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Response of African Catfish (Clarias gariepinus) Fry to Wild and Cultured Zooplankton

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Abstract
This study is designed to determine the growth and survival rate of C. *gariepinus* fed on wild zooplankton, cultured zooplankton and artemia. The experiment was conducted in four (4) different trials with each trial lasting for two weeks. The entire experiment took place over eight (8) weeks. It was found that trials which were fed with cultured zooplankton recorded the highest weight gain with a value of 0.022 g, followed by the trials fed with wild zooplankton with a value of 0.020 g and lastly the least weight gain was for the trials fed with artemia with a value of 0.017 g. No significant difference ($p>0.05$) existed amongst all feeding trials. It was also found in this study that larval catfish of age 3-15 days (average total length 1.167-1.600 cm) consumed zooplankton and gave better growth compared to those fed with Artemia. The study showed that larval catfish fed with artemia had the highest specific growth rate with value of 6.08 % followed by the trials fed with cultured zooplankton with a value of 5.88 % and the least specific growth rate was for trials fed with wild zooplankton with a value of 4.32 %. The survival rate showed that trials fed with artemia had the highest survival rate with a value of 82.250 % followed by trials fed with cultured zooplankton with a value of 78.785 % and the lowest survival rate was for trials fed with wild zooplankton with a value of 28.625 %. A significant difference ($p<0.05$) existed amongst all trials fed with artemia. From these present research findings it can be concluded that cultured zooplankton is advisable and should be fed to larval catfish.
Keywords: Cultured zooplankton, Wild Zooplankton, Artemia, *C. gariepinus.*

INTRODUCTION

In Nigeria, the demand for fish is estimated to be 1.83 million MT (Tobor, 1993). However, the actual fish supply according to a 1993 report was 619, 210 MT with a decline to 515,135 MT in 1994 (FDF, 1995). The shortfall and decline in the fish supply has been attributed to inefficient management, inadequate development and poor harvest technology in terms of handling, preservation, processing, storage and distribution and subsistence aquaculture.

Aquaculture, which promises the most renewable and sustainable option, currently only supplies 2 % of the national demand (Oyero, 2006). This is because aquaculture development in Nigeria has so far been constrained generally by inappropriate technology for the production essentials especially in the area of aquaculture nutrition. The availability of cheap, balanced easily available fish feed and indigenous culture species cannot be over emphasised in the aquaculture industry.

When fish are removed from their natural environment to an artificial one, enough food must be supplied to enable them to grow. This could be in the form of complete rations where the artificial diet furnishes all the nutrients required by the fish or a supplementary diet where part of the nutritional needs of the fish is supplied by the natural feed in the aquatic environment (Eyo, 1996). According to Hetch (2000), the research into inexpensive feed ingredients has not contributed greatly to aquaculture growth and expansion. Fish feed constitutes about 40 % to 60 % of the recurrent cost of most intensive fish farm ventures and can sometimes negate the economic viability of a farm if suitable feeds are not used (Madu *et al*., 2003). This has motivated the search for cheaper alternative sources of protein that is aimed at reducing production cost without compromising fish quality.

Newly hatched fish (larvae) survive and grow best when raised on a diet of live feed notably Artemia nauplii which is not readily available and tends to be very expensive and not easily accessible to the fish farmers. Moreover, experiments have shown that Artemia as a marine organism does not serve as the best feed for fresh water fish fry or larvae. This is based on the fact that Artemia as a marine organism dies in fresh water within two hours of introduction due the problems associated with osmoregulation (Porticelli, 1987, Ovie, *et al*., 1993).

In an attempt to obtain the most suitable alternative for Artemia nauplii as live feed, most local farmers employ the use of zooplankton harvested from the wild when feeding fish fry. However, it has been observed that most of this zooplankton exposes the fish to infectious diseases and predators from the environment. This reduces the gain of obtaining this preferred food (zooplankton) from the wild. Hence there is a need to acquire this feed for larvae that will be free of infectious diseases and predators.

