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Effects of Sorting on Cannibalism in Catfish (*Clarias gariepinus*) Rose in Concrete Tanks in Maiduguri, North-Eastern Nigeria

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Abstract: This research study was carried out on the effects of cannibalism in catfish (*Clarias gariepinus*; commonly called "*Tarwada*" in Hausa language), rose in indoor aquaculture, at the hatchery complex, NIFFRI, Maiduguri. The experiments were designed into three treatments; 'A' no sorting (control), 'B' daily sorting and 'C' weekly sorting, performed after stocking with two replications. Randomly sourced, sampled brood stocks (2 males and 2 females). Standard method was used to induce breeding of *Clarias gariepinus* by using Ova-prim and fry were obtained. The Juveniles catfish were sorted, counted and stocked into tanks. Their average weight were taken (2.45kg) and density of 100 fish / m^2 was tested in each treatment, water parameters, survival rate, growth performance, rates and effects of cannibalism in *Clarias gariepinus* were determined. Treatment A had the highest mean weight (11.45g ± 2.4), cannibalism rate (40%), with lowest survival rate (60%). Highest survival rate was observed in C (86%), while optimum growth performance was observed in B (4.2g, 5cm, and 8cm). Results revealed that cannibalism is high in treatment A, less in C (2%), same with shooters. High cannibalism in *Clarias gariepinus* juveniles has been established, this could be controlled by frequent sorting (daily). Further studies are to be conducted on the cost implication of controlling cannibalism in outdoor aquaculture.

Keywords: Aquaculture, Cannibalism, *Clarias gariepinus*, Concrete Tank, Fry, Hatchery, Indoor, Ova-Prim

1. Introduction

Catfishes of the family Clariidae, known as "*Tarwada*" in Hausa language, "*Kumudu*" in Kanuri and "*Gbotongo*" in Fulfulde languages, comprise the most commonly cultivated in Nigeria. The growth of Aquacultures rising in Nigeria at the expense of catfish now is largely being boosted. Fishes, especially, catfish (*Clarias gariepinus*) are sources of food for human beings. It is very rich in proteins and vitamins, especially, vitamin A (Retinol). They are source of animal protein. Fishes such as those in the class Clariidae are highly, used and commercialized [31]. Every fish require energy for living, for growth maintenance, migration and reproduction, which is must to obtain food for its survival [22, 26, 29, 34]. Understanding diet and feeding habits (behavior) of fish is useful to all fisheries Scientists who were concerned with the aspect of fisheries [13, 7]. Royle (2001) reported that food of

