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Effect of unconsumed feed on water quality and growth rate of *Clarias gariepinus* under semi intensive culture system

V. A. Okonji* and M. O. Amrevuawho

Department of Fisheries, Faculty of Agriculture University of Benin, Benin City ,Nigeria.

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ABSTRACT: The effect of unconsumed feed on growth rate and water quality in semi- intensive culture system of *C. gariepinus* was investigated over a hundred and eighty days culture period. Four out door concrete tanks measuring 2.5 x 1.5 x 1.5m (3m^2) was used for the experiment. Two treatments involving the collection of unconsumed feed (tank with collection tray) and non-collection of unconsumed feed (no tray) was used. A stocking rate of 10 fishes/m^2 was applied for each tank with a stocking density of 30fishes/tank. Tanks were fertilized at the rate of 700kg/ha/wk and 60kg/ha/wk for organic fertilizer (poultry droppings) and inorganic fertilizer (N.P.K. 15:15:15) respectively. Cultured fish were fed at the rate of 15%, 10%, 5%, and 3% body weights for the first, second third, and fourth – sixth month respectively. The unconsumed feed was removed four hours after feeding. The experiment was designed as a Complete Randomized Design and data collected were tested using analysis of variance. Data collected include; mean monthly weight gain, survival, total yield and water quality parameters (Dissolved oxygen, Carbon dioxide, biological oxygen Demand, Alkalinity, Calcium, Conductivity, Total Dissolved Solid, Total Suspended Solid, and nitrate concentrations).

The result of the experiment showed that fish survival and yield varied significantly ($P< 0.05$) between treatments. Removal of unconsumed feed resulted in higher fish yield and survival. The water quality analyses showed that dissolved oxygen, biological oxygen demand, conductivity, total dissolved solid, total suspended solid, total solid were better in the tray culture system than in the no tray culture system. Thus, removal of unconsumed feed seems to have improved water quality. It is concluded that fish reared under the tray culture system where unconsumed feed was removed had higher fish survival, yield and better water quality and thus, it is a good culture system.

Key Words: Fisheries; Aquaculture; Water quality; *Clarias gariepinus*.

Introduction

The fishery sector is made up of three main sub-sectors, which include; Artisanal, Marine and Aquaculture sub-sectors. Of these sub-sectors, the bulk of fish for consumption comes from artisanal and marine sub-sectors, with regular decline of fish supply from these sectors over the years.

FAO (1981) reported that the total world fish captured in 1980 declined by almost one million tonnes when compared to 1979 catch. This is due to over fishing of natural fish stock arising from high demand for fish by the ever increasing world population, environmental pollution, use of destructive fishing techniques, increase in cost of meat and other livestock products.

*To whom correspondence should be addressed. E-mail: okovica@yahoo.com

Fish supply is currently short of the demand worldwide and in Nigeria in particular (FAO, 2001). This has necessitated the need to search for an alternative means of increasing fish supply. Aquaculture has been identified as that alternative with its introduction into the Nigerian agriculture industry. It has the advantage of producing large quantities of fish from limited space and in shorter time. It also has a potential of being practiced in areas unsuitable for any other form of agriculture.

Continuous effort had been made to improve aquaculture technology to achieve faster growth and higher yield of fish. Efforts had been focused on stocking, fertilization and natural and supplementary feeding of fish and water quality management. Feeding and good water quality has been identified as one of the most important keys to the success of any fish-farming venture particularly as intensity of stocking increases (Tacon, 1988). Advantages of feeding fish with artificial supplemental diets includes; doubling of growth rate of fish compare to natural feeding alone, enhanced quantity and quality of fish produced, higher feed conversion rate and reduced competition for forage fish.

However, increasing introduction of feed into pond water results in the change of water chemistry and physical properties leading to water quality problem (Norm, 1996). Feed though an important key to the success of any fish culture system has been proven to affect water quality. Therefore, there is a growing consensus on the need to reduce waste from feed in aquaculture so as to minimize the negative effect on the environment (Dominique and Young, 1979).

Farmers and researchers have tried various methods to minimize the water quality problem arising from fish feeding (particularly under intensive and semi-intensive culture system) and maximize the gains of fish feeding by using various methods such as the use of feeding tray (for removal of unconsumed feed) and regular flushing of the pond (flow through system). The use of feeding trays as a means of removing unconsumed feed had not been fully studied and examined.

