



SURVIVAL AND GROWTH PERFORMANCE OF *Clarias gariepinus* (CLARIIDAE) FRY ON DIFFERENT DIETS IN AERATED AND UNAERATED NURSERY CONDITIONS



O.O.C. Evolubi^{1*}, K.V. Absalom¹, G.A. RUMA², M. Damshit¹ and A.I. Uja¹

¹Department of Zoology, University of Jos, Plateau State, Nigeria

²Department of Agriculture, Federal College of Education, Pankshin, Nigeria

*Corresponding author: ocevulobi2727@yahoo.ca

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Abstract: A sixteen-days' trial feeding was conducted in the Aquaculture Laboratory of the University of Jos, Nigeria to assess the survival and growth performance of *Clarias gariepinus* fry on four diets in aerated and unaerated nursery conditions: freshwater rotifer (*Brachionus calyciflorus*) cultured on yeast, freshwater rotifer cultured on algae, whole chicken egg and shell-free *Artemia*. 100 fry each were placed in 15 litre plastic tanks with 10 litres of water. Each experimental unit had two replicates. Trial feeding commenced on the 6th-day-post-hatch. Counting and measurement of lengths and weights were taken before and after the feeding trial to determine the percentage survival, mortality rate, percentage length increase, percentage weight gain, condition factor and specific growth rate. The unaerated shell-free *Artemia* treatment had the highest percentage survival (75%) while the highest mortality rate (0.33) was in the aerated whole egg treatment. The unaerated algae-fed rotifer treatment had the best of the growth parameters: percentage length increase (30.56%), percentage weight gain (2600%), condition factor (2.09 g/mm³) and specific growth rate (20.60%/day) while the worst was in the aerated whole chicken egg treatment. Two-way ANOVA and DMRT on the Microsoft[®] Excel[®] platform revealed a significant interaction between the nursery condition and feed-type in all the growth parameters determined (P<0.05). There was also significant difference between aerated and unaerated treatments in all the growth indicators assessed (P<0.05) but there was no significant difference in percentage survival and mortality rate (P>0.05). The findings indicate that shell-free *Artemia* is best for the survival of *Clarias gariepinus* fry while algae-fed rotifers ensure best growth. It also suggests that catfish fry performs better in unaerated nursery condition than aerated one.

Keywords: *Artemia*, *Clarias gariepinus*, growth-parameters, rotifer, whole-chicken egg, zooplankton

Introduction

There has been an ongoing interest of researchers on what should be the appropriate first feed for fish larvae during post-endogenous feeding stage. It is in record that inadequate feeding and poor acceptance of feed is the source of mortality within the first month of the fry's post-endogenous feeding life (Madu *et al.*, 1990; Ekelemu & Nwabueze, 2011). Ovie (2002) and Ibrahim *et al.* (2008) reported that many a fish fry require live feed at the commencement of exogenous feeding. Madu *et al.* (1990) showed that within the first weeks of life, the food of mudfish fry are predominantly zooplankton such as *Moina*, *Brachionus spp.*, *Daphnia* and *Ceriodaphnia*. This is possible because Zooplankton is a living food capsule from which the young growing fish hatchlings derive both macro and micro nutrients, especially the essential amino acids, vitamins, enzymes and in some cases antibiotics (Gatesoupe, 1982).

Among all the possible live food alternatives, rotifer seems more promising. Some of the reasons that have apparently singled it out as live food organism in aquaculture are: one, they have small body size (100-340 µm) and round shape (Lavens & Sorgeloos, 1996) and this makes it a good prospect as first food. Two, they have a slow swimming speed and are planktonic (i.e. can stay in the water column as suspension for a long time) (Lavens & Sorgeloos, 1996; Arimoro, 2006). Three, they can easily be enriched with external nutrient resources. The filter-feeding nature of the rotifers facilitates the inclusion into their body tissues of specific nutrients essential for the larval predators through bio-encapsulation (Lavens & Sorgeloos, 1996). The fourth reason is that they have high reproduction rate (0.7-1.4 offspring.female⁻¹.day⁻¹) and can be reared at very high culture densities; densities of 2000 animals' ml⁻¹ have been reported by Hirata (1979 cited in

Lavens & Sorgeloos, 1996). Even at high densities, the animals reproduce rapidly and can thus contribute to the build-up of large quantities of live food in a very short period of time (Lavens & Sorgeloos, 1996). The fifth reason is that they tolerate a wide range of environmental conditions (Nash & Novotny, 1995; Lavens & Sorgeloos, 1996). They also carry digestive enzymes that facilitate their digestion in the gut of the larvae whose digestive tract development are incomplete at this stage (Abavo *et al.*, 2016).