fish consist of all materials present in its environment. Fishes have been known to food on wide variety of things ranging from Sandy particles, phytoplankton, zooplanktons, leaves, roots, insects, insect larvae, warms, fishes e.t.c. [10, 30, 28, 32]. *Clarias gariepinus* is a benthopelagic fish which is known to have wide range of diet [1, 8, 11, 32, 33]. According to Yalcin *et. al.,* (2002), this specie is economically exploited for food and ornamentals purpose [5]. Catfishes (*Clarias* species) are some of the important fish species for aquaculture due to its high growth rate, significant tolerance to environment stress; reproduction in captivity, resistance to high density culture and its market demand [16]; especially *Clarias gariepinus* is widely accepted by Nigerian consumers and was acknowledged that, these bigger fish are sold for about twice the price of 30 days old fish [16, 24]. *Clarias gariepinus* has an average adult length of more than 1 metre long. These fish have slender bodies, a flat bony head, and a broad, terminal mouth with 4 pairs of barbells. They also have a large accessory breathing organ. They can weigh up to 29 kg or more [4]. Cannibalism is the act of killing and consuming the whole or major part of an individual belonging to the same species, irrespective of its stage or development. It is a common and widespread phenomenon throughout the animal kingdom [18, 27]. Young fish exhibit allometric growth patterns, high growth potentials than the older ones, the intensity of cannibalism would reach a maximum in the early weeks or months of the history when the variability of individual growth would be maximum [10]. Heterogeneous size distributions often lead to social dominance, which in turn results in aggressive behaviour and cannibalism [17]. Cannibalism is thus facilitated by size heterogeneity. But it also affects size heterogeneity, since the smallest fish are consumed by the larger ones, and thus be view as a cause or consequence of heterogeneity [6, 16]. Cannibalism among *Clarias gariepinus*, *Tilapia*, *Heterobranchus longifilis* fry and fingerlings have been identified as one of the major problems by small – scale hatchery operators [26]. Despite the increasing interest in this species, cannibalism among cultured *Clarias gariepinus* has received little attention and the factors underlying it have not much been investigated in details [2]. Therefore, Aquaculture remains the viable alternative for increasing fish production in order to meet the protein need of the people [2, 3, 19, 25]. It was observed that of the over 3,000,000 million tonnes of various freshwater and brackish water fish species in the years 2000, catfish were more abundant next to tilapia [12, 24]. It was reported by Food and Agricultural Organization [12] that 27, 488 million tonnes of catfish produced in 1990 were consumed locally. There is still great need for higher production for both local and international markets which would create labour opportunity. The objectives of this study are to ascertain and assess the effects of cannibalism in *Clarias gariepinus* rose in concrete tanks, the number of juveniles and shooters, determine the optimum sorting frequency for raising and the growth rate of *Clarias gariepinus* juveniles in concrete tanks.

2. Methodology

2.1. Study Area and Location

The study was conducted in Maiduguri, North – Eastern Nigeria. Majority of the local people are small scale business men, farmers, fishermen and herdsmen, Islamic and Western scholars [14]. The major languages are Kanuri, Shuwa-Arab, Hausa and English. It has an area land-mark of 300 square kilometres (300 km^2), lies between latitude 12^0 North to 13^0 North and longitude 13^0 East to 15^0 East. With an estimated population of 629,486 people, out of which 340,809 are males and 288,977 are females [23]. The climatic condition in this area is of a hot dry season (27^0C to 42^0C), and an annual rainfall of 500 to 600 mm has been recorded [14].

2.2. Materials

2.2.1. Apparatus Used

Constructed concrete tanks structure size of 4 m^2 (2 m x 2 m x 1 m)**,** galvanized pipe connected to bore-hole, hatchery metre rule, counting table, pH meter, thermometer, Koi air pump (50 KA), Analytical balance, glass container, syringes and needles, Petri-dishes, bowl and siphon, kankabans (Sponge).

2.2.2. Reagents Used

Hormone (Ova-prim), Normal saline solution (0.85% of NaCl salt), salt (NaCl), Artemia feed and 2mm Copens feed, detergent and bore-hole water.

2.3. Methods

2.3.1. Preparation and Sanitation of Experimental Tanks or Ponds

Six concrete tanks were constructed, having the sizes of 4m^2 (2m x 2m x 1m) each. They were then supplied with water from the Institute bore-hole through galvanized pipe to each. Each tank has independent inlet and outlet ports as part of drainage system. These tanks were first thoroughly washed with water, later with detergent, salt solutions, and rinsed with water finally. They were later filled with water for the experiment. The temperature and the pH of the water were taken and recorded by using the thermometer and the Ph meter respectively.

2.3.2. Sampling of Sample Brood Stocking of Catfish (Clarias Gariepinus)

Four sampled brood stocks (2 males and 2 females), each weighed between 1.2 kg and 1.5 kg, and were randomly sourced from a commercial farm in Maiduguri metropolis, for the purpose of breeding fingerlings for the experimental research study. These brood stocks were stocked in to 2 tanks with high water levels flow for five days for acclimatization as described by [21].

2.3.3. Experimental Stage of Induced Breeding of Clarias gariepinus

The breeding of *Clarias gariepinus* were induced by using the standard method, Ova-prim (hormone) was used to carry

out and to obtain fry for the experiment that is research study.