Generally, three types of strategies had been used to reduce aquaculture waste output i.e. feed formulation, feed requirement prediction models and biological waste elimination. Feed formulation reduces waste at the source i.e. the diet. Pollution problems often result from undigested carbohydrates, nitrogen and phosphorus in the water. Protein and lipids are well digested by fish and represent minor causes of pollution. However, nitrogen excretion resulting from dietary protein oxidation is a major cause of pollution. Optimizing protein energy ratio in diets reduces nitrogen excretion. This principle has led to the formulation of high nutrient diets which are both highly digestible and nutrient/energy dense.

Scientific estimation of feed requirement gives the quantity of feed required by stocked fish using scientific measure. This method deals with minimizing feed waste from an environmental point of view. It supposes that only a small quantity/proportion of a given amount of feed consumed by fish will be excreted as solid waste and suspended waste. Dominique and Young, 1979 noted that as feed wastage increase from 0-30%, solid nitrogenous waste output by the fish quadruples, total solid waste triples and solid phosphorus waste is increased by about 60%. However, in practical terms not all the feed fed to fish can be consumed immediately. Some will still be retained in water and may cause water quality problem over time (Boyd, 1973).

The strategies of feed formulation and requirements fail to put into consideration the effect of unconsumed feed on the environment (Water). It is very difficult to determine accurately the quantity of sinking food that is not eaten by the fish and thus wasted. Unconsumed feed contains such nutrients as nitrogen, carbohydrate, and phosphorus which are dangerous to the water quality at higher levels (Swingle, 1969), thus, it is important to minimize the accumulations of these nutrients by seeking for means of removing the unconsumed feed so as to improve water quality and increase fish yield. It is in line with this that this study is designed to determine the effect of removing unconsumed feed on water quality and fish growth using feeding tray in the semi-intensive culture of *C. gariepinus*.

Materials and Methods

The experiment was carried out at Department of Fisheries concrete tank. A total of four concrete tanks measuring 2.5 x 1.5 x 1.5m each were used. Trays of size 60 x 60cm(covering 10% of pond area) were randomly immersed into two of the tanks under the established feeding point as a treatment while the other two tanks without feeding tray served as another treatment, making a total of two treatments replicated twice. A total of one hundred and twenty (120) *Clarias gariepinus* of five weeks old were collected from fish hatchery and stocked at the rate of 10fishes/m^2. The tanks were fertilized with a combination of organic and inorganic fertilizers at the rates of 700kg/ha/week and 60kg/ha/week respectively. The organic fertilizer used was poultry droppings and the inorganic fertilizer used was N.P.K. 15:15:15. The stocked fingerlings were fed at 15, 10, 5, and 3% of their body weight in the 1st, 2nd, 3rd, and 4-6th months respectively. They were fed twice daily, morning and evening. A 45% crude protein feed was formulated and fed to stocked fish. The unconsumed feed was emptied from the feeding tray daily four hours after feeding. During the culture period, water quality analysis was conducted at a monthly interval to ensure that the culture water is at a desirable range for fish culture through out the culture period and to compare the differences in the water quality of the experimental tanks .The parameters tested included, water transparency, dissolved oxygen, pH, biological oxygen demand (BOD), ammonia, total hardness, nitrate, rite, magnesium and calcium. Water samples were analyzed using the AOAC, 1984 procedure. Also mean weight of fish in each treatment unit was measured monthly through sampling with the seine net and at the end of culture period total weight of fish harvested (fish yield) was measured.

The experiment was designed as a 6 (months) x 2 (treatments) factorial experiment in a Complete Randomized Design (CRD). Each treatment was replicated two times. Table of Analysis of Variance was used to test the data. Means were compared using Duncan Multiple Range Test and Least Significant Difference of Means.

Results and Discussion

The mean monthly weight gain, fish survival and fish yield for the culture period was measured and analyzed. The result of the physico-chemical parameters was also analyzed. The results are presented in two sections as growth parameters and water quality parameters.

a) Growth parameters

i) Mean monthly weight gain

There was no significant difference ($p>0.05$) in the mean monthly weight gain of *C. gariepinus* among the two treatments (table 1). Mean monthly weight gain for the two treatments was similar. This result indicates that removal of the unconsumed feed does not significantly lead to higher weight increment of the fish. This may be attributed to the fact that water pollution due to unconsumed feed is gradual due to gradual breakdown of organic particles by bacteria and consequently gradual release of the excess nutrient that may not be enough to retard growth of the fishes that can withstand the nutrient level.

However, there was a significant difference ($P<0.05$) between the monthly means of the different treatments over time (Table 1 and Figure 1). There was a gradual weight increase from the first month of fish culture to the sixth month. This agrees with Boyd 1973 that noted that culture fish increase in weight over time under cultural practice particularly when fed.

Table 1: Mean monthly weight of *C.gariepinus* in tray and no tray culture system.

