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Performance of *Heterobranchus bidorsalis* Larvae Fed Artificial Starter Diets

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Abstract

An experiment was conducted for 28 days to assess the survival and growth performance of *Heterobranchus bidorsalis* swim-up larvae fed (decapsulated artemia, commercial feed, egg powder and fish meal). Each diet was tested in triplicate on 1000 larvae per 75ltr plastic bowl experimental unit arranged in a completely randomized design. The highest survival (43.1±5.87) % was achieved in larvae fed decapsulated artemia, and was significantly ($p < 0.05$) higher than those subjected to Egg powder, but similar to other treatments. Percentage weight gain (3421.18±181.47) were found to be significantly ($p < 0.05$) higher in larvae fed decapsulated artemia than the other three treatments. There was no significant ($p > 0.05$) difference between the SGR (12.71±0.19) of larvae fed decapsulated artemia and Fish meal in which values of 12.71±0.19 and 11.64±0.30 were recorded respectively. The condition factors were all less than one (1) and not significant between the larvae fed the control diets. Fish meal and the commercial diet are recommended as starter diets for larvae survival.

Keywords: *Heterobranchus bidorsalis,* Swim-up larvae, Artificial starter diets, Survival and growth.

Introduction

The story of aquaculture in Nigeria is essentially that of catfish culture particularly those of the genus *Clarias* and *Heterobranchus* (Adewumi and Olaleye, 2011). After successful fertilization and hatching of larvae of this species, the main goal of a hatchery operator is to ensure high percentage larval survival and growth of high quality and healthy fry to attain fingerlings that will be stocked in grow-out production ponds. One of the major problems faced by aquaculture in Nigeria is shortage of seeds for stocking ponds. The production of *H. bidorsalis* from field observations is marred by its slow growth rate and low survival in its early stage of life in the hatchery. According to Ajah (2010), fine-tuning of larval nutrition is important at the transition from endogenous to exogenous feeding in order to avoid high mortalities during this first critical stage in larval life. Success of larval rearing depends mainly on the availability of suitable diets that are readily consumed, efficiently digested and capable of providing the required nutrients to support higher growth and good health (Kumar *et al.,* 2008). How to reduce the use of live foods by weaning the larvae to formulated diets earlier in the life history has been a critical issue (Phelps, 2010). It then becomes apparent that management protocols covering egg production, egg hatching, and particularly production techniques that enhance fry and fingerling survival need to be further simplified to ensure sufficient supplies of fish seeds (de Graaf *et al.,* 1995; Macharia *et al.,* 2005). Hence the test of the performance of *H. bidorsalis* larvae different starter diets.

Materials and Methods

Three-day old swim-up larvae of *Heterobranchus bidorsalis* were placed on four different starter diets which constitute the treatments. They were spawned at the teaching and research hatchery at the Fish Farm of the department of fisheries and Aquaculture Usmanu Danfodiyo University Main campus on latitude 13° 07′ 78′′ N and longitude of 05° 12′ 25′′E at 275m above sea level (Google Earth, 2017), The site is located in the Dry Sub-Humid Illela- Sokoto- Yelwa Plain of Nigeria, with agro-climate characterized by seven long dry months, occurring from October to April of every year, mean monthly maximum temperature of 31°C - 40°C and mean monthly minimum temperature of 12°C - 24°C and evapotranspiration of the order 1670mm. The area is characterized with cool dry air during the harmattan from November to February and hot season from March to May. Annual rainfall in the area ranged from 508 to 1016mm/year (Ojanuga 2006).

The starter feeds were fish meal, chicken egg powder (KARA KARA brand), shell free artemia (AQUA-LUSH brand), and commercial starter feed concentrate (Aqualis® brand). The names of the starter diets and manufacturer's address are presented in Table 1. while their proximate compositions are presented in Table 2. The proximate composition of the starter diets used were determined following the AOAC (1990) procedure.