This present study is therefore aimed at examining the effective use of cultured zooplankton over wild zooplankton for raising hatchlings of *Clarias gariepinus.*

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research farm of Delta State University Abraka, Asaba campus between the months of July and September 2013. The experiment was conducted in four (4) different trials and each trial lasted for two weeks. The entire experiment took place over eight (8) weeks.
Two major steps were involved in this experiment. These were:

- Culturing of zooplankton from pig dung
- Spawning of fish and feeding trials

Culturing of zooplankton

A mixed zooplankton population made up largely of *Daphinia sp* and *Moina sp* were isolated and cultured in two 100 litre plastic bowls using a slight modification to the techniques reported by Adeniji and Ovie (1986) and Ovie, *et al* (1993). The zooplankton used was identified by viewing water samples under an Olympus Tokyo (HSB 376700) microscope and using the identification key provided by Jeje and Fernando (1988). A total of 300 g each of pig dung was collected, wrapped in paper foil and sterilised by autoclave at 100 °C at the Delta State University Fisheries Research Laboratory. The sterilised pig dung was then tied in a sack in its cool state and suspended in the bowls containing 70 litres of water. The arrangement was kept under outside illumination in order to encourage photosynthesis and was covered with a mosquito net to avoid unwanted organisms from breeding in it. Fertilisation was allowed to occur for three days before inoculation (introduction of drainage water containing the zooplankton). To ensure a continuous supply of zooplankton, the pig dung was discarded and replaced periodically. Each medium was constantly aerated by stirring.

Spawning of fish

Spawning refers to the natural procedure the fish go through in order to give birth to their fry. The broodstock used for the spawning was procured from a well-established farm. After the procurement, the broodstock were disinfected using saline solution (30 g of NaCl per 10 litres). The sexes were kept separate to avoid indiscriminate spawning, and were allowed to acclimatise for 24 hours.

Broodstock Selection

The male broodstock were selected based on the following criteria:

I. Aggressiveness to other males.
II. Extruding papilla that touches the base of the pectoral fin.
III. Reddish reproduction organ.
IV. Brood fish of 1.5 to 2 kg and 13 to 15months of age.

The female broodstock were selected based on the following criteria:

I. Swollen soft abdomen.
II. Reddish or pinkish urogenital organ.
III. Release of eggs on slight pressure to the abdomen

Administration of Hormone

The female fish were injected intramuscularly above the lateral line just below the dorsal fin at a rate of 0.5 ml of hormone (ovaprim) to 1 kg of body weight of fish. The male fish were not injected. All the broodstock were returned to solitary confinement for a latency period of 9 hrs.

Stripping

The male fish were sacrificed and dissected to get the milt. The female fish were stripped off their eggs after 9 hrs latency period, and at a time when the eggs were freely oozing out on slight touch. The eggs were stripped into a clean receptacle and care was taken while stripping to guard the eggs and the milt from coming in contact with water.

Fertilisation

Milt solution was prepared by macerating the milt with a mortar and pestle, and mixing the extract with saline solution (0.09 % salt). The milt solution was mixed with the eggs and mechanically shaken for one minute. The eggs and milt were then spread on the hatching mat.

Hatching

Hatching is simply the mechanical enzymatic process of breaking the egg shells and the release of the larvae. The hatching of the eggs occurred after a fertilisation process of about 26 hours after incubation. The hatchlings have the yolk sac attached to them for a period of four days at which time they become swim up fry.

Experimental Design and Larvae Rearing

Nine (9) bowls labelled A1 A2 A3, B1 B2 B3 and C1 C2 C3 of 100 litres capacity containing 60 litres of screened borehole water were stocked with 100 fish (four days old) each. Two treatments based on wild and cultured zooplankton were used. The fish in bowls A1 A2 A3 were fed with wild zooplankton, the fish in B1 B2 B3 were fed with cultured zooplankton and the fish in C1 C2 C3 which represented the control were fed with Artemia.

Feeding was done twice daily. Morning (7.00 – 8.00 am) and evening (6.00 – 7.00 pm), with feeding adjusted in accordance with their body weight. The cultured zooplankton were collected from the culture bowl using a standard plankton net and rinsed thoroughly before feeding to the fish. The wild zooplankton was harvested daily during the morning and evening hours from a domestic drainage system outside the school premises, was washed and screened through mosquito netting to eliminate larvae, debris and predators before using it to feed the fish. The uneaten feed in each experimental setup was siphoned off on a daily basis, while the water was also renewed by reducing and adding the same amount of water in each bowl in order to avoid accumulation of ammonia which is harmful to the fish.

Fish sampling

The initial mean weight and total length of the fry were taken using a sensitive analytical balance and a metre rule before commencement of feeding. Subsequently, the weight and total length of the experimental fish were observed on a weekly basis throughout the culture period of two weeks.