Foreign starter feeds for larvae, such as decapsulated *Artemia* eggs, are usually very exorbitant and the shelf-life are usually easily lowered when handled by unskilled hatchery staff or where there is lack of adequate facilities. Thus utilising cheaper and easily managed alternative sources like culture of live zooplankton (*Brachionus sp.*) and whole-chicken egg may ameliorate these challenges and provide cheaper fingerlings which will enhance fish production. It is therefore necessary to establish their level of performance against standard use of shell-free *Artemia*.

Materials and Methods

The experiment was carried out in Aquaculture Laboratory of the Hydrobiology and Fisheries Unit of the Zoology Department, University of Jos, Nigeria. This research was conducted using a 4 x 2 x 2 factorial design; representing the feed-types, the aeration factor and the replicates respectively. 100 individual fry were placed in each 15 litres conical plastic bowl containing 10 litres (10,000 ml) of water. The treatments were labelled according to the following four feeding trial regime under aerated and unaerated rearing conditions: yeast-fed rotifer (Yr), Algae-fed rotifer (Ar), whole chicken egg (EG) and decapsulated-*Artemia* cysts (AT) as the control and in two replicates for each pair. Trial feeding commenced on the 6th day-post-

hatch (dph) and lasted for 16 days. The average length and weight of the fry were measured at the beginning and end of the treatments. The experimental fish were fed at 1,900 rotifer /larvae/day (Nash & Novotny, 1995) in the respective rotifer treatments, while whole egg diet was fed at the rate of 1 table spoonful per pond (Chow, 1980) for the first-three days; then, 1 ml/tank/day and the decapsulated-*Artemia* was administered at 8% body weight accordingly; administered in two rations in each case. The feeding schedule was doubled after the eighth day in the case of the rotifer-fed groups and whole egg-fed groups while that of the decapsulated-*Artemia*-fed groups were adjusted based on the average body weight.

Gravid male and female broodstocks of 1.1 kg each raised in a private hatchery were procured in Jos. The female was injected intraperitoneally with ovaprim at a dose of 0.5 ml/kg body weight as recommended by the manufacturer. The fish were kept individually in half-filled 70l glass aquaria covered with net. After a latency period of 14 h at 23°C the eggs were stripped, collected and fertilized artificially with milt from the sacrificed male. The fertilized eggs were evenly spread on the 'kakaban' in the incubation tank. The eggs were incubated in a flow-through system for 27 h before hatching commenced. After 48 h of incubation, the larvae were separated from the incubation tank into the experimental tanks while the remaining were put into the brooding tanks as recommended (Viveen *et al.*, 1985). The water in the experimental tanks were replaced every third day till the end of the experiment.

Zooplankton sampled from the wild was isolated using various filters (Lavens & Sorgeloos, 1996). After some preliminary toxicity tests, 0.09 ppm dichlorvos treatment of the sample and subsequent 20 ppm formalin treatment (Lavens & Sorgeloos, 1996) resulted to a monoculture of rotifer. Two groups of rotifer were cultured in separate 70l circular plastic tanks containing 55 litres (55,000 ml) of water: the first group was raised on baker's yeast fed at 1 g/10⁶ rotifer-day (Lavens & Sorgeloos, 1996) while the second group were raised on algae culture. Algal culture was developed using 65 g of dry chicken dropping, 1 g of super-phosphate, 30 g of groundnut cake and 12.5 g of baker's yeast. The algae inoculum used was sampled from a private fish farm in Jos and screened with 53 µm mesh sieve. It was treated with 0.09 ppm dichlorvos and 20 ppm formalin as with the pure rotifer culture. The whole chicken egg was prepared as described by Chow (1980). The algal culture was covered with a mosquito net to prevent the infestation by water-loving flies and stood for five days before being inoculated with the rotifer culture. Rotifer was harvested using a 53 µm mesh-sized standard laboratory sieve. The harvest was washed into a bowl with water. Three samples of 10 µl were taken from the bowl after stirring gently with glass rod. Each of the samples was fixed with 2 µl formalin for population estimation. The fixed samples were counted under x40 magnification and the population density (p.d) was deduced based on the following formula:

$$p.d = \frac{A1+A2+A3}{3} \times 100 \text{ (individuals ml}^{-1}\text{)}$$

Where: A1, A2, A3 = number of *Brachionus* sp. in samples A1, A2 and A3, respectively. 100: division factor for 1 ml. the appropriate volume of harvest for a ration was then calculated based on the p.d. The harvest was usually done during the feeding period to ensure that nutritional quality of the rotifers do not diminish before feeding them to the fry (Delbos & Schwarz, 2009).

Five physicochemical parameters were monitored daily while the treatments lasted viz: temperature, pH, Dissolved Oxygen (D.O.), conductivity (k) and ammonia. The temperature was measured using standard glass thermometer. The pH was read using Hanna® pH meter (accuracy: ±0.1); while the Dissolved Oxygen was determined using the Winkler method. The ammonia assay was done via the phenol-hypochlorite method. The conductivity (µS/cm) was read-off the digital conductivity meter (Shzhisun Model DDS-12A, China). The parameters were determined using standard procedures outlined by AOAC (1980) and Stirling (1985).

The percentage survival, mortality rate and percentage length increase was calculated based on NACA (1989): Percentage Survival = $\frac{N_2}{N_1} \times 100$. Where N₁= Initial number of fry or number of fry at time t₁; N₂ = Number of fry at time t₂ or final number of fry. Mortality rate (Z) = $\frac{\log_e N_0 - \log_e N_1}{t}$ where N₀ = Initial number of fry; N₁ = final number of fry and t = time in days. Percentage length increase = $\frac{L_2 - L_1}{L_1} \times 100\%$ where L₁: initial length; L₂: final length. The Percentage weight gain (% WG) = $\frac{W_2 - W_1}{W_1} \times 100$ (%) where w₁ = initial weight of fry; w₂ = final weight of fry (Sveier *et al.*, 2000). Condition factor (K) = $\frac{w}{l^3} \times 100$ Where w= weight in grams and l=length in mm (Bagenal & Tesch, 1987). Specific growth rate (SGR) = $\frac{\ln W_2 - \ln W_1}{t} \times 100$ where w₁ = initial weight of fry; w₂ = final weight of fry; t = culture time in days (Castell & Tiews, 1980).

The data obtained were subjected to two-way ANOVA and Duncan's Multiple Range Test (DMRT) using Microsoft® Excel® data analysis platform.

Results and Discussion

The culture media physicochemical parameters monitored within the period is presented in Table 1. Virtually all the parameters were within the acceptable tolerance limit for the experimental fish. These are pH 7.2, dissolved oxygen of 1.7 mg/l, ammonia of 0.2 mg/l (Peteri *et al.*, 1992) and conductivity 20-1500µS/cm (DWAf, 1996 cited in Njoku *et al.* 2015). The only exception was the temperature which had uniform mean value of 21.72±0.11°C in all experimental units relatively lower than the 25°C minimum recommended by Peteri *et al.* (1992). From the table, it will be observed that the highest pH of 7.3 was recorded in the yeast-fed rotifer pair of treatments while the least 7.0 was in the unaerated whole chicken egg treatment. Aerated-Algae-fed rotifer recorded the highest dissolved oxygen content 6.05±0.15 mg/l and conductivity 75.71±4.71 µScm⁻¹ while unaerated-whole chicken egg treatment had the least value of 4.24±0.15 mg/l and 64.41±1.17 µScm⁻¹, respectively. Unaerated-whole chicken egg treatment had 0.0128±0.0015 mg/l unionized ammonia as the highest while Unaerated Algae-fed rotifer treatment had the lowest value of 0.0059±0.0008 mg/l. The two-way ANOVA was significant for pH, Dissolved Oxygen (D.O) and conductivity at the aeration factor level (nursery condition) (P<0.05) while temperature and unionized ammonia was not (P>0.05). At the feed-type factor level, two-way ANOVA was significant for pH, D.O and unionized ammonia (P<0.05) while temperature and conductivity was not (P>0.05). There was significant interaction between the nursery condition and feed-type in only conductivity (P<0.05).