1000 randomly sampled swim-up larvae of three days old were stocked per experimental unit (same colour plastic bowls of 70-liter capacity). Twelve experimental units were used for 4 treatments (starter diets) applied in triplicates. The treatments were randomly allocated in a completely randomized design. The fish used in this study were three-day old newly hatched *H. bidorsalis* larvae after yolk absorption. The initial weight, and standard length of the fish for each of the plastic bowls were measured using JT 210N series electronic top loading balance of two digits and a plastic ruler (cm), respectively. This was done by quickly taking them out of water with the aid of a linen cloth and transferring them into a pre-weighed container using feather and then weighed on the balance. The length (mm) was taken by collecting some fry from the container and a plastic ruler was used to measure the reading. The larvae were fed to satiation and feeding trial lasted for four weeks (28 days) and weekly survival and weight were monitored. Feeding was done three (3) times daily, in the morning (8:00am), afternoon (1:30pm), and evening (6:30pm). Feed remains were siphoned out of the culture medium every morning before feeding, and same quantity of water removed during siphoning were replaced immediately. Total renewal of whole water in the bowls was done every two days, and the bowls bottoms was scrubbed in order to remove dirt from the bowl bottom by gentle use a soft sponge. The bowls were supplied with oxygen using Resun Air Pump (Model ACO-008).

Table 1: Names and manufacturers of starter diets used in this study

Starter Diet	Manufacturer
KARA KARA whole Chicken egg powder	Answer Industries Ltd, Nigeria
AQUA-LUSH shell free Artemia	Wudi Fengtai Aquaculture Co. Ltd China
Prime Quality Triple Nine 999 Fish Meal	TrippleNine 999 Fish protein, Denmark
Aqualis Starter Fry high performance extruded fish feed	Invivo Nutricao e´ Saude´ Animal Ltda´ Brazil

Table 2: Proximate composition of the starter diets (% Dry Matter)

Starter Diet	Crude Protein	FAT	Crude Fibre	Ash	Moisture	NFE
KARA KARA Checken egg powder (Whole egg)	47.06±0.78	27.92±0.09	1.22±0.02	7.80±0.70	5.58±0.35	10.43±0.30
AQUA-LUSH Artemia shell free	56.00±0.25	8.89±0.53	8.58±0.22	5.41±0.21	3.37±0.14	17.76±0.56
TrippleNine 999 Fish Meal	65.98±0.16	6.78±0.06	0.48±0.02	6.26±0.05	7.36±0.24	13.14±0.21
Aqualis Starter Fry	49.93±0.16	7.40±0.35	12.16±0.40	6.95±0.16	3.93±0.09	19.63±0.46

NFE = Nitrogen Free Extract
NFE =100 - (crude protein + fat + crude fibre + ash)
AOAC, (1990) procedures.

Five water quality parameters (temperature, pH, dissolved oxygen, ammonia and conductivity) were determined daily during spawning and feeding experiments. These parameters were determined for each of the treatments. The temperature was determined with the aid of mercury in glass thermometer which ranges from 0°C to 100°C, calibrated at 1°C interval. The thermometer was immersed into the water in the culture tanks for a period of time sufficient to permit complete equilibration, and the mercury level was read as water temperature. The pH was determined with the aid of a pH meter (Jenway 13015). The dissolved oxygen was determined by using the Winkler's azide titrimetric method. Conductivity was measured using Adwa AD32 EC/TDS Digital meter.

Data analysis
Data collected on growth, survival, and feed utilization were subjected to data analysis using the following procedures.

Percent survival rate (S)

$$S\ (\%) = \frac{N_i}{N_o} \times 100$$ (Ayinla and Nwadukwe, 1990)

Where, N_o = number of fry stocked at the beginning of the experiment.
N_i = number of fry alive at the end of the experiment.

Weight gain (WG)
The weight gain was computed as follows:

$$WG = Final\ weight\ (g) - Initial\ weight\ (g)$$ (Sveier *et al.*, 2000)

Percent weight gain (PWG)
This was calculated as follows:

$$PWG = \frac{Final\ weight\ (g)\ -\ Initial\ weight\ (g)}{Initial weight} \times 100$$ (Sveier *et al.*, 2000)

Specific growth rate (SGR)

This was calculated as

$$SGR\ \% = \frac{\mathrm{Log}_e\, w_f - \mathrm{Log}_e\, w_i}{\text{Time (days)}} \times 100$$ Castell and Tiewes (1980)

Where, Log_e = Natural logarithm
W_i = initial weight (g) of fish at the beginning of experiment.
W_f= final weight (g) of fish at the end of the experiment.

Percent Length Increase

$$PLI(\%) = \frac{\textit{Final length (mm) - Initial length (mm)}}{\textit{Initial length (mm)}} \times 100$$

Condition factor (K)

Condition Factor (K) of the fry was calculated at the beginning and at the end of the experiment following the procedure of Bagenal and Tesch (1987).

$$K = \frac{100W}{L^3},$$

Where, W = weight of fish (g)
L = total length of fish (cm).

