total)	6.8	8.6	10.3	12.1
(E) = Added from External source				

Table 2 Percentage Lipid contribution of individual ingredient to the Total Lipids of the feeds.

Ingredients Diets	N.F.	A	B	C
Palm Kernel Cake (R)	4.59	4.34	4.10	3.84
Wheat offals (R)	1.01	1.01	1.01	1.01
Fish meal (R)	1.21	1.21	1.21	1.21
Vegetable Oil (E)	–	2.0	4.0	6.0
Total Lipid (overall)	6.80	8.60	10.30	12.10
Total Vegetable Oil	5.59	7.39	9.09	10.89
Ratio - Fish oil: Vegetable Oil	1:4.6	1:6.0	1:7.5	1:9.0
(R) = Residual Oil				
(E) = Externally added				

Table 3 Proximate composition of the experimental feed (%).

Components Diets	N.F			
Crude protein	38.50	37.93	37.54	37.13
Crude fibre	9.0	8.72	8.44	8.16
Lipid	6.80	8.60	10.30	12.10
Moisture	13.42	13.68	13.64	13.55
Others	32.28	31.07	30.08	29.06

Table 4 Results of 7 Weeks Feeding Trial of Catfish.

Ingredient Diets	N.F	A	B	C
No of fish at start	10	10	10	10
Mortality during 2 weeks feeding trial	1	1	1	1
Average Initial Body Weights (gms)	85	90	96	75
Av. Final Body weights (gms)	100	101.25	98.90	94
Average % Wt. gain	17.64	12.50	3.02	25.33
Average weekly feed efficiency (Feed consumed /wt. gain)	4.88	8.32	22.3	3.1

Table 5 Proximate Composition of Muscle Tissues of the experimental Fish (Wt %).

Component Diets	N.F	A	B	C
Lipid	1.20	0.90	1.02	1.63
Protein	17.72	17.50	20.90	20.40
Moisture	76.10	77.67	75.30	76.38
Ash	1.40	1.10	1.26	1.30

Table 6 Liver and heat indices and the Lipid Contents of the Tissues of experimental Fish.

Components Diets	N.F	A	B	C
Liver index (a)	1.52	1.68	1.50	1.36
Heart index (b)	0.09	0.07	0.08	0.08
% Lipid in liver	1.97	2.23	1.23	1.84
% Lipid in heart	1.68	2.10	5.02	0.41
% Lipid in air sac	0.68	0.51	1.40	1.01
a and b expressed as organ Wt/x100 Wt of Fish				

Table 7 Effects of experimental dietory treatments on Components of catfish liver lipids (%).

Components Diets	N.F	A	B	C
Phospholipids	28.45	20.12	13.84	35.83
Monoglycerides	7.84	1.72	2.20	8.44
Cholesterol	29.48	37.98	37.24	22.57
Free fatty Acids	17.75	-	8.54	30.31
Triglycerides	13.04	40.18	38.18	2.85
Cholesterol Esters	3.44	-	-	-
Total Polar Lipids	28.45	20.12	13.84	35.38
Total Neutral Lipids	71.55	79.88	86.16	64.17

RESULTS

The effects of the seven weeks feeding trial on the weight gain and feed efficiency are presented in Table 4. While there was no abnormality in any of the group fed with the four experimental diets, those fed diets N.F, A and B had mortality of one each. Those fed diet C had the highest weight gain while those fed diet B had the least. Feed efficiency was also optimal in the group fed diet C and least in that fed diet B. Figures 1 and 2 also show the average body weights and average cummulative weight gains during the seven weeks feeding trial. The groups fed diets N.F and A had their peaks of weight gain by the 4th week, after, which the former continued to loose weight until the 6th week and the latter until the 5th week. During the first four weeks of the feeding trial, catfish fed diet B gained and lost weight alternately; apart from the loss in weight in the 2nd week of the feeding trial the group fed diet C gained weight through out the duration of trial.

The proximate composition of the muscle tissues, of catfish fed the four experimental diets are also presented in Table 5. While group C had the highest level of lipid in their muscle, groups A had the least. The groups fed diets B and C also had elevated protein levels in their muscle. On the other hand group A which had the lowest level of lipid in their muscle had the highest moisture level as compared to N.F, B and C.

In Table 6 are presented the liver and least indices (.i.e. weight of organ expressed as a percentage of body weight), the lipid contents of liver, heart and air sac of catfish fed the experimental diets. While there was no significant difference between the liver and heart of the group fed the experimental diets, the groups fed diet A had slightly enlarged livers. Catfish fed diet C had reduced level of lipids in their heart as compared to the other three groups. Diet A also led to increased accumulation of lipids in the liver as compared to groups, N.F, B and C. Groups B and C with the highest levels of dietary lipids also had the highest levels of lipids in their air sacs.