Table 1: Physicochemical Parameters for the Experimental Feeding (Mean±S.E)

Treatment	Temperature °C	pH	D.O. (mgL ⁻¹)	Conductivity (µScm ⁻¹)	NH ₃ (mgL ⁻¹)
Yeast-fed rotifer ₁	21.72±0.1098	7.3	5.31±0.1408 ^c	72.21±1.5826 ^e	0.0100±0.0013 ^c
Yeast-fed rotifer ₂	21.72±0.1098	7.3	5.85±0.1007 ^c	69.49±1.2815 ^h	0.0112±0.0014 ^c
Algae-fed rotifer ₁	21.72±0.1098	7.2	5.62±0.1934 ^c	62.59±2.2087 ^e	0.0059±0.0008 ^c
Algae-fed rotifer ₂	21.72±0.1098	7.3	6.05±0.1548 ^c	75.71±4.7093 ^h	0.0080±0.0009 ^e
Whole chicken egg ₁	21.72±0.1098	7.0	4.24±0.1597 ^b	64.41±1.1742 ^e	0.0120±0.0024 ^f
Whole chicken egg ₂	21.72±0.1098	7.2	4.48±0.2418 ^b	68.75±1.3206 ^h	0.0128±0.0015 ^f
Control ₁	21.72±0.1098	7.2	5.29±0.2018 ^c	70.38±1.3699 ^e	0.0062±0.0008 ^{e,f}
Control ₂	21.72±0.1098	7.2	5.91±0.1353 ^c	71.44±1.0983 ^h	0.0060±0.0006 ^{e,f}

1,2= unaerated and aerated, respectively. Values with the same superscript are not significantly different.

The result of the survival and growth parameters is in Figs. 1-6. The best survival record is in the unaerated-control (shell-free *Artemia* egg) treatment (75±0%) followed by unaerated algae-fed rotifer (52±1%). The aerated-algae-fed rotifer treatment survived more fry (45.5±0.5%) than the aerated-control (shell-free *Artemia*) (12%). This survival records is not fully in line with the report of Okunsebor and Sotolu (2011) who opined that live feed is superior to use of shell-free *Artemia*. The survival records attunes more to the report of Olurin *et al.* (2012) who suggested that shell-free *Artemia* is better than live feed and that of Adewolu *et al.* (2009) which gave a similar result. The least percentage survival (0.00%) (Fig. 1), and highest mortality (Fig. 2), was in aerated-whole-chicken egg. This study recorded a relatively lower survival of fry in aerated ponds compared to the unaerated ones in all the feed - types except in the Yeast-fed rotifer where the reverse was the case (Fig. 1) contrary to the reports of a closely related work by Vijaya and Varghese (1986) and Okunsebor *et al.* (2015). The result on survival in algae - fed rotifer (52 %) is lower than that of Okunsebor *et al.* (2015) who reported a 95% survival of *Clarias gariepinus* fry on rotifers and that of Arimoro (2007) who reported 62.5% and 68% survival for different rotifer diets; this could have arisen from differences in culture condition of the rotifers, methodology and (or) the sanitary regime of the entire process. There was a low survival for fry reared on whole-egg (8 %); this record is just a little higher from another work reported by Abdulraheem *et al.* (2012) where there was a low survival (4.1%) for fry fed on egg yolk alone; and yet lower than the report of Hirimuthugoda *et al.* (1999) where they got 13.3% survival of *Cyprinus carpio* on whole-egg.

