NIGERIAN INSTITUTE FOR OCEANOGRAPHY AND MARINE RESEARCH

ISBN – 978 – 2345 – 034

Technical Paper No:37

GROWTH RESPONSE OF *CLARIAS GARIEPINUS* (BURCHELL 1822) ON SILAGE-BASED DIETS

BY

O. A. AYINLA AND AKANDE G. R.

JUNE 1988

ISBN – 978 – 2345 – 034

GROWTH RESPONSE OF *CLARIAS GARIEPINUS* (BURCHELL 1822) ON SILAGE-BASED DIETS

BY

O. A. AYINLA AND AKANDE G. R.

TECHNICAL PAPER NO. 37

JUNE 1988

GROWTH RESPONSE OF *CLARIAS GARIEPINUS* (BURCHELL 1822) ON SILAGE-BASED DIETS

O. A. AYINLA AND AKANDE G. R.

ABSTRACT:

The feeding trial of *C. gariepinus* using three silage based diets and one fish meal-based diet was carried out in concrete tanks. The four experimental diets were fed to *C. gariepinus* fry of relatively the same size. At the end of 8 weeks feeding trial the fish increased from their initial body weight of 0.2g, 0.4g, 0.4g and 0.4g to average final weights of 21.2g, 15.4g, 12.8g and 13.8g respectively.

The diet containing 41.1% resulted in the least food conversion efficiency of 1.2 over the eight weeks period. Of the experimental treatments the diets containing the highest level of fish silage (41.0%) performed better than any of the other two treatments of 19.0% and 33.5% fish silage contents.

Apart from the nutritional superiority of 14% fish meal-based diet over the 41% fish silage-based diet the commercial production of fish silage is not yet feasible in Nigeria hence the need to look for the alternative protein source for the replacement of the expensive fish meal in the diet of culturable fish.

INTRODUCTION

It is an established fact that animals including fish perform differently on different sources of nutrient. Fish under the most favourable environmental conditions will grow best if fed with adequate quantity and quality of nutrients.

Clarias gariepinus is an omnivore with the propensity of being carnivorous. Carreon *et al* (1976) noted that young *Clarias gariepinus* feed on zooplankton but after a few months old become omnivore feeding on other live food as large as their buccal cavity can permit. Tobor *et al* (1972) noted that the main food of *Clarias gariepinus* consists of fish, crustaceans and aquatic vegetable.

Christensen (1981) also reported that it can also utilize vegetable proteins. It is not surprising therefore that the species has long been regarded as one of the most suitable species for culture in Africa.

It has been observed by various authors (Albert *et al* 1984, Ayinla in print) that fish meal is a very important protein source in the diets of fish. In view of the high market cost of good quality fish meal, relatively constant chemical composition, it is not surprising therefore that feed costs up to 40 - 60% of the total operating cost of intensive aquaculture enterprise. Clearly, alternative and ideally less expensive sources of good quality protein must be found. Nose (1971), Gropp *et al* (1976), Attach and Matty (1979) and Attach *et al* (1979) found that most attempts to replace fish meal with plant protein for example soyabean meal have lea to reduced grow and low feed conversion in carp and some other fish species.

This study therefore is to determine the growth efficiency of fish silage as a possible replacement for fish meal. Fish silage production is neither capital intensive nor labour intensive.

MATERIALS AND METHODS

COMPOSITION AND PREPARATION OF DIETS.

FISH SILAGE PRODUCTION:

The mixed silage used in this experiment was prepared from herring waste procured from ASTRA Sea Food and produced in the NIOMR processing plant. The raw materials was first minced into suitably small particles obtained using a hammer mill grinder fitted with a screen containing 10mm diameter holes. Immediately after mincing, 360cm3 formic acid was added to the minced flesh and bone mixed together and weighing 12kg. The amount of acid added was calculated on the basis of a known standard of 30 litres of acid to one tonne of fish. After adding the acid, the products were thoroughly mixed so that all the fish come into contact with the acid as pockets of untreated material usually putrefy. Because the rate of liquefaction is effected by the temperature, (the warmer the mixture the faster the process) the mixture was kept under the sun and with occasional stirring for uniformity Complete liquefaction was achieved after 3 days.

EXPERIMENTAL DIET:

Production of Diets:

The wet fish silage was mixed with other ingredients as wheat offal, soyabean meal, mineral and vitamin premix for diets 2, 3 and 4 in calculated percentage composition to produce pelleted diets. Diet 1 was prepared from herring waste into fishmeal and mixed with wheat offal, soyabean meal, mineral and vitamin premix. The wheat offal and soyabean were hammer milled separately and were mixed with the other ingredients at the proportion shown in Table I below. Each of the ingredients were weighed separately according to formulation and carefully mixed in a tray. To the mixed feed ingredients mineral and vitamin premix were added and the compounded diets thoroughly mixed together to produce uniform particule size. Diets that contained wet silage were sun dried to reduce the moisture content after which the mixed diets were pelleted.