The gravid females were weighed individually and injected intramuscularly with Ova-prim (hormone) at a dosage of female, 0.5ml / kg of body weight. The injected breeding stocks were kept in a glass container with little water and well covered to avoid the breeding stocks from escaping. The stripping of the female was carried out after a latency period of 8 hours at 28^{O}C water temperature, by means of gentle hand stripping into clean Bowls. The males were sacrificed, testes were removed into clean Petri-dish and milt were collected by maceration of the testes and mixed 0.85% saline solution as described by [20]. This was added to the eggs and mixed by gently shaking the Bowl. The eggs were allowed to fertilize by adding small volume of clean water. The fertilized eggs were then spread on kankabans inside the breeding tanks already prepared with water level of 0.2m respectively.

2.3.4. Experimental Observation of Hatching Fertilized Eggs

The eggs were observed to hatch after 22 hours at 28^{O}C water temperature; hatchings were noticed swimming around the spawning mats, carrying their yolk. The spawning mats were removed on the second day after hatching took place, the tanks were cleaned and the dead eggs were siphoned out. The feeding commenced on the third day after absorption of the yolk. The early fry were fed six times a day between 6:00 AM and12:00 mid-nights with artemia. Aeration through powered aerator and flow through was ensured for five hours daily. Feeding with artemia had being continued, until lasted for two weeks as described by [29].

2.3.5. Experimental Design and Observation

(i) The experimental designed were completely randomized designed, which was consisted of three (3) treatments with two (2) replications; Treatment A, no sorting was done, that is, Control treatment. Treatment B, sorting was done on daily basis after stocking. Treatment C, sorting was done on weekly basis after stocking.

(ii) Prior to the start of the experiment, juveniles were sorted and counted before stocking into experimental tanks. The average weight of the juveniles catfish were taken (2.45g), and the density of 100 fish per metre square (100 fish / m^2) was tested in each treatment. The fish (juveniles catfish) were fed three (3) times daily at 7:00 am, 12:00 pm and 5:00 pm with 2mm Copens feed at 5% body weight respectively. Each tank was supplied with compressed air from Koi-Air Pump (50KA) via air stone. Dead fish were removed and recorded daily, juveniles fish were cropped and counted in the last observation day at the 8th weeks respectively. Data were obtained and recorded accordingly.

2.4. Data Analysis

Data obtained from this research study were subjected to statistical analysis by using means for the measurement of central tendency, and standard deviations for measurement of dispersion and or discrepancy within the variables (determined in triplicates) reported in percentage as described by [30] and as performed by [15].

3. Results and Discussion

3.1. Results

The Data obtained from this research study conducted on the effects of cannibalism in the catfish (*Clarias gariepinus*) rose in the indoor concrete tanks, hatchery complex of the National Institute of Freshwater Fisheries Research, along Gamboro – Ngala Road, Eastern part of Maiduguri, Borno state, Nigeria. Observed to yield the following results in tabulated:

Table 1 shows the stocking density (800 Juveniles Catfish), number of tanks used (6), 2 tanks per treatment which contained 400 Juveniles in each, mean water temperature of the tanks in treatments were; A (28.2^{O}C), B (28.0 ^{O}C) and C (27.9 ^{O}C), the pH in each of the treatment was; A (pH 7.15), B (pH 7.14) and C (pH 7.17) respectively.

Table 2 shows the growth performance of the Catfish (*Clarias gariepinus)* in each treatment A, B, and C to their weight in grams, standard length and the total length in centimetres per the sampling period of eight (8) weeks per each week, and the values obtained were expressed as mean of 2 tanks in each treatment.

Table 3 shows the number and the percentage of fish mortality (natural dead rate) per treatment during the experiments, thus; treatment A had 5 (1%), B had 32 (4%) and C had 102 (13%), which varies significantly with the treatments.