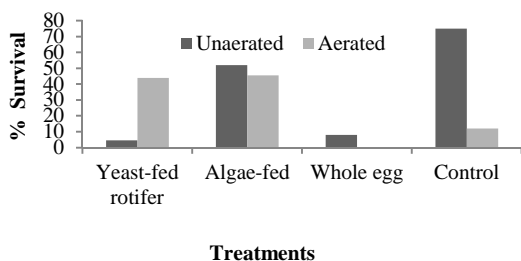


Fig. 1: Percentage survival of *Clarias gariepinus* fry in aerated and unaerated treatments.

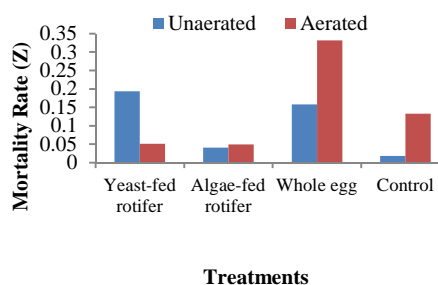


Fig. 2: Mortality rates of *Clarias gariepinus* fry in aerated and unaerated treatments.

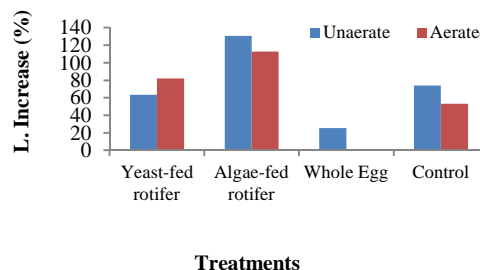


Fig. 3: Percentage length increase of *Clarias gariepinus* fry in aerated and unaerated treatments.

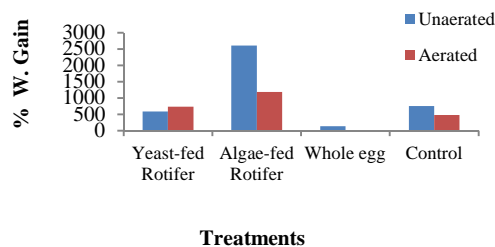


Fig. 4: Percentage weight gain (% WG) of the *Clarias gariepinus* fry in different treatments.

The growth parameters: percentage length increase (Fig. 3), percentage weight gain (Fig. 4) condition factor (Fig. 5) and specific growth rate (Fig. 6) were better for the unaerated tanks than for the aerated ones with the

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exception of Yeast-fed rotifer suggesting that aeration constitute some form of disturbance to fry growth. Percentage length increase was highest (130.56%) in aerated-Algae-fed rotifer followed by aerated-Algae-fed rotifer (112.83%). The control (shell-free *Artemia*) had 73.96% and 53.10% for the unaerated and aerated respectively while the least (0.00%) was the aerated-whole-chicken egg (Fig. 3). The highest percentage weight gain, 2600%, was in unaerated-Algae-fed rotifer followed by aerated-Algae-fed rotifer with 1180%; the next is the unaerated control (shell-free *Artemia*), then you have the yeast-fed group at 729.1% and 586% for the aerated and unaerated respectively. Thereafter, you get the aerated-control at 475.2% followed by unaerated whole chicken egg at 132.7% while the least, 0%, was in aerated whole chicken egg (Fig. 4). The percentage weight gain in unaerated algae-fed rotifer treatment (2600%) is higher than that reported by Okunsebor *et al.* (2015) 265%.