TABLE 1

Composition of the experimental diets (%)

Ingredients	diet 1	diet 2	diet 3	diet 4
Herring meal	14.0	9.0	4.0	0
Herring silage	0	19.0	33.5	41.0
Wheat Offal	52	38	28.5	25
Soyabean meal	33	33	33	33
Vitamin and mineral premix	1.0	1.0	1.0	1.0

PREPARATION OF TANKS:

The feeding trial experiments were carried out in 8 equal concrete tanks each measuring about 1 x 1.99 x 1.15.m. Before stocking the fish, the tanks were drained, cleaned and filled with sand to simulate earth pond bottom condition. The tanks were then exposed to sun light for a week to ensure the elimination of any predaceous and competitive animals and parasites. The tanks were later impounded with water fertilized with N.P.K. (15:15:15).

STOCKING:

The 8 tanks were randomly stocked with 30 fry per tank (average weight 0.2g, and 0.4g and average total length 2.58cm). Two tanks were used for each feed treatment.

SOURCE OF THE EXPERIMENTAL FISH:

The fry used for this feeding trial experiment were from the result of an induce breeding experiment carried out on the 19th September, 1986.

FEEDING OF THE FISH:

The fish were fed twice daily (half of the ration at 0.7.00- 08..00 hour and the other half at 18.00 - 19.00 hour) and except on weighing days when feeding was done after weighing. The rate of feeding was 5% body weight per day.

Feeding application was by hand. The grinded particules and few pellets were dropped at the corners of the tanks during each feeding. The fish usually come to the surface to pick the particules, while perhaps the sunk pellets added to the growth of few phytoplanktons.

MEASUREMENT OF THE FISH:

Measurements of the fish weight and length were taken at weekly intervals to assess the growth rate, and revised feeding allowances were calculated on the basis of the total weight of fish. At the end of each week, the water in each tank was bailed out manually using plastic buckets to make for easy examination and counting of the fish. Then 5 fish were usually taken from each tank randomly, measured and weighed individually and recorded as in Table 3. The calculated average weight gain of each fish was multiplied with the total number of fish in each tank for the estimated total biomass of the tank.

ANALYTICAL TECHNIQUES:

Composite samples of two whole fish from each of the four tanks were analysed at the end of the trial. Crude fat was assayed by the procedure of Bligh and Dyer (1959) in the presence of butylated hydroxyl toluene (BHT). Ash was determined by dry ashing at 450oC to burn off all organic material. The inorganic component which did not volatilize at that temperature is known as ash. The moisture was assayed by drying to a constant weight in an air oven with 5g of sample at $103 \pm 2^{o}C$ for 24 hours. Crude protein was determined as N x 6.25 by the Kjeldahl method.

TABLE 2

Proximate composition of the Diets

	Diet 1	Diet 2	Diet 3	Diet 4
Moisture	10.5	11.0	10.7	10.5
Protein	31.12	30.65	29.99	29.35
Lipid	1.49	4.19	5.32	5.89
Fibre	13.96	10.32	8.5	5.8
Ash	3.3.	3.7	3.5	3.4
NFE	39.63	40.14	41.99	45.06

RESULTS:

Proximate Composition of Diets:

Clarias gariepinus fry were fed 3 silage based diets and one fish meal based diets in concrete troughs for eight weeks. The percentage gross composition of the diets is shown in Table 1 and the proximate composition in Table 2. The diets were almost of the same crude protein (30%) and moisture levels. The diets were all high in fibre content which decreased from diet 1 to diet 4. Higher content of wheat offal in diet 1 (52%) accounted for its high fibre content. The lipid content of the diets ranged from 1.49% to 5.89% with diet 4 having the highest.

Growth performance:

Percentage Weight Gain:

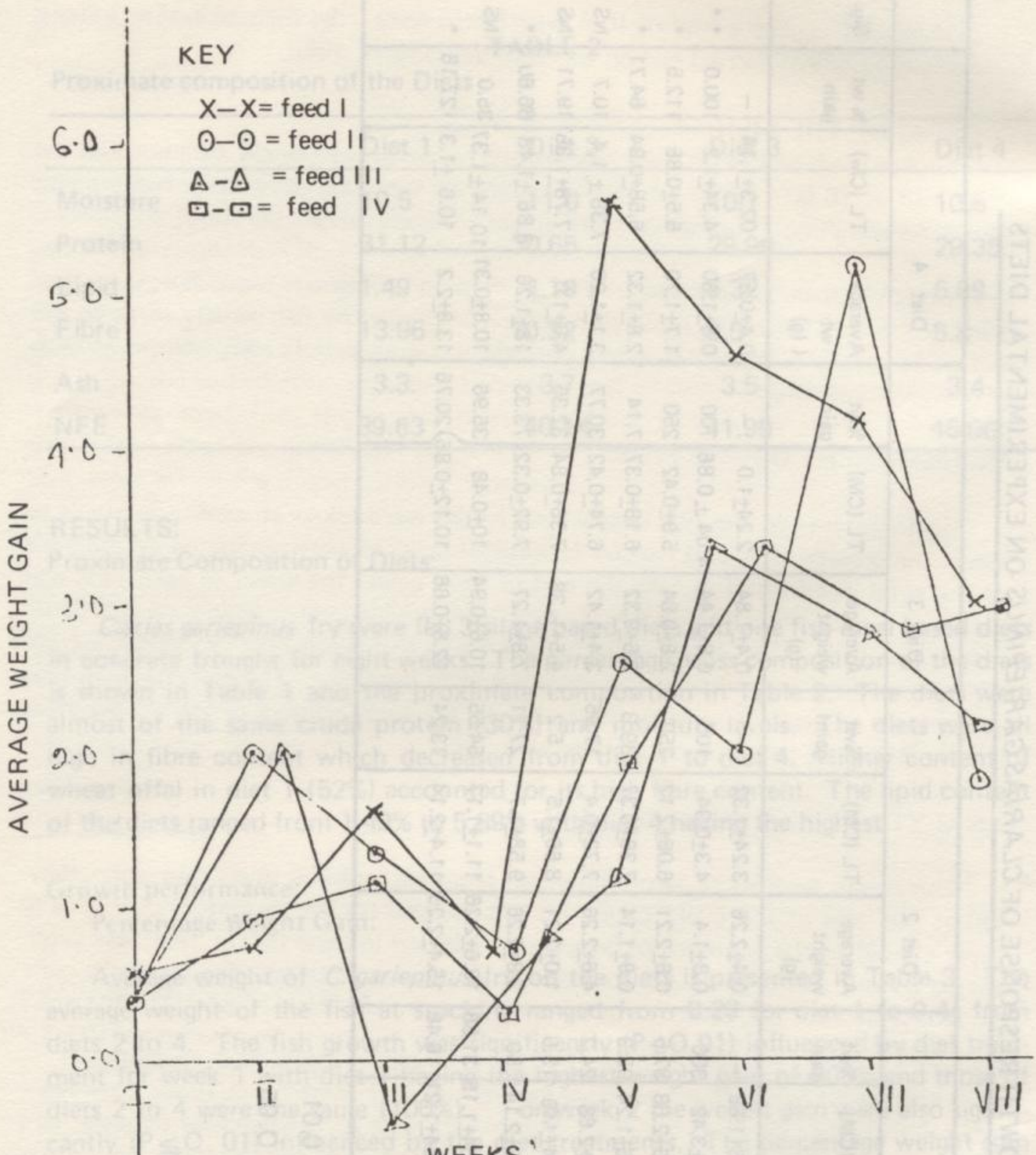
Average weight of *C. gariepinus* fry on the diets is presented in Table 3. The average weight of the fish at stocking ranged from 0.29 for diet 1 to 0.4g from diets 2 to 4. The fish growth was significantly ($P \leq O.01$) influenced by diet treatment for week 1 with diet 1 having the highest weight gain of 300% and those of diets 2 to 4 were the same (100%). For week 2 the weight gain were also significantly ($P \leq O.01$) influenced by the diet treatments. The percentage weight gain ranged from 87.5% to 250% with diets 2 and 3 performing best. Diet 4 showed a better percentage weight gain than diet 1. The trend was changed again for week 3 when diet 1 had the highest percentage weight gain. The diet treatments did not show significant effect on the percentage weight gain of the fish on weeks 4, 5, and 7. The fish growth was significantly ($P \leq O.05$) influenced on week 5 (see figure 1). Fish meal diet showed a better performance than the silage based diets as far as percentage weight gain was concerned.