Table 4 shows the mean values of shooters in relation to number, weight, standard length and total length within the experiment conducted, thus; treatment A had 112 shooters, 19.02g, 11.8cm and 13.6cm; treatment B had 48 shooters, 11.41g, 9.4cm, and 10.5cm, then treatment C had 27 shooters, 6.06g, 8.0cm and 9.0cm respectively.

Table 5 shows the survival rate in percentage out of the total number of fish (800 Juveniles Catfish) in each treatment been stocked, thus; treatment A had 478 fish been harvested and the percentage of survival is 59.75%, treatment B had 562 fish been harvested with survival rate of 70.75%, while treatment C had 685 fish been harvested and the percentage of survival is 85.63%.

Table 6 shows the rate of Cannibalism in *Clarias gariepinus* Juveniles under the trial which occurred in the three (3) treatments of the experiments, thus; treatment A recorded 39.62%, and treatment B had 25.75%, while treatment C had been recorded1.62% respectively.

Table 7 shows the summarized rates of fish mortality, survival rate and the cannibalism rate occurred in the three treatments, thus; treatment A had the fish mortality rate of 0.63%, survival rate of 59.75% and the cannibalism rate of 39.62%. Treatment B had the fish mortality rate of 4%, survival rate of 70.25% and the cannibalism rate of 25.75%, while Treatment C had the fish mortality rate of 12.75%, survival rate of 85.63% and the cannibalism rate of 1.62% only.

Table 1. *Values of Density, Number of Tanks Used, Mean Water Temperature and pH.*

Treatment.	Sorting Times.	Density.	Number of Tanks Used.	Mean Water Temperature (°C).	Mean Water pH.
A	no sorting	800	2	28.2	7.15
B	Twice weekly	800	2	28.0	7.14
C	weekly	800	2	27.9	7.17
Total (Mean ± SD).		2400 (800 ± 0).	6 (2 ± 0).	84 (28 ± 0.2).	21.5 (7.2 ± 0.02).

Table 2. *Growth Performance of Clarias gariepinus Juveniles under Trials*

Sampling Periods. (Week).	Treatment A.			Treatment B.			Treatment C.		
	W (g).	SL (cm).	TL (cm).	W (g).	SL (cm).	TL (cm).	W (g).	SL (cm).	TL (cm).
1	2.16	3.1	3.7	2.15	3.0	3.6	2.16	3.1	3.7
2	2.68	3.8	4.5	2.39	3.6	4.1	2.4	3.8	4.1
3	3.2	4.6	5.3	2.94	4.0	4.6	2.4	4.0	4.5
4	4.14	6.5	6.4	3.51	4.6	5.4	3.19	4.6	5.3
5	5.83	6.5	7.5	4.13	5.5	6.4	3.41	5.1	5.8
6	7.3	7.7	8.8	4.99	6.1	7.0	3.86	5.7	6.4
7	8.76	9.0	10.4	6.12	6.9	7.9	4.11	6.2	6.8
8	11.45	10.8	12.0	7.20	8.0	9.0	4.57	6.5	7.2
(M±SD).	46(6±3.3).	52(7±2.6).	59(7±3).	33(4.2±2).	42(5±2).	48(8±2).	26(3.3±0.9).	39(4.9±1).	44(5.5±1.3).

Note: Values are expressed as Mean of two (2) tanks in each Treatment.

Table 3. *Catfish Mortality Rate In The Experiment.*

Treatment.	Number of Death.	Percentage of Mortality.
A	5	0.63
B	32	4.00
C	102	12.75
Total (Mean ± SD).	139(46.33 ± 50.06).	17.4 (5.8 ± 6.3).

Table 4. *Mean Values of Shooters in Relation to Number, Weight and Length*

Treatment.	Number of	Weight Shooters (g).	Standard Length	Total Length
A	112	19.02	11.8	13.6
B	48	11.41	9.4	10.5
C	27	6.06	8.0	9.0
(Mean±SD).	18 (62.33 ± 44.3).	37 (12.2 ± 7).	29 (10 ± 2).	33 (11 ± 2.4).