The best condition factor (2.10 g/cm³) was in unaerated-Algae-fed rotifer followed by the aerated-control (1.69 g/cm³), unaerated-control (1.54 g/cm³), unaerated-Yeast-fed rotifer (1.47 g/cm³), aerated-Yeast-fed rotifer (1.33 g/cm³); while the least (0.00 g/cm³) was in aerated-whole-chicken egg (Fig. 5). The condition factor of the aerated-Yeast-fed rotifer seem to suggest that the length increase in the fry fed with this feed did not have a commensurate weight increase probably due to disturbance from aeration. Therefore, in spite of the fact that they have a longer mean length (12.05±0.30 mm), the body mass were smaller than those of closest in rank (11.43±0.23 mm) lengthwise (Fig. 3 & 5). Some of the fry showed signs of lordosis (broken back disease). These suggest lack of certain essential nutrients (components of bone formation) in the rotifers grown with bakers' yeast alone (Jatau, 1995; Lavens & Sorgeloos, 1996). The highest specific growth rate (20.60%/day) was in unaerated-Algae-fed rotifer, followed by aerated-Algae-fed rotifer (15.93%/day), unaerated-control (13.41%/day), aerated-Yeast-fed rotifer (13.22%/day), unaerated-Yeast-fed rotifer (12.19%/day), unaerated-whole-chicken egg (5.36%/day) (Fig. 6).

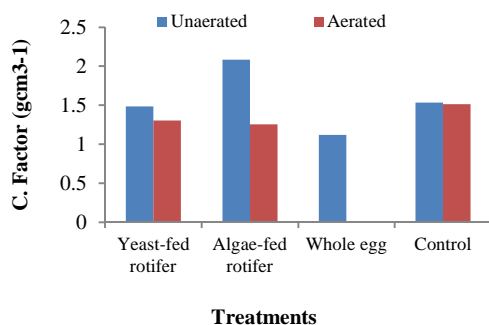


Fig. 5: Condition factor of *Clarias gariepinus* fry in different treatments.

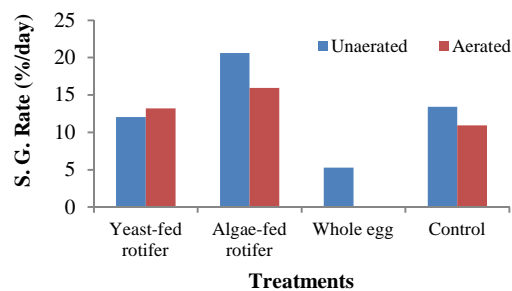


Fig. 6: Specific growth rate of *Clarias gariepinus* fry in different treatments.

Two-way ANOVA test was carried out on all the parameters and *Duncan's Multiple Range Test* (DMRT) was done where applicable. There was no significant difference in survival in all feed-types ($P>0.05$) except between algae-fed rotifer and whole chicken egg which was significantly different ($P<0.05$). There was a significant difference between all the feed-types in SGR and percentage weight gain ($P<0.05$) except between yeast-fed rotifer and control (*Artemia*) where there was no significant difference ($P>0.05$). For the condition factor, there was a significant difference only between whole chicken egg and algae-fed rotifer, yeast-fed rotifer, as well as with the control (*Artemia*) ($P<0.05$). There was also significant difference between aerated and unaerated nursery conditions in SGR, percentage weight gain, condition factor and percentage length increase ($P<0.05$); but this was not the case for percentage survival and mortality rate. There was significant difference for all the percentage survival and mortality rate at the feed-type factor level but at the aeration factor level percentage survival and mortality rate was not significant ($P>0.05$). There was significant interaction between the feed-type and the nursery condition in all the parameters measured ($P<0.05$).

Conclusion

It is evident here that aeration of nursery water, much as it improves the Dissolved Oxygen content of culture ponds, inhibits growth probably through the mechanical shock to which it exposes the fry. Observations made during the work, especially in the whole - egg treatments suggested that the fry begins to get uneasy when the dissolved oxygen level drops below 1 mgL⁻¹. There was total mortality in the aerated whole chicken egg within the first eight days of the trial feeding probably due to mechanical shock. It can also be inferred that algae- cultured rotifer stands a better chance of serving as *Clarias gariepinus* first food than shell-free *Artemia*, whole chicken egg and yeast cultured rotifer considering performance in various growth parameters. Hatchery operators are encouraged to use algae-fed rotifer as first food for their fry if they target good growth as it is easily cultured and readily accessible from local pools. When the goal of hatchery operation is maximum survival, shell-free *Artemia* is effective. Fry nursery management should also deemphasize use of aerators for better growth. There is need for more study to ascertain the possibility of a synergistic effect of using both *Artemia* and rotifer as first food.

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