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Study of the growth and survival of Heterotis niloticus fry (Cuvier, 1829) under rearing conditions in Kisangani (Tshopo, DRC)

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Abstract: *The objective of this study was to evaluate the growth performance and survival of Heterotis niloticus fry based on local ingredients. A total of 120 fry with an initial weight of 6.9±5.2 g and an initial size of 4.5±3.1 cm in length were used for the experiment. After a seven-day acclimation period, these fry were randomly distributed in the 4 happas due to 30 fry per happa and two happens per feed. The experimental feeds were distributed manually to feed the fry until satiety, due to two feedings per day (8:30 a.m. and 4:30 p.m.). The feeding rate was given according to the body weight of the fish and readjusted after 2 weeks. For growth monitoring and survival of the fry, a sample of 40 fry was drawn from the happas due to 10 fry per happa every 6 weeks. The purpose of the operation was to measure the weight and total length of the fish. The experiment lasted 45 days. At the end of the study, the results obtained on growth and survival indicate that the average daily gain was 0.57 g/day for the fry fed with the T1 feed containing 36.5% animal protein and 0.46 g/day with the fry fed with the T2 feed containing 38% vegetable protein. The survival rate is 71.6 to 75% from one treatment to the next. The feed conversion ratio is 1.70 to 1.71 and the feed conversion ratio is 0.85 to 1.06 kg in the various treatments. The results as a whole show that pond rearing of H. niloticus can be considered for large-scale production and its extension should be encouraged.*

Keywords: *Happas, Growth, survival, fry and Heterotis niloticus*

I. Introduction

Heterotis niloticus (Cuvier, 1829) is the only species of the genus Heterotis of the family Osteoglossidae, an African water fish (Moreau, 1982). This species was officially introduced in the Democratic Republic of Congo between the 50s and 60s in the Kipopo station (Micha, 1973 and FAO, 2017). Indeed, the interest of this approach was to experiment with the aquaculture potential of Heterotis, which would be superior to that of Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus), unfortunately its breeding has not developed (FAO, 2017).

Today, the species is easily adapted and colonizes almost every river in the country (Moreau 1982 and Reizer 1964). And it remains among the least studied introduced species in fish farming. Thus, very few studies exist on its growth and survival, or even its food and nutritional needs of fry in a controlled environment. The available data are those of Amon et al., (2021) and Monentchamp, (2009); respectively, some worked on the growth and survival of juveniles in concrete tanks in Côte d'Ivoire and the other on the feeding and nutrition of juveniles based on plant by-products.

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In the DRC, no scientific data are available on the growth and survival of H. niloticus fry, let alone on its feeding and nutrition in experimental settings. The available data are on biology and ecology in the natural environment (Micha, 1973; Kiloso, 2016; FAO, 2017).

Therefore, knowledge of the growth of farmed fish is useful for assessing the potential of a fish species and helping fish farmers to choose the appropriate production methods and systems for that species. This knowledge involves intervention in the rearing process to improve productivity, improve growth and reduce the mortality rate of the species (Fish base, 2018).

It should be noted that the rearing of a species also requires knowledge of survival rates at the different stages, especially at the rearing stage, a period during which mortality is always high (Philippart, 1975). In the wild, it is difficult to determine the number of young that die during their first weeks of experience. Pond experimentation must be used despite the difficulties of transposition that this presents (Moreau, 1979). Knowledge of a high-performance compound feed of a species in a controlled environment ensures optimal growth while guaranteeing the quality of the final product and is also a cornerstone in the economic success of fish farming (IGA-IGA, 2008).

H. niloticus is also chosen in this study because it has several advantages for its breeding. It has a strong aquaculture potential due to its strong growth; his double breathing; good taste quality of its flesh and high commercial value (Oswald et al., 2003). On the other hand, its breeding also presents some constraints, such as: the very small number of researchers interested in the issue; larval and fry rearing in a controlled environment is not yet mastered, the lack of knowledge about the nutritional needs essential for its growth and the induced lack of control of reproduction (Monentcham, 2009).

The present study is a logical continuation of an experimental study to evaluate the growth performance and survival of H. niloticus fry fed diets based on local ingredients. This is a way of observing the effects of these diets on the growth and survival rate of the species' fry in order to consider its vulgarisation.

I.1 Objective

The objective of the present study is therefore to evaluate the growth performance and survival of H. niloticus fry (Cuvier, 1829) under rearing conditions in Kisangani.

II. Research Methods

2.1 Study Environment

The present study took place in the Kisangani region, more precisely in the Makiso Agro-Fish Development Center (CDAM) station.
The figure above illustrates the map of the central ponds.

Figure 1. Map of the Makiso agro-fish farming development center station (Ngalya, 2022).