Table 5. *Survival Rate of Clarias gariepinus Under Trials.*

Treatment.	Number of Fish Stocked.	Number of Fish Harvested.	Percentage of Survival of Fish.
A	800	478	59.75
B	800	562	70.75
C	800	685	85.63
Total (Mean±SD).	2400 (800 ± 0).	1725 (575 ± 104).	216 (72 ± 13).

Table 6. *Rate of Cannibalism on the Clarias gariepinus Under Trials*

Treatment.	Number of Fish Stocked.	Number of Fish Lost.	Percentage of Cannibalism.
A	800	322	39.62
B	800	238	25.75
C	800	115	1.62
Total (Mean±SD).	2400 (800 ± 0).	675 (225 ± 104).	67 (22 ±19).

Table 7. *Rate of Fish Mortality, Survival and Cannibalism Occurred in the Three Treatment*

Treatment.	Fish Mortality Percentage.	Survival Rate Percentage.	Percentage of Cannibalism.
A	0.63	59.75	39.62
B	4.00	70.25	25.75
C	12.75	85.63	1.62
Total (M±SD).	17.4 (6 ± 6).	216 (72 ± 13).	67(22 ± 19).

4. Discussion

The research study on the assessment of cannibalism rate in the growth of *Clarias gariepinus* juveniles in indoor concrete tanks which was conducted in Maiduguri, was designed into three experimental treatments; A (no sorting), B (twice sorting weekly), and C (weekly sorting), with two tanks each, which were stocked 400 juveniles catfish each, and gave a total of 2400 juveniles catfish. The mean temperature and pH of the water used in experiments were 27.9^{o}C and pH 7.17 recorded.

These results revealed that the growth performances of the Catfish in the 3 treatments are expressed as mean value of the two tanks in each treatment. In treatment A, the weight, standard length and the total length were found to be 6g, 7cm, and 7cm. In treatment B, are c, while that of treatment C, are 3.3g, 4.9cm, and 5.5cm respectively. It implies that, in terms of weight treatment A is the highest, seconded by B and the lowest is treatment C. Likewise, with regard to the total length and standard length, treatment C had the highest values, and then followed by treatment B and the lowest is treatment A. This could be as a result of the cannibalism rate amongst the Juvenile catfish. This is due to the cannibalism by shooters which feed on the younger ones. Shooters are those juvenile catfish which grow faster than their counter of the same age.

In another observation made, the results revealed that, number of Catfish mortality in each of the treatments were observed to be in treatment A, B and C are 0.63%, 4% and 13%. This shows that, treatment C has the highest loses, followed by treatment B and the least is treatment A respectively. In another findings, the mean values of shooters in relation to their numbers, weights and lengths in the experimental treatments revealed that, treatment A had the highest number of shooters (112), followed by treatment B (48) and the least was treatment C (27) only. The mean weight of shooters in the 3 treatments A, B and C are that A had the highest values than B, while the least was observed C. i.e. treatment A has the highest, seconded by treatment B and the lest is treatment C. Likewise, the highest mean values of the standard length of the shooters in the 3 treatments A, B and C were 12cm, 9cm and 8cm, and that of the total length are 14cm, 11cm and 9cm respectively. That means, with regard to both lengths, treatment A possessed the highest, treatment B followed and the least is treatment C.

The results revealed that, the survival rates of the Catfish (*Clarias gariepinus*) juveniles under the experimental trials, which were stocked with 800 juveniles each, treatment C had the highest with 685 (86%), followed by treatment B with 562 (71%) and the least is treatment A with 478 (60%). Within the same research study, it revealed that the rates of cannibalism in Catfish under the experimental trials in the 3 treatments A, B and C are found to be 40%, 26% and 2% approximately, of which the highest is treatment A, seconded by treatment B and the least is treatment C and this support the work of most authors such as Hecht, T. & Pienaar, 1993; Dadebo E, 2009.