The composition of the lipids from the livers of the four experimental groups are shown in Table 7. Groups C and N.F with the highest growth had the highest concentration of hepatic phospholipids with values of 35.83% and 28.45% respectively. The B group with the least growth had also the least level of liver phospholipids. The phospholipid content of the livers from catfish fed diet A was between the level in B and N.F. Furthermore, the monoglyceride and free fatty acid contents of the livers were highest in those fed diets N.F and C which also gave the best growth. On the other hand, groups A and B with the least growth concentrated more cholesterol and triglycerides in their liver lipids than the N.F and C groups.

DISCUSSION

Nutritionally, fish could be classified into two main groups on the basis of their essential fatty acid requirements. Firstly, there are those like rainbow trout that require only linolenic acid (18:3n-3) or any other members of the n-3 series for efficient nutrition. (Castell et al 1972 a, b and c). Secondly those like carp that seem to need both linolenic and linoleic acids in their diets (Watanabe et al - 1975). The levels of n-3 and n-6 fatty acids in the diets used in the present study are not known, but from the accummulated evidence in literature, fish lipids are much richer in the 18:n-3 fatty acids and higher members than vegetable oils. It is assumed that catfish would belong to any of the two groups described above.

In the present study, although the four experimental diets contained the same levels of fish oil, they were not isocaloric in relation to the levels of total dietary lipids. Furthermore, the growth of the four groups could not be positively correlated with increased dietary lipid levels. Catfish fed diet N.F with the lowest level of lipid had a growth rate almost as good as that of the group fed diet C with the highest level of dietary lipid. The reason for this may not be clear but it is similar to the observations of Watanabe et al (1975). The latter workers observed in their studies on the growth of carp that fat free diets were even more efficient in promoting the growth of carp than the diet containing methyl laurate as the sole lipid source.

In the same study, they found that a certain ration of linolenic to linoleic acids should be maintained in the diets of carp for optimum growth.

The results of the present study would probably indicate that catfish like carp might require both 18:2n-6 and 18:3n-3 fatty acids as their essential fatty acids. This is in consonance with the result that diets N.F and C with the highest and lowest rations of fish oil to vegetable oil had no optimum growth. Although the ratios of fresh oil to vegetable oil in A and B were close to the ratios in N.F and C respectively, the essential fatty acids ratios might have been much wider as to upset the optimum ratios of requirements. Further studies would therefore involve establishing the specific essential fatty acids required in catfish nutrition.

That catfish fed diet C had the highest level of muscle lipid (Table 5) might necessarily reflect composition rather than the levels of dietary lipid, since fish muscle lipids contain more saturated fatty acids than organ lipids. Watanabe et al (1974) found that rainbow trout fed fat free diet or low lipid or essential fatty acid diets had reduced levels of protein and fat and increased levels of moisture in their muscle, heart, liver etc, and tissues. In the present study there was no positive correlation between dietary lipid levels and the levels of moisture, protein and fat in the tissues of catfish. Although Castell et al (1972) observed poor growth and enlarged livers as some of the symptoms of essential fatty deficiency in rainbow trout, the slightly enlarged livers of catfish fed diet A in this study might not have been due to essential fatty acid deficiency. This is so because group B which had the poorest growth had non-enlarged livers.

The effects of the experimental diets on the lipid composition of liver were similar to the observation of Takeuchi and Watanabe (1977). They found that rainbow trout fed poor growth promoting lipid diets accummulated more neutral lipids than phospholipids in their liver lipids. In this study, catfish fed diets N.F and C which promoted more growth accummulated more phospholipids and less neutral lipids in their hepatic lipids.

REFERENCES

Bligh, E. G. and Dyer, W. J. (1959) A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol., 37: 911-917.

Castell, J. D., Lee. D. J., Sinnhuber, R. O. (1972a) Essential Fatty acids in the diet of rainbow trout (*Salmo gairdner*): Lipid Metabolism and fatty acid composition. J. Nutr. 102: 93-100.

Castell, J. D., Sinnhuber R. O., Lee, D. J. and Wales J.H. (1972b) Essential fatty acids in the diet of rainbow trout. Physiological symptoms of EFA deficiency. J. Nutrition 102: 87-92.

Castell, J. D., Sinnhuber R. O., Wales, J. H. and Lee, D.J. (1972a) Essential fatty acids in the diet of rainbow trout: Growth, feed conversion and some gross deficiency symptoms. J. Nutr. 102: 77-86.