Treatment type	Time (months)						Treatment mean
	1	2	3	4	5	6	
No tray	31.7	70.7	125.8	216.1	272.9	332.9	175.0a
Tray	19.3	43.0	101.2	198.9	261.4	332.5	159.4a
Monthly means	25.5d	56.9dc	113.5c	207.5b	267.1b	332.7a	

** Means with different alphabet is significantly different at 5% probability.
Vertical and horizontal comparison for treatment and monthly means respectively

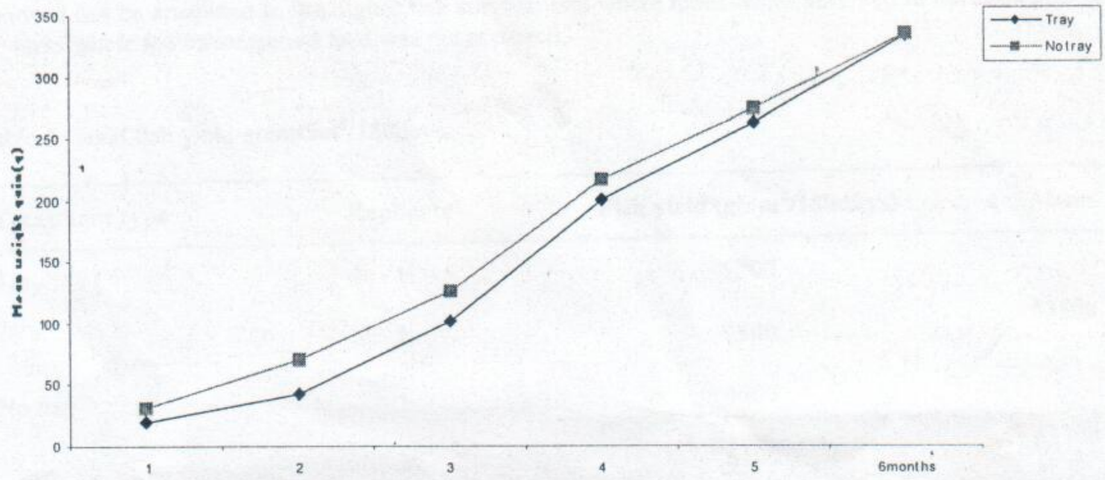

Fig. 1: Mean monthly weight gain of Clarias gariepinus in Tray and no tray treatments

ii) Survival of C. gariepinus in different treatment.

Table 2 shows the survival of *C. gariepinus* in the treatment types recorded from the study. There was a significant difference ($p<0.05$) in the survival rate of both treatments. Survival in the tank where unconsumed feed was not removed (no tray treatment) is lower than that of the treatment where unconsumed feed was removed (tray treatment). This could be attributed to the removal of unconsumed feed in the tray culture system as reported by Boyd, (1973) that nutrient in the feed not consumed by the fish reach the water as metabolic waste and that these nutrient stimulate plankton growth which when in high density lead to poor water quality and eventually mortality of cultured fish.

Table 2: Percentage fish survival.

Treatment type	Replicate	Survival (%)	Mean
Tray	1	80	
	2	57.14	67.1a
No tray	1	54.29	
	2	39.86	48.5b

** Means with same alphabet is significantly different at 5% probability.

iii) Total fish yield

Table 3 shows the total fish yield per gram per $3m^2$ per 180 days. The result showed that there was significant difference ($p<0.05$) between the yield of both treatments. Fish yield for the tray treatment is higher than that of the no tray treatment. The higher fish yield in the treatment where unconsumed feed was removed can be attributed to the higher fish survival rate where more fishes survived to the adult size than the units where the unconsumed feed was not removed.

Table 3: Total fish yield/gram/$3m^2$/180days

Treatment type	Replicate	Fish yield (g/$3m^2$/180days)	Mean
Tray	1	9900	8350a
	2	6800	
No tray	1	4600	5350b
	2	6100	

** Means with different alphabet is significantly different at 5% probability

Also the size distribution of the harvested fish is shown in table 4. The treatment where unconsumed feed was removed recorded higher number of larger and average sized fishes than smaller fishes compared to the treatment where unconsumed feed was not removed ($p<0.05$). This reflects the gradual effects of the inorganic pollutants arising from gradual breakdown of the unconsumed feed.

Table 4: Total weight of cultured fish harvested for the different size ranges.

Treatment type	Size ranges	Replicate	Total weight (g)
Tray	Average	1	4200
	Big	1	3300
	Small	1	2400
	Average	2	2900
	Big	2	3000
	Small	2	900
No tray	Average	1	1900
	Big	1	1300
	Small	1	1400
	Average	2	2900
	Big	2	3200
	Small	2	-

iv) Feed Consumption and feed conversion ratio.