Statistical Analysis

Analyzed data were subjected to analysis of variance (ANOVA) and means were separated using New Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984). Computer analysis will be carried out using the SPSS V: 20.0 package for windows.

Results

The results of the growth and survival of the fish larvae fed four different starter diets (Artemia, Egg powder, Aqualis commercial larvae feed and Fish meal) are as presented Table 3.

Survival rate

The survival rate of *Heterobranchus bidorsalis* larvae on the different starter diets is presented on Table 3. The highest survival (43.1±5.87) was achieved in larvae fed dietary TRT I (Artemia), and was significantly ($p < 0.05$) higher than those subjected to TRT II (Egg powder), but significantly ($p > 0.05$) not different from TRTs III (29.70±0.61) and IV (29.77±7.90). The survival of the fry fed dietary TRT II (Egg powder) was significantly ($p < 0.05$) lower than other treatments. Figure 1, illustrates the trend in survival rate over the period. Larvae fed dietary TRT IV (Fish meal) survived favourably with those fed dietary TRT I up to the third week when mortality start setting in. It was also observed that those fed dietary TRT III compared favourably up to the second week, indicating some limitation to the usage of this diet as the larvae advances in growth.

Growth performance

The growth performance of *Heterobranchus bidorsalis* larvae on the different starter diets is presented on Table 3. The final body weight (73.94±3.81), weight gain (71.84±3.81), and percentage weight gain (3421.18±181.47) were found to be significantly ($p < 0.05$) higher in larvae fed dietary TRT I (Artemia) than the other three treatments. The growth parameters were not significantly ($p > 0.05$) different between larvae fed dietary treatments III and IV, but they were significantly ($p < 0.05$) higher than those larvae fed dietary TRT II (Egg powder) which was the lowest. Specific growth rate (SGR) of the larvae also followed the same pattern as these parameters. However, there was no significant ($p > 0.05$) difference between the SGR (12.71±0.19) of dietary treatment I and IV in which values of 12.71±0.19 and 11.64±0.30 were recorded respectively. The trend at which the fry on different dietary treatments increased in weight over time, during the experiment is illustrated in Fig. 2. Larvae fed dietary TRT I (Artmeia) superseded other treatments right from the first week of trial. It could be noted that despite the initial poor performance of larvae subjected to dietary treatment IV (Fish meal) it subsequently performed above those placed on diets II (Egg powder) and III (Aqualis). In terms of length increase (Table 3), the percentage increase was not significant ($p > 0.05$) among larvae fed dietary treatments I, III and IV while those placed on treatment II (egg powder) was significantly ($p < 0.05$) lower than in other treatments. There was no significant difference ($p > 0.05$) in the condition factor across the four treatments, but fry fed dietary treatment II had the highest value.

Water quality parameters

Table 4 shows the water quality parameters (temperature, pH, conductivity, dissolved oxygen and ammonia) measured during the period of the experiment. The mean water temperature was almost uniform in the afternoon and evening been (29.8±0.45 and 29.6±0.49) respectively, while the lowest (26.9±0.56) temperature was recorded in the morning. However, the maximum temperature (32 ^{o}C) was in the evening while the minimum (24 ^{o}C) was recorded in the morning hours. The overall mean temperature recorded was 28.77±0.5. The mean, minimum and maximum pH values recorded are 7.96±0.07, 7.59 and 8.32 respectively. The mean dissolved oxygen (DO) value recorded among treatments were not significantly different ($p > 0.05$). The minimum DO (3.82) and the maximum (5.32) were recorded in treatments II and III respectively. The mean values of ammonia measured in all treatments were not significantly different ($p > 0.05$); the overall mean was (0.0095 ±0.003) while the minimum and maximum values were 0.0085 and 0.0108, respectively.