Freeman, C. D. and West D. (1966) Complete separation of lipid classes on a single thin layer plate. J. Lipid Res. & 7: 324.

Takeuchi, T. and Watanabe, T. (1977) Dietary levels of methyl laurate and Essential fatty Acid Requirement of RAinbow Trout. Bull. jap. Soc. Sci. Fish 43: (7) 893.

Watanabe, T. Takaghima, F. and Ogino C. (1974) Essential fatty acid requirements of rainbow trout. Bull. jap. Soc. Sci. Fish 40: 181.

Watanabe, T., Takeuchi, T. and Ogino C., (1975) Effects of Dietary methyl Linoleate and Linolenate on Growth of Carp - II Bull. jap. Soc. Sci. Fish. 41 (2): 263.

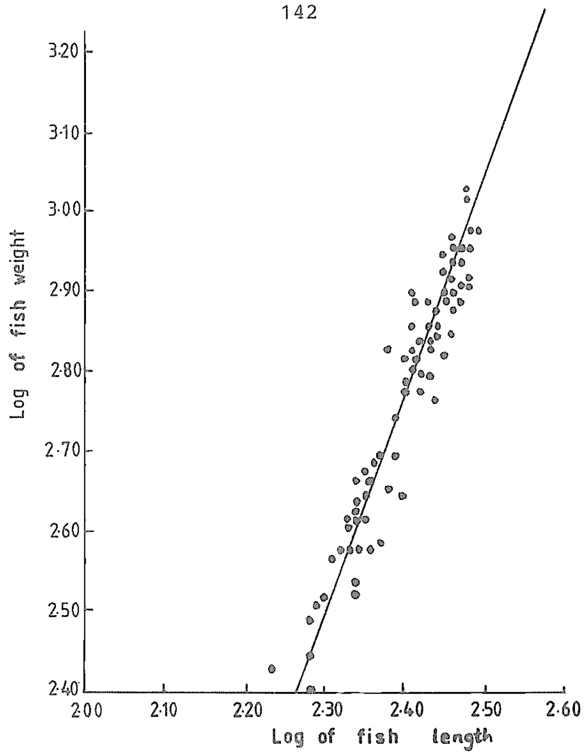

Fig. 1 Fish standard length/scale length relationship for Sarotherodon niloticus in Opạ Reservoir, University of Ife.

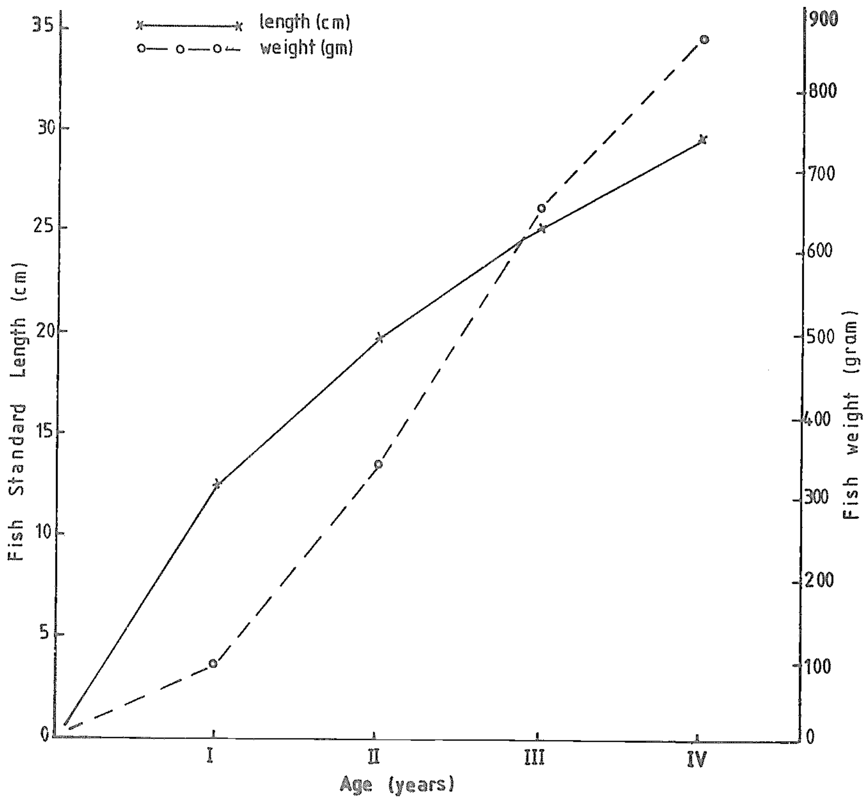

Fig. 2 Growth in length and weight for Sarotherodon niloticus in Opa Reservoir, University of Ife.