- **Weight determination**

Samples to be weighed were randomly removed from each experimental bowl and kept alive in a small plastic bowl and weighed collectively on weighing days. The fish were not fed until the whole exercise was completed. After the measurements, the fish were put in fresh water and then returned to the rearing bowls while subsequent weighing was done individually and the mean weight gain was determined according to Sogbesan and Ugwumba (2008).

$$\text{Weight gain (WG)} = \frac{W1 - Wf}{d}$$

where Wf is the final mean weight gain (mg), W1 is the initial mean weight gain (mg), d is the nursing period in days.

- **Specific Growth Rate**

This was estimated from the logarithm difference in the final and initial mean weights of the fingerlings according to Sogbesan and Ugwumba (2008).

$$SGR = \frac{LogW2/T2 - LogW1 \times 100}{T1}$$

where W2 is the Final weight of the fry, W1 is the Initial weight of the fry, T2 is the Final time, T1 is the Initial time.

- **Survival rate**

At the end of each trial (14 days), all the surviving fish were harvested, counted and divided by the total number stocked.

$$\text{Percentage survival} = \frac{\text{No of fish harvested} \times 100}{\text{No of fish stocked}}$$

Determination of water quality parameters

Water quality data collected during the study included temperature, dissolved oxygen (DO) and hydrogen concentration (pH) and other physiochemical requirements that were monitored and stabilised based on the methods of Boyd and Lichtkpper, (2002),Vivieen and Huisman (2003). These were observed routinely. The water temperature was maintained at 28 to 30 °C, pH at 7.5 to 7.8 and dissolved oxygen (DO) at 7.5 to 8.8 mg\l.

Statistical Analysis

The data collected and computed from the experiment was analysed with one-way ANOVA using the Duncan Multiple Range Test (DMRT) to separate the mean at the 5 % level of significance.

RESULTS AND DISCUSSION

Production parameters for the various feeding samples for all trials are presented in Table 1 to Table 4. From Table 1 which shows results for feeding with cultured zooplankton, it was observed that Trial 2 and Trial 3 had the highest weight gain with a value of 0.024 g followed by Trial 4 with a value of 0.022 g and the least weight gain was Trial 1 with a value of 0.019 g. No significant difference ($p>0.05$) existed amongst all the trials fed with cultured zooplankton.

The length gain in Table 1 shows that Trial 3 had the highest value at 1.90 cm which is slightly higher

than the rest of the trials in this group with values of 1.37 cm for Trial 1, 1.63 cm for Trial 2 and 1.60 cm for Trial 4. No significant difference ($p>0.05$) existed amongst all the trials fed with cultured zooplankton.

Table 1 also shows that Trial 2 had the highest specific growth rate with a value of 6.29 % followed by Trial 1 with a value of 6.20 % and the least level of growth rate was for Trial 4 with a value of 5.32 %. No significant difference ($p>0.05$) existed amongst all the trials fed with cultured zooplankton.

The survival rate in Table 1 shows that Trial 3 had the highest survival rate with a value of 80.00 % followed by Trial 1 at 79.00 % and the least survival rate was for Trial 2 and Trial 4 both with the same value of 78.07 %. No significant difference ($p>0.05$) existed amongst all the trials fed with cultured zooplankton.

Table 2 shows the results for feeding with wild zooplankton and shows that Trial 3 had the highest weight gain with a value of 0.022 g followed by Trial 2 and Trial 4 a value of 0.020 g and the least weight gain was for Trial 1 with a value of 0.018 g. No significant difference ($p>0.05$) existed amongst all the trials fed with cultured zooplankton.

The length gain in Table 2 shows that Trial 3 had the highest value of 1.800 cm which is slightly higher than the rest of the trials with values of 1.30 cm for Trial 1, 1.533 cm for Trial 2 and 1.500 cm for Trial 4. No significant difference ($p>0.05$) existed amongst all the trials fed with wild zooplankton.

Trial 2 had the highest specific growth rate with a value of 5.29 % followed by Trial 1 with a value of 5.20 % and the least growth rate was for Trial 4 with a value of 4.32 %. No significant difference ($p>0.05$) existed amongst all the trials fed with wild zooplankton.