Table 3: Survival and growth indices of *H. bidorsalis* larvae fed different starter diets for 28 days

Parameter	Treatment / Starter Diet			
	TRT I (Artemia)	TRT II (Egg powder)	TRT III (Commercial feed Aqualis powder)	TRT IV (Fish meal)
Initial fish number	3000	3000	3000	3000
Final fish number	1293	413	891	893
Survival rate (%)	43.1±5.87^{a}	13.77±4.79^{b}	29.70±0.61^{a}	29.77±7.90^{a}
Initial body weight (mg)	2.10	2.10	2.10	2.10
Final body weight (mg)	73.94±3.81^{a}	34.29±5.93^{c}	48.27±0.37^{b}	55.04±4.55^{b}
Weight gain (mg)	71.84±3.81^{a}	32.19±5.93^{c}	46.17±0.65^{b}	52.94±7.88^{b}
Weight gain (%)	3421.18±181.47^{a}	1533.09±282.24^{c}	2198.37±17.85^{b}	2520.90±216.57^{b}
Specific growth rate (%/day)	12.71±0.19^{a}	9.87±0.61^{c}	11.19±0.03^{b}	11.64±0.30^{ab}
Initial body length (mm)	4.10	4.10	4.10	4.10
Final body length (mm)	23.43±1.07^{a}	17.33±0.33^{b}	22.77±0.86^{a}	21.87±1.22^{a}
Length increase (mm)	19.33±1.07^{a}	13.23±0.33^{b}	18.67±0.49^{a}	17.77±1.22^{a}
Length increase (%)	471.55±26.17^{a}	322.76±8.13^{b}	455.28±12.14^{a}	433.33±29.68^{a}
Condition factor (k)	0.59±0.09	0.67±0.14	0.41±0.02	0.53±0.06

Mean values in row with same letter are not significantly different ($p > 0.05$)

Table 4: Mean water quality parameters measured during different starter diet experimental period

Parameter	Mean	Minimum	Maximum
Temperature (°C)			
.. Morning (°C)	26.9±0.56	24.0	29.0
Afternoon (°C)	29.8±0.45	27.5	31.5
Evening (°C)	29.6±0.49	27.5	32
Overall Mean (°C)	28.77±0.5	26.3	30.8
pH	7.96±0.07	7.59	8.32
Dissolved Oxygen (mg/l)			
TRT1	5.13±0.04	4.91	5.32
TRT2	4.37±0.11	3.82	4.92
TRT3	4.79±0.06	4.48	5.05
TRT4	4.82±0.06	4.59	5.20
Overall Mean	4.78±0.07	4.45	5.13
Ammonia (mg/l)			
TRT1	0.0092±0.002	0.0084	0.0099
TRT2	0.0096±0.002	0.0086	0.0113
TRT3	0.0093±0.002	0.008	0.010
TRT4	0.0098±0.003	0.009	0.012
Overall Mean	0.0095±0.003	0.0085	0.0108

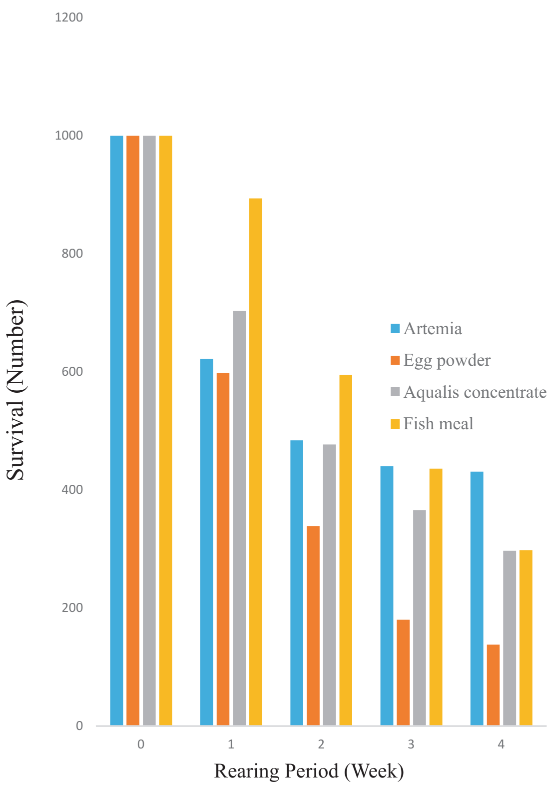

Figure 1: Survival of *Heterobranchus bidorsalis* larvae fed different starter diets for 28 days