TABLE 3: **GROWTH RESPONSE OF *CLARIAS GARIEPINUS* ON EXPERIMENTAL DIETS**

Period	Diet 1			Diet 2			Diet 3			Diet 4			
	Average wt weight (g)	TL (CM)	%wt gain	Average weight (g)	TL (CM)	%wt gain	Average weight (g)	TL (CM)	%wt gain	Average wt ((g)	TL (CM)	% wt gain	Sig.
Stocking	0.2±3.38	2.48±1.68	–	0.4±2.26	3.24±1.32	–	0.4±1.84	2.24±1.0	–	0.4±0.87	02.3±1.14	–	
Wk. 1	0.8±0.24	3.9±3.42	300	0.8±1.4	4.3±0.94	100	0.8±1.44	4.04 ± 0.86	100	0.8±1.60	4.34±1.2	100.0	* *
Wk. 2	1.5±0.28	4.56±2.68	87.5	0.8±2.21	6.08±2 12	250	2.8±0.84	5.9±0.42	250	1.7±1.70	5.5±0.88	112.5	*
Wk. 3	2.9±0.38	6.26±1.24	93.3	0.9±1.14	7.36±0.37	39.3	2.6±0.32	6.18±0.37	7.14	2.8±1.32	6.58±0.94	64.71	*
Wk. 4	3.6±0.36	7.1±2.68	24.2	4.6±2.26	7.72±0.4	17.95	3.4±1.42	6.74±0,42	30.77	3.1±1.20	7.38 ± 1.4	10.7	NS
Wk. 5	9.2±0.20	9.64±1.68	15.6	1.0±2.21	8.66±1.5	5.2	4.5±1. 38	7.36±0.84	32.35	4.8±1.0	7.78±1.38	19.71	NS
Wk. 6	13.8±0.41	11.3±2.14	50	3.8±2.26	9.58±1.7	27.71	7.8±1.27	7.92±0.32	73.33	18±1.26	8.86 ±1.48	66.60	*
Wk. 7	18.2±0.72	12.54±1.15	31.88	13.6±2.26	11.1±1.17	54.55	10.6±0.94	10±0.48	35.96	10.8±0.31	10.14±1.37	35.0	NS
Wk. 8	21.2±3.38	13.54±1.21	16.48	15.4±2.26	11.4±2.14	13.24	12.8±0.66	10.12±0.86	20.76	13.8±2.2	10.6 ±1.3	127.18	*

* * Significant at P $\leq$ 0.01

* Significant at P $\leq$ 0.05



-1.0 FIG I THE EFFECIS OF EXPERIMENTAL DIETS ON THE AVERAGE WEIGHT GAIN OF *C. gariepinus*

The cummulative effect of the diets on the fish weight gain has shown that the fish on diet 1 treatment attained a weight of 21.2g after 8 weeks feeding, whereas the fish on diets 2, 3 and 4 attained weights of 15.4g, 12.8g and 13.8g respectively over the same period. This finding has attested to the superiority of fish meal based diet over the silage based diets.

Food Conversion ratio:

The calculated food convertion ratio (FCR) of *C. gariepinus* fry on the diets is presented in Table 4. The FCR of diet 1 treatment was significantly different ($P \leq 0.05$) from the other diet treatment on week 1. For week 2 FCR for diets 1 and 4 treatments were similar and significantly different ($P \leq 0.05$) from those of diets 2 and 3 treatments which were equal. There was no significant difference in the FCR for the diet treatments on weeks 3, 4, 5, 7 and 8. The FCR for week 6 was significantly ($P \leq 0.05$) influenced by the diet treatment on week 6 (see the graphical illustration in Fig. 2).

TABLE 4 The effects of experimental diets on the Food Conversion ratio of *C. gariepinus*.

PERIOD	DIET I	DIET II	DIET III	DIET IV	SIG
WEEK 0	—	—	—	—	—
WEEK 1	2.14	0.71	0.71	0.71	*
WEEK 2	1.25	3.57	3.57	1.61	*
WEEK 3	1.33	0.81	-0.10	0.92	NS
WEEK 4	0.69	0.51	0.88	0.31	NS
WEEK 5	1.44	1.60	0.92	1.57	NS
WEEK 6	1.43	0.79	2.10	1.91	*
WEEK 7	0.91	1.62	1.03	1	NS
WEEK 8	0.47	0.38	0.58 0.59	0.79	NS

Significant at $P \leq 0.05$

Daily Growth Rate:

The daily growth values for weeks 1, 2, 7 and 8 were not significant. The daily growth for weeks 3 and 4 were significantly ($P \leq 0.05$) influenced by diet treatments with diet 1 having the best performance compared with the other diets treatments (see table 5 and fig. 3) for graphical illustration of the effect of the diets on the daily growth rate of *C. gariepinus*.