The survival rate in Table 2 shows that Trial 2 and Trial 3 had the highest survival rate with a value of 30.00 % and 30.50 % respectively followed by Trial 1 and Trial 4 with value of 27.50 % and 27.00 % respectively. No significant difference ($p>0.05$) existed amongst all the trials fed with wild zooplankton.

From Table 3, it was recorded that Trial 2 and Trial 3 which was fed with Artemia had the highest weight gain with a value of 0.017 g followed by Trial 1 which was also fed with Artemia with value of 0.016 g and the least weight gain was for Trial 4 fed with Artemia with a value of 0.015 g. No significant difference ($p>0.05$) existed amongst all the trials fed with Artemia.

The length gain in Table 3 shows that Trial 3 had the highest value of 1.17 cm which is slightly higher than the rest of the trials with values of 1.00 cm for Trial 1, 1.07 cm for Trial 2 and 1.10 cm for Trial 4. No significant difference ($p>0.05$) existed amongst all the trials fed with Artemia.

Table 3 also shows that Trial 1 had the highest specific growth rate with a value of 10.84 % followed by Trial 3 with a value of 6.08 % and the least growth rate was for Trial 4 with a value of 5.56 %. No significant difference ($p>0.05$) existed amongst all the trials fed with Artemia in Table 3.

The survival rate in Table 3 shows that Trial 2 and Trial 3 had the highest survival rate with a value of 85.00 % followed by Trial 1 with a value of 80.00 % and the least survival rate was for Trial 4 with a value of 79.00 %. No significant difference ($p>0.05$) existed amongst all the trials fed with Artemia.

From Table 4, it was recorded that trials which were fed with cultured zooplankton had the highest weight gain with a value of 0.022 g followed by the trials fed with wild zooplankton with a value of 0.020 g and the least weight gain was for the trials fed with Artemia with a value of 0.017 g. No significant difference ($p>0.05$) existed amongst all the feeding trials.

The length gain in Table 4 shows that trials fed with cultured zooplankton had the highest value of 1.60 cm followed by trials fed with wild zooplankton with a value of 1.50 cm while the least value of length gain was for the trials fed with wild Artemia with a value of 1.17 cm. No significant difference ($p>0.05$) existed amongst all the feeding trials.

Table 4 shows that trials fed with Artemia had the highest specific growth rate with a value of 6.08 % followed by the trials fed with cultured zooplankton with a value of 5.88 % and the least growth rate was for the trials fed with wild zooplankton with a value of 4.32 %. A significant difference ($p<0.05$) existed amongst all the feeding trials.

The survival rate in Table 4 shows that trials fed with Artemia had the highest survival rate with a value of 82.25 % followed by trials fed with cultured zooplankton with a value of 78.79 % and the least survival rate was for trials fed with wild zooplankton with a value of 28.63 %. A significant difference ($p<0.05$) existed amongst all the trials fed with Artemia.

The food supply during the larval stage of fish is an important factor in achieving high survival and growth rates. Mass mortality of larval and juvenile fish will often occur if the food supply is inadequate (House, 1978). Different species require a different sequence of food during their early life stages. Most freshwater fish are given rotifer or *Molina* as a first feeding (Tarnchalanukit *et al.,* 1982; Tawaratmanikul, *et al.*, 1988; Vatcharakornyothin, *et al.*, 1988), and artificial feeds for juveniles are generally in the form of fine crumbles of appropriate particle size. The larval catfish is no exception. The type of feeding for larval cultured catfish such as zooplankton and Artemia is similar to that for other fish, but the time for feeding may be different. It was found in this study that larval catfish of age 3-15 days (average total length 1.167-1.600 cm) consumed zooplankton and gave better growth compared to those fed with Artemia. Watanabe *et al.* (1983) described the food regimes

used most extensively in the larvae of various fish production in Japan. In newly hatched fish greater than 2.3 mm of body length, rotifers were exclusively given as an initial feed. When the fish reached 7 mm or more, marine copepods such as *Tigriopus*, *Acartia*, *Oithona*and *Paracalanus*were were given. Brine shrimp, *Artemia salina*, were frequently used for the larvae of many fish species during shortages of marine copepods. Tsukashima and Kitajima (1981) reported the rearing of larval and juvenile filefish, *Stephanolepis cirrhifer*, up to the stage of young fish. They were fed rotifer, *Tigriopusjaponicus, Artemia* and subsequently fish meal. Tarnchalanukit *et al.* (1982) reported that *Clariasbatrachus* of age 2-15 days were fed on *Moina,* and fed with a commercial catfish pellet when they reached 10 days old. Chawpaknam *et al.* (1990) reported that fry nursing of two-spot glass catfish, *Ompokbimaculatus,* of age 3-15 days fed with *Moina* showed a better growth and higher survival rates than those fed with egg custard.