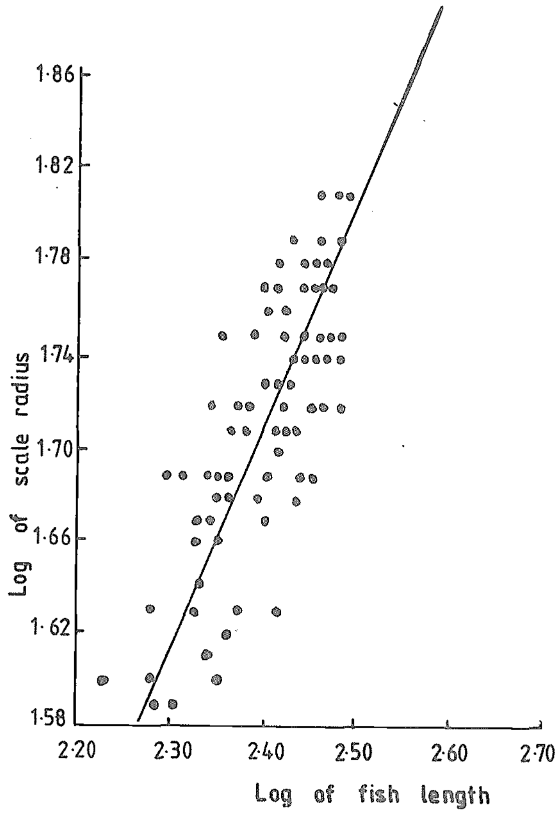

Fig. 3 Log length/log weight relationship for S. niloticus in Opa Reservoir, University of Ife.

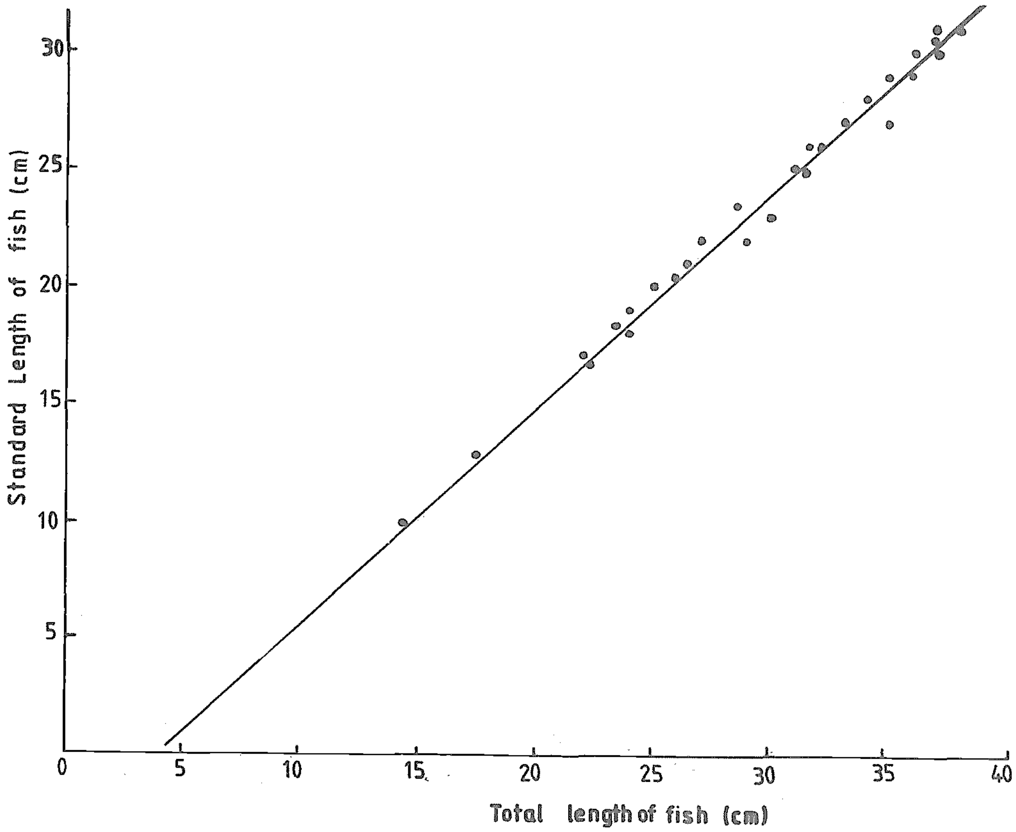

Fig. 4 Fish total length/standard length relationship for S. niloticus in Opa Reservoir, University of Ife.