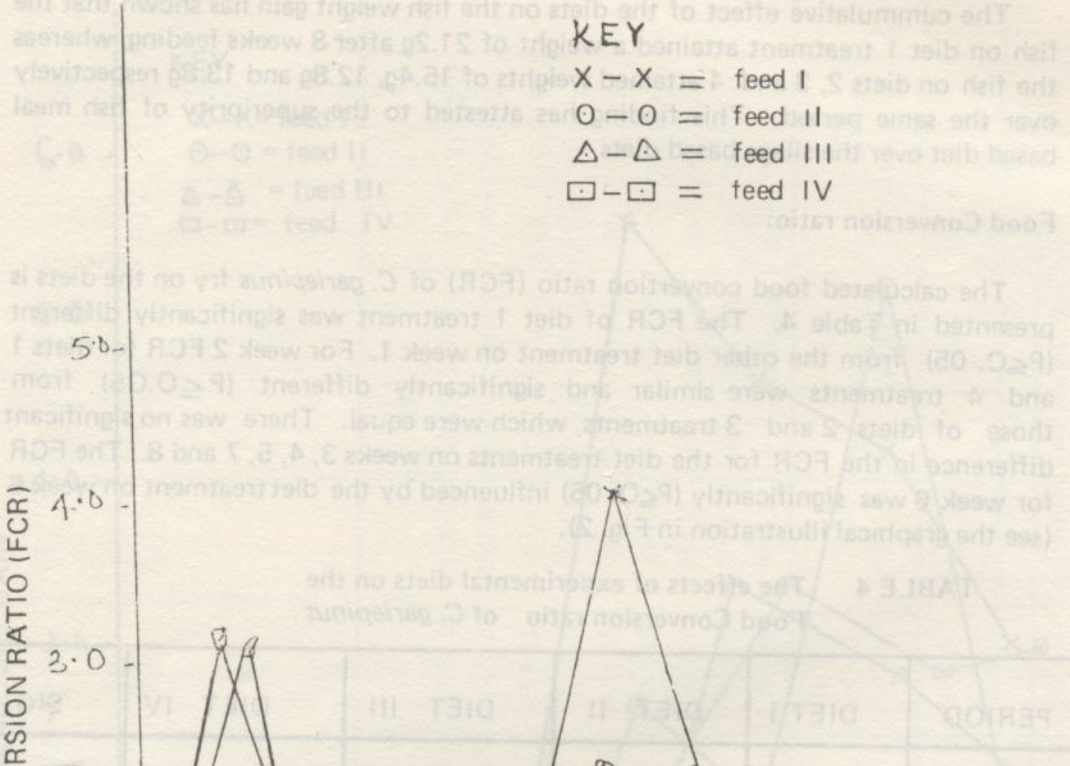


FIG 2 THE EFFECTS OF EXPERIMENTAL DIETS ON THE FOOD CONVERSION RATION *C. gariepinus*

Protein efficiency ratio:

The diets significantly influenced ($P \leq 0.05$) the PER of the *C. gariepinus* on weeks 1 and 2. Diet 1 had the highest PER while the PER for diets 2, 3 and 4 were the same. Diets 2 and 3 had the highest PER for Week 2 while the PER for diets 1 and 4 were comparable and were lower than those of diets 2 and 3. There was no significant different in PER of *C. gariepinus* on weeks 3, 4, 5, 7 and 8. The diets significantly ($P \leq 0.05$) influenced the PER for week 6 with diet 3 having the highest value. The PER of the fish fed the experimental diets is in Table 6.

The Effect of the Experimental Diets on the C. gariepinus Carcass Proximate Composition

The proximate composition of the carcass of *C. gariepinus* fed the experimental diets is in Table 7. The diet did not significantly influence the proximate composition of the muscle of the fed fish. The moisture level ranged from 70.05% to 72.0% while the crude protein level was within the range of 18.2% to 18.6%, lipids content of the fish muscle was within the range of 6.7% to 7.1% while the ash was 2.6% to 2.9%.

TABLE 5: DAILY GROWTH RATE OF *CLARIAS GARIEPINUS* IN EXPERIMENTAL DIETS

Period Weeks	Feed 1 Average Wt gain in wt (g)	DGR (g)	Feed 2 Average wt gain in (g)	DGR (g)	Feed 3 Average wt gain in (g)	Daily Growth Rate (g)	Feed 4 Average wt gain in (g)	DGR (g)	SIG
Week 1	0.6±0.85	0.09	0.4±0.66	0.06	0.4±0.51	0.06	0.4±0.47	0.06	NS
Week 2	0.7±0.85	0.1	2±0.66	0.29	2±0.51	0.29	0.9±0.47	0.13	NS
Week 3	1.4±0.85	0.2	1.1±0.66	0.16	0.2±0.51	0.03	1.1±0.47	0.16	*
Week 4	0.7±0.85	0.1	0.7±0.66	0.1	0.8±0.51	0.11	1.1±0.47	0.16	*
Week 5	5.6±0.85	0.8	2.4±0.66	0.34	1.1±0.51	0.16	1.7±0.47	0.24	NS
Week 6	4.6±0.85	0.66	1.8±0.66	026	3.3±0.51	0.47	3.2±0.47	0.46	NS
Week 7	4.4±0.85	0.63	4.8±0.66	0.69	2.8±0.51	0.39	2.8±0.47	0.4	NS
Week 8	3.3±0.85	0.43	1.8±0.66	0.26	2.2±0.51	0.33	3±0.47	0.45	NS