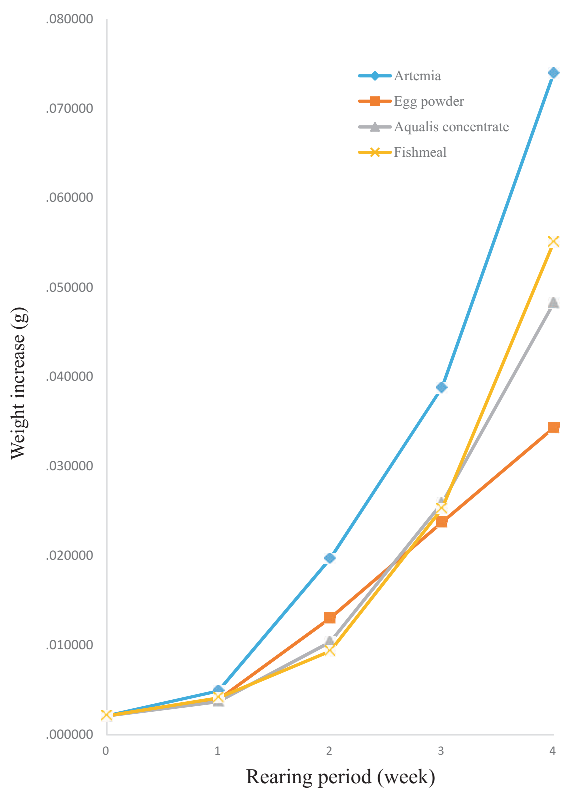

Figure 2: Growth of *Heterobranchus bidorsalis* larvae fed different starter diets for 28 days

Discussion

Survival Rate

The performance of fry on the three diets could be as a result of the better assimilation of the diets by the *H. bidorsalis* larvae. The poor survival of fish fed the egg powder could be attributed to the in ability of the larvae to effectively pick the egg powder which floats on the surface of the water due to the particle size of the powder. The larvae were observed to subsist and herbage at the bottom not coming up to pick the egg powder and most eventually die due to starvation. Kerdchuen and Legendre (1994), recorded no significant difference in the survival of *Heterobranchus longifilis* on different starter diets but poor survival of those fed commercial trout diet.

Growth Performance

The larvae responded better to decapsulated Artemia that recorded the highest weight gain just as Adewumi (2015), Olurin *et al.,* (2012) recorded significantly better growth in *Clarias gariepinus* fry fed decapsulated Artemia when compared with commercial starter diets. According to Rahman *et al,* (1997), the variation in the larval weight gain on the starter diets could be due to interplay of factors like particle size variation of the test diets, floatation, palatability, protein and non-protein nutrients content availability, plant and animal protein origin vis-à-vis nutrient availability and water stability of the feed in relation to feed ingestion by the larvae. Primarily, the searching, identification and ingestion processes are influenced by physical and chemical factors including colour, shape, size, movement and olfactory stimuli at a molecular level (Kolkovski, 2001, Koven *et al*., 2001).

Fish meal had the highest percent crude protein of 65.98±0.16 (Table 3.4) but did not give the best weight gain, percent weight gains and specific growth rate, while the egg powder had the highest lipid content (27.92±0.09) but had the poorest growth rate. The performance of the egg powder in this study is similar to the report of Samir and Banik (2015) who found that in the rearing of *Ompok bimaculatus* catfish larval with live and artificial diets, that the speedy breaking down and scattering of egg paste in the rearing units resulted to high fouling rates. Pal *et al*. (1997) studied the effect of six different feed types such as wheat, flour, rice bran, soybean powder, prawn meal, zooplankton and cooked egg on the growth and survival rate 2-days old larvae of climbing perch and reported that the fish larvae fed egg yolk showed poor survival and growth rate, while feeding live organisms depicted relatively greater growth and survival rate. These findings showed that the physical properties of diet is important in starter diet for fish larvae. Assessing the growth performance recorded in this study from the growth trend as in Fig 4.6 it can be deduced that egg powder can enhance growth of *H.* bidorsalis larvae competitively with other test diets up to two weeks of rearing. The condition factors were all less than one (1) and not significant between the larvae fed the control diets an indication that they were all in a good condition of rearing.

Water Quality Parameters

All the water quality parameters monitored during the experiment were within the required range for larvae survival as stated in (Boyd, 1979, 1998; Viveen *et al.,* 1985; ICAR, 2006).

Conclusion

Conclusively, *Heterobranchus bidorsalis* larvae fed decapsulated artmia performed better in terms of survival and growth. However, in the absence of artemia, fish meal and aqualis commercial feed can be used. More so *Heterobranchus bidorsalis* swim-up larvae subsist well on non-live food tested.

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