The study also showed that larvae fed with artemia showed the highest specific growth rate. This was in line with the results of Amornsakun *et al.* (1997) and Amornsakun *et al.* (1998a).

In this present study, artemia indicated the highest survival followed by cultured zooplankton, while wild zooplankton had a very low survival rate. This must have been as a result of disease infection from the wild environment. This was in line with the findings of Amornsakun, *et al.* (2004[a]).

CONCLUSION AND RECOMMENDATION

From this present research findings it can be concluded that cultured zooplankton is advisable and should be fed to the larvae of catfish. It is recommended that further studies be undertaken on this subject to enhance the available literature and to provide further findings so that fish farmers can be better informed of how to culture zooplankton.

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Table 1: Mean production parameters for the four trials of Cultured Zooplankton

Feeding Sample	Treatment	WG (g)	LG (cm)	SGR (%)	SR (%)
Cultured Zooplankton	1st Trial	0.019±0.011^a	1.37±0.30^a	6.20±3.49^a	79.00±0.67^a
	2nd Trial	0.022±0.012^a	1.63±0.49^a	6.29±3.98^a	78.07±0.10^a
	3rd Trial	0.024±0.012^a	1.90±0.63^a	5.70±3.97^a	80.00±0.70^a
	4th Trial	0.022±0.010^a	1.60±0.47^a	5.32±3.98^a	78.07±0.10^a

Means with the same superscript in the same column are not significantly different (P>0.05).
Where: ± represents the standard error of the mean, WG is the weight gain, LG is the length gain, SGR is the specific growth rate and SR is the survival rate

Table 2: Mean production parameters for the four trials of Wild Zooplankton

Feeding Sample	Treatment	WG (g)	LG (cm)	SGR (%)	SR (%)
Wild Zooplankton	1st Trial	0.018±0.011^a	1.30±0.20^a	5.20±3.39^a	27.50±0.90^a
	2nd Trial	0.020±0.012^a	1.53±0.39^a	5.29±3.88^a	30.00±0.80^a
	3rd Trial	0.022±0.012^a	1.80±0.53^a	4.70±3.87^a	30.50±0.90^a
	4th Trial	0.020±0.010^a	1.50±0.37^a	4.32±3.881^a	27.00±0.60^a

Means with the same superscript in the same column are not significantly different (P>0.05).
Where: ± represents the standard error of the mean, WG is the weight gain, LG is the length gain, SGR is the specific growth rate and SR is the survival rate

Table 3: Mean production parameters for the four trials of Artemia

Feeding Sample	Treatment	WG (g)	LG (cm)	SGR (%)	SR (%)
Artemia	1st Trial	0.016+0.010^a	1.00±0.21^a	10.84±7.61^a	80.00±0.50^a
	2nd Trial	0.017+0.009^a	1.07±0.26^a	5.97±3.58^b	85.00±0.50^a
	3rd Trial	0.017+0.009^a	1.17±0.38^a	6.08±3.69^b	85.00±0.60^a
	4th Trial	0.015+0.008^a	1.10±0.27^a	5.56±3.63^b	79.00±0.700^a

Means with the same superscript in the same column are not significantly different (P>0.05).
Where: ± represents the standard error of the mean, WG is the weight gain, LG is the length gain, SGR is the specific growth rate and SR is the survival rate

Table 4: Mean production parameters of the various feedings samples

Feeding Sample	WG (g)	LG (cm)	SGR (%)	SR (%)
Cultured Zooplankton	0.022+0.011^a	1.60±0.47^a	5.88±3.86^b	78.79±0.39^b
Wild Zooplankton	0.020+0.010^a	1.50±0.37^a	4.32±3.88^c	28.63±0.60^c
Artemia	0.017+0.009^a	1.17±0.38^a	6.08±3.69^a	82.25±0.58^a

Means with the same superscript in the same column are not significantly different (P>0.05).
Where: ± represents the standard error of the mean, WG is the weight gain, LG is the length gain, SGR is the specific growth rate and SR is the survival rate