* Significant at $p \leq 0.05$

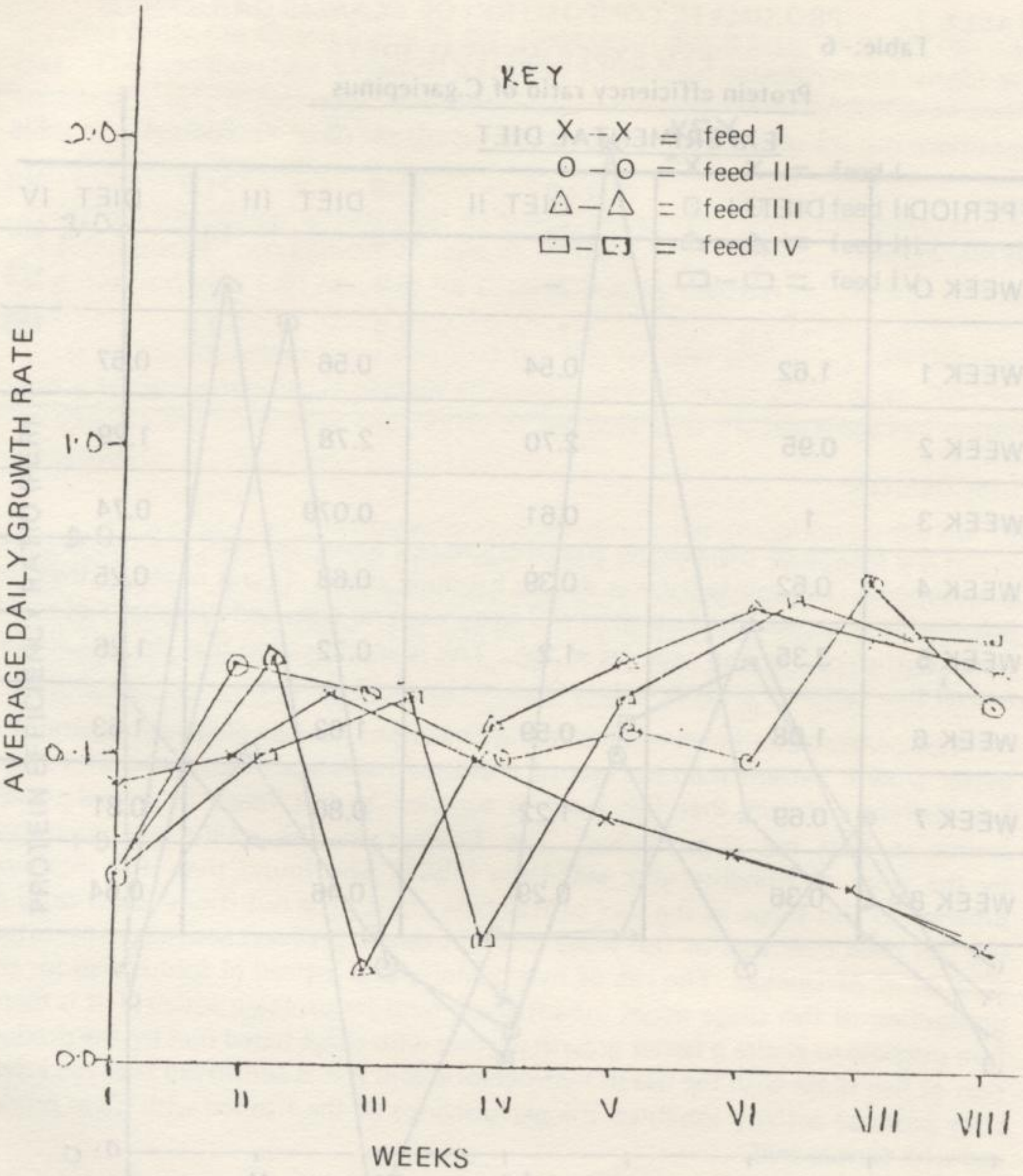


FIG 3 :- EFFECTS OF EXPERIMENTAL DIET ON THE DAILY GROWTH RATE OF *C. gariepinus*

Table:- 6

Protein efficiency ratio of C.gariepinus

EXPERIMENTAL DIET

PERIOD	DIET I	DIET II	DIET III	DIET IV
WEEK O	—	—	—	—
WEEK 1	1.62	0.54	0.56	0.57
WEEK 2	0.95	2.70	2.78	1.29
WEEK 3	1	0.61	0.079	0.74
WEEK 4	0.52	0.39	0.68	0.25
WEEK 5	3.35	1.2	0.72	1.26
WEEK 6	1.08	0.59	1.63	1.53
WEEK 7	0.69	1.22	0.80	0.81
WEEK 8	0.36	0.29	0.46	0.64