Table 5 shows the feed conversion ratio of the two treatment types. Result from Table 5 revealed that for the culture system with tray (i.e. collection of unconsumed feed), 1kg of feed applied results in 1kg of flesh while in the no tray culture system, 1.3kg feed applied result in 1kg wet fish i.e. fish in the tray culture system had lower feed conversion ratio than the no tray culture system. As noted by Boyd, (1973) fish with low S values (feed conversion ratio) are economical to rear because it is assumed that all the feed fed to the fish are converted to flesh. Thus, fishes reared under the tray culture system are more economical to rear since more fish flesh is produced from lesser fish weight. The better feed conversion ration in the culture units where unconsumed feed are removed may be attributed to better water quality leading to better feeding and growth.

Table 5: Feed Conversion Ratio of the two treatment types.

Treatment types	Feed served (g)	Feed recovered (g)	Fish yield	Feed Conversion Ratio
Tray	16575	110	16700	1.0
No tray	14250	-	10700	1.3

b) **Water quality parameters.**

Results for the determination of water quality parameters of the culture medium are shown in table 6. The result showed that culture units where unconsumed feed was collected had better water quality than units where unconsumed feed was not collected particularly for dissolved oxygen, biological oxygen demand, conductivity, total dissolved solids, total suspended solid, total solid and nitrate concentration. The result (table6) showed that removing the consumed feed improves water quality. This may be attributed to the fact that the unconsumed feed is usually broken down by bacteria into inorganic nutrients which leads to water pollution at higher concentration. This may have also lead to better fish survival and yield in the culture units where unconsumed feed was removed. This result agrees with Boyd, 1979 that reported that reduce level of organic matter in water such as organic fertilizer and feed may improve water quality.

Table 6: Mean values of water quality parameters

Parameters	Treatment types	
	No tray	Tray
pH	6.37	6.36
Dissolved oxygen (mg/L)	4.82	6.00
BOD (mg/L)	4.00	5.11
Carbon dioxide (mg/L)	18.05	13.12
Hardness (mg/L)	55.88	52.00
Alkalinity (mg/L)	141.07	106.00
Calcium (mg/L)	20.95	15.59
Magnesium (mg/L)	2.40	3.14
Chloride (mg/L)	28.76	28.49
Conductivity (Scm^{-1})	0.12	0.09
Total Dissolved Solid (mg/L)	88.97	60.34
Total Solid (mg/L)	90.94	61.78
Total Suspended Solid (mg/L)	2.00	1.47
Nitrate (mg/L)	0.43	0.39

Thus from the result of the experiment, it can be concluded that removal of unconsumed feed from pond water will lead to improve water quality and better fish survival and yield.

References

AOAC (1984). Official Method of analysis(15^{th} ed).association of Official analytical chemist, Washington D.C pp1-10

Boyd, C.E. (1973). The Chemical Oxygen Demand of Waters and Biological Materials from ponds. Trans. Amer. Fish. Soc. 102: 606-611.

Boyd, C.E. (1979). Water Quality in Warm Water Fishponds. Auburn Univ. Craftmaster Printers Inc. Alabama, USA. 359pp. (Opelika).

Dominique, P.B. and Young, Cho, C. (1979).Nutritional Strategies for the Management of Aquaculture Wastes. Addressing Concerns for Water Quality Impacts from Large-scale Great Lakes Aquaculture. http://www.ijc.org/php/publications/html/aquaculture/app04.html. accessed 27/4/2006.

Doudoroff, P. and D.L. Shumway. (1970). Dissolved oxygen Requirements of Fresh water Fishes. FAO Fisheries Biology Technical Paper, No. 86. 291pp.

Food and Agricultural Organization FAO. (1981): Review of State of Aquatic Pollution of East Africa Inland Waters. FAO/CIFA Occasional paper. No. 9. 21pp.

Food and Agricultural Organization FAO. (2001). The State of the World Fisheries and Aquaculture 2000. FAO, Rome, Italy.

Norm Meck. (1996). Pond Water Chemistry. Koi club of San Diego. 7pp.

Swingle, H.S. (1969). Methods of Analysis for Waters, Organic matter, and Pond bottom soils used in Fisheries Research. Auburn Univ., Auburn, Alabama. 119pp.

Tacon, A.G.J. (1988). The Nutrition and Feeding of farmed fish and shrimp- A training manual,2. Feeding methods. FAO Field Document Project GCP/RLA/075/ITA, Field Document No. 2/E, Brasilia, Brazil, 129pp.