Finally, the total rate of Catfish mortality is 17%, the total Catfish survival rate is 26% and the total Catfish cannibalism rate is 67% approximately and also the growth performance were high when compared with, there was no sorting. Cannibalism is facilitated by size heterogeneity. But it also affects size heterogeneity, since the smallest fish are consumed by the larger ones, and thus be view as a cause or consequence of heterogeneity. The results obtained from this study supports the works of most authors amongst others are; Hecht and Appelbaum, (1988); Pantastico *et. al*, (1988); Hecht & Pienaar, 1993; Baras, (1999); Dadebo, 2009; Yalcin et al, 2002. Cannibalism among cultured *Clarias gariepinus*, *Tilapia*, *Heterobranchus longifilis* fry and fingerlings have been identified as one of the major problems by small – scale hatchery operators, despite the increasing interest in this species, cannibalism among cultured *Clarias gariepinus* especially, has received little attention and the factors underlying it have not totally been investigated in details. From the findings of this study, it revealed that frequent sorting could reduce the cost of fish lost due to cannibalism, and if that is the case, it will encourage farmers and unemployed persons to take part in the fish production, processing and entrepreneurship as means of job creation.

With the recent plan of the Federal Government of Nigeria's programme on the structured ban on fish importation, according to the Agricultural and Rural Development Minister, statement on the programme [9], "the Government decision to gradually stop the importation of fish is understandable, spends a whopping Ninety seven billion Nigerian Naira (NGN 97 billion) on the importation of 700,000 metric tonnes of fish every year" he made this known at the 27th ANC of Fisheries Society of Nigeria held at Yenago, Delta state. He reiterated that, "there is no debating the wisdom in reducing Nigeria's over-dependence on imported fish, it is important that we develop the capacity to produce the adequate food that we need in adequate quantities. The ban will boast local fish production; create jobs for unemployed Nigerians and some foreign exchange". This study provides the solutions to the problems of catfish cannibalism (by frequent sorting of the shooter which reduces the cannibalism) and the programme on the ban on fish importation is an opportunity to aquaculture farmers and it is a challenge to all fish farmers and fish entrepreneurs at large.

5. Conclusion and Recommendations

5.1. Conclusion

The findings obtained from the research study conducted on the effects of sorting on cannibalism among juveniles catfish growth, had been experimentally designed into three treatments A, B and C, and observed to revealed this results. The total rate of cannibalism is much higher. The rate of cannibalism in treatment A, when compared to other

treatments (B and C) revealed that there could be high loss of juveniles' catfish where no sorting was applied when raising *Clarias gariepinus* in indoor rearing system. Also the optimum performance of treatment B in terms of cannibalism rate and survival rate gave a clear indication that sorting is been required (on daily bases) when raising *Clarias gariepinus* juveniles, which was observed in this research study by the used of optimum sorting in the treatment B, when considered its optimum growth performance, survival rate is high and mortality rate is low and the growth performance is high. The rate of cannibalism is highly noticed in treatment A and less in treatment C, and likewise, same with the number of shooter obtained, this gave a clear indication that there is a high cannibalism rate in *Clarias gariepinus* juveniles and this could be influence by sorting frequencies. The problem of cannibalism in juvenile fish production should be considered. This is because many farmers are being discouraged already from stocking their ponds with fingerlings. The need to encourage and sustain fish in Arid-zone, Nigeria, so as to make aquaculture more reliable and resilient prompted this study with a view of recommending strategies to fish farmers, most particularly in Maiduguri, Borno state, north – eastern Nigeria.

5.2. Recommendations

We recommends that further studies are to be carried out on the cost implication, to evaluate cannibalism rates in *Clarias gariepinus* juveniles in outdoor rearing operations and within a large scope, and same research studies are to be carried out both in indoor and outdoor to ascertain and evaluate the effects of sorting on cannibalism in the same Catfish species raising.

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