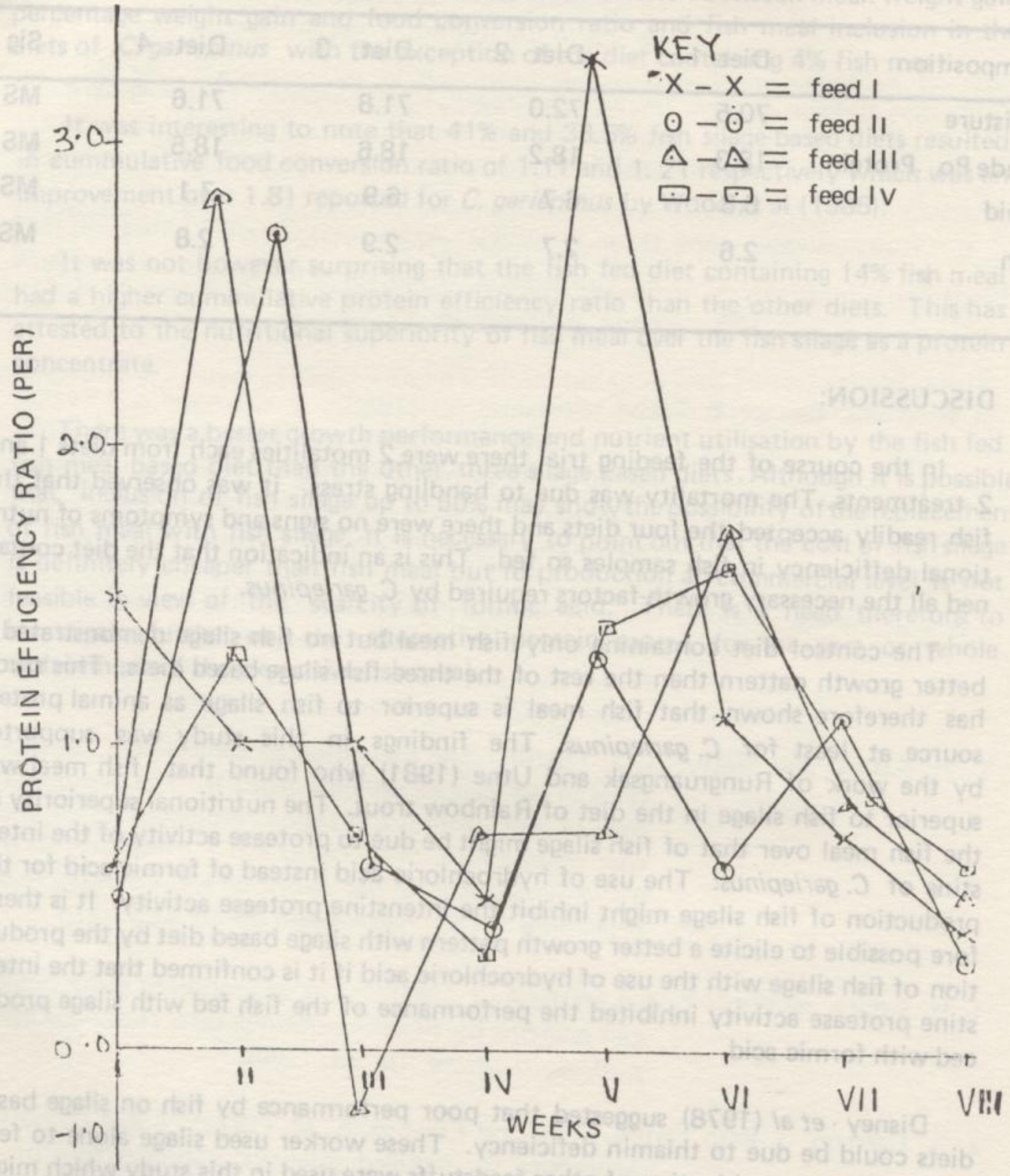


FIG 4 : THE EFFECTS OF EXPERIMENTAL DIETS ON THE PROTEIN EFFICIENCY RATIO OF *C. gariepinus*

TABLE 7 PROXIMATE COMPOSITION OF *CLARIAS GARIEPINUS* FED EXPERIMENTAL DIETS

Composition	Diet 1	Diet 2	Diet 3	Diet 4	Sig
Moisture	70.5	72.0	71.8	71.6	MS
Crude Po Protein	18.3	18.2	18.6	18.5	MS
Lipid	6.8	6.7	6.9	7.1	MS
Ash	2.6	2.7	2.9	2.8	MS

DISCUSSION:

In the course of the feeding trial there were 2 motalities each from diets 1 and 2 treatments. The mortality was due to handling stress. It was observed that the fish readily accepted the four diets and there were no signs and symptoms of nutritional defficiency in fish samples so fed. This is an indication that the diet contained all the necessary growth factors required by *C. gariepinus*.

The control diet containing only fish meal but no fish silage demonstrated a better growth pattern than the rest of the three fish silage based diets. This study has therefore shown that fish meal is superior to fish silage as animal protein source at least for *C. gariepinus*. The findings in this study was supported by the work of Rungruangsak and Utne (1981) who found that fish meal was superior to fish silage in the diet of Rainbow trout. The nutritional superiority of the fish meal over that of fish silage might be due to protease activity of the intenstine of *C. gariepinus*. The use of hydrochloric acid instead of formic acid for the production of fish silage might inhibit the intenstine protease activity. It is therefore possible to elicite a better growth pattern with silage based diet by the production of fish silage with the use of hydrochloric acid if it is confirmed that the intenstine protease activity inhibited the performance of the fish fed with silage produced with formic acid.

Disney *et al* (1978) suggested that poor performance by fish on silage based diets could be due to thiamin deficiency. These worker used silage alone to feed the fish, but a combination of other feedstuffs were used in this study which might prevent the thiaminase effect as reported by Disney et al (1978).

On the other hand Jackson *et al* (1984) found that formic acid silage included at 50% level resulted in a comparable growth with a fish meal based commercial pellet of similar composition in Atlantic Salmon. Probably inclusion of 50% fish silage in the diet may result in a better growth response and nutrient utilisation in *C. gariepinus* instead of 19%, 33.5% and 41.0% silage inclusion levels in this study.

This study has shown that 41% fish silage based diet is superior to 4% fish meal diet. This has therefore suggested a positive correlation between mean weight gain, percentage weight gain and food conversion ratio and fish meal inclusion in the diets of *C. gariepinus* with the exception of the diet containing 4% fish meal.

It was interesting to note that 41% and 33.5% fish silage-based diets resulted in cummulative food conversion ratio of 1.11 and 1. 21 respectively which was an improvement over 1.81 reported for *C. gariepinus* by Wood et al (1985).

It was not however surprising that the fish fed diet containing 14% fish meal had a higher cummulative protein efficiency ratio than the other diets. This has attested to the nutritional superiority of fish meal over the fish silage as a protein concentrate.

There was a better growth performance and nutrient utilisation by the fish fed fish meal based diet than the other three silage based diets. Although it is possible that inclusion of fish silage up to 50% may show the possibility of the replacement of fisn meal with fish silage, it is necessary to point out that the cost of fish silage is definitely cheaper than fish meal but its production at commercial level is not feasible in view of the scarcity of formic acid. There is a need therefore to investigate further on the alternative protein source for the part or whole replacement of the expensive fish meal.

REFERENCE

J. G. Disney, Hoffman, A. V Iley, J. Barrance, I. J. and Francis B. J. (1978): Development of fish silage/carbohydrate animal/feed for use in the tropics. *Trop. Sci. 20:* 129 – 144.

A.. J. . Jackson , Ken, A. K. and Cowey, C. B. (1984a): Fish silage as a dietary ingredient for salmon. Nutritional and storage characteristics, *Aquaculture*: 38:211 - 220.

K. Rungruangsak, and Utne, F. (1981): Effect of different audited wet feed on protease activities on growth rate of rain bow trout, *Aquaculture* 22. 67 - 79.

J. F. Wood, Capper, B. S. and Nicolaides, L. (1985): Preparation and Evaluation of diets containing fish silage, cooked fish preserved with formic acid and low temperature dried fish meal as protein sources for mirror carp *(Cyprinus Carpio), Aquaculture*, 44: 27-40.

T & G. J. Albert, Jacon, I, and Andrew,J. (1984): Utilization of conventional and unconventional protein sources in practical fish feeds. A Review presented in Fish feeding and Nutrition Symposium, Aberdeen July 1984.

T. H. Attach and Matty, A. J. (1979): The evaluation of some single cell proteins in the diet of rainbow trout II. The determination of wet protein utilization, biological value and true digestibility. *In K. Tiaros and J. Halver (Editors), World Symposium on fish Nutrition and F. Technology) i Hamburg 1978 Hadnoeman Berlin* 263 - 273

T. H. Attack, Jauncey, K. and Matty A. J. (1979): The utilisation of some single cell proteins by fingerlings/Mirror carp *(Cyprinus carpio), Aquaculture*, 18: 337 - 348.

J. A. Carreon, J. Esto carpio, F. A. and Enderez, E. M. (1976): Recommended procedure for induced spawning and fingerling production of *Clarias macroceptalus,* Aquaculture: 269 - 281.

J. G. Tobor (1972): The food and feeding habits of some Lake Chad Commercial fishes Bulletin De L' Institut Fondamental D' Afrique Noise. Serie A. Scien Naturelles Tome X X X IV 179 – 211

T. Nose (1971): Determination of Nutritive Value of Food Proteins in Fish. III. Nutritive value of casein; white fish meal and soybean mean in raibon trout fingerlings.
Bull. Fresh Water Fish Res. Lab. Tokyo University 21 : 85 – 96

M. S. Christensin (1981) A note on the breeding and growth rates of the catfish *Clarias mosambicans* in Kenya, Aquaculture 25: 285 – 288

J. Gropp, H. Koops. K. Tiews and H. Beck (1976) : Repalcement of fishmeal by other feedstutfs. *Advances in Aquaculture.* p 596 – 601

E. G. Bligh and W.J. Dyer (1959): A rapid method for total lipid extraction and purification. *Canadian Journal of Biochemistry and Physiology,* 37, 911 – 917