2.2 Hardware

The biological material of this study consists of the 120 fry of H. niloticus (Cuvier, 1829). These fish were bought from a fisherman on the Tshopo River, upstream of the Tshopo hydroelectric dam. Immediately after purchase, the fish were transported directly to the experimental site.

2.3 Methods

To monitor the evolution of growth and survival, 4 rectangular mosquito net happas of useful volume were installed in an 800m² pond due to 2 happas per treatment. The water height in each happa was maintained around 70 cm. A total of 120 fry were randomly distributed in the different happas, due to 30 individuals per happa. When loading the fry into the happas, a sample of 10 fry was randomly drawn by happa to take measurements of fish weights and length. The operation of weight and length measurements was done at the end of each week, and this, for 6 weeks. The length and weight were determined using a precision 0.02 cm caliper and a GENOMSNITT electronic scale. The deaths of the registered fry were counted, removed and weighed. Throughout the experiment, the various physicochemical parameters (temperature, dissolved oxygen, pH, conductivity, turbidity and transparency) were taken from the beginning to the end of the experiment.

For the feeding of the fry, the experimental feeds were distributed manually until apparent satiety, due to two meals per day (8:30 a.m. and 4:30 p.m.). The feeding rate was given according to the body weight of the fish and readjusted after 2 weeks. They were subjected to two types of feed, feed T1 was composed of termite meal 36.5% as a protein ingredient of animal origin and feed T2 of soybean meal 38% ingredient of vegetable origin. The experiment took 45 days.

2.4 Calculation of zootechnical

The parameters in this study, a number of indices and zootechnical parameters were used to assess the growth performance and survival of Heterotis niloticus fry.
The average initial weight (MIL)
Is calculated on the basis of the formula below:

$$\text{Initial biomass (g)} = \frac{\text{Average initial weight (g)}}{\text{Initial number of fish}}$$

The final average

size It is calculated on the basis of the following formula:

$$\text{Final biomass (g)} = \frac{\text{Final Average Weight (g)}}{\text{Final number}}$$

Average Daily Gain (ADG)

$$\text{ADG (g/d)} = \frac{\text{(Final Average Weight – Original Average Length)}}{\text{Time (j)}}$$

Specific Growth Rate

It is calculated on the basis of the following formula:

$$\text{SGR (\%/d)} = \frac{\text{[ln (Final Average Length) –ln (Initial Average Weight)]}}{\text{Number of days}} \times 100$$

Average biomass gain

Calculated on the basis of the following formula

$$\text{AB (g/d)} = \frac{\text{[ln (average final weight) – ln (average initial weight)]}}{\text{Number of days}} \times 100$$

Feed conversion ratio (FCR)

It is obtained on the basis of the following formula:

$$\text{FCR} = \frac{\text{Amount of feed distributed (g)}}{\text{Weight Gain (g)}}$$

Survival Rate (SR)

The survival rate (100% - Mortality rate) is calculated from the number of fish at the end of the experiment and the total number at the beginning of the culture, according to the following relationship:

$$\text{TS (\%)} = \frac{\text{Final number of fish}}{\text{Initial number of fish}} \times 100$$

Feed conversion ratio (FCR)

It is a feed processing index that measures the efficiency of the conversion of a feed into fish flesh, it represents the ratio between the total quantity of feed distributed to the fish and the gain obtained in biomass.

$$\text{FCR (kg)} = \frac{\text{(Final biomass (g) - Initial biomass (g)}}{\text{Ration (g)}}$$

Statistical Analyses: The various statistical analyses were carried out using the Past version 2. software. The growth parameters and physicochemical parameters of the different batches (T1 and T2) were compared by the analysis of variances (ANOVA) according to Tukey's HSD (Honest Signifier Difference) test at the 5% significance level. All statistical analyses are carried out using the STATISTICA 7.1 software and the various tables, graphs and histograms with Microsoft Office Excel 2016.

III. Results and Discussion

3.1 Physico-chemical parameters of the water of the experimental pond

The analysis of the evolution of the physico-chemical parameters in the water of the 4 experimental happas shows that the measured values are well within the recommended ranges for the rearing of Heterotis niloticus.

Table 1. Average values of the physico-chemical parameters of the water during the entire experimental period.

Paramèters physico-chimical	**The different treatements**		
	N	**T1**	**T2**
Temperature (°C)	6	27,21 ± 0,02[a]	27,40 ± 0,17[a]
Ph	6	6,9 ± 0,11[a]	6,9 ± 0,21[a]
Dissolwed oxygen dissous (mg/l)	6	4,9 ± 0,10[a]	4,9 ± 0,10[a]
Conductivity(µs/cm)	6	18,28 ± 0,15[a]	18,09 ± 0,21[a]
Turbidity (NTU)	6	16,9 ± 0,02[a]	16,8 ± 0,01[a]
Transparence (%)	6	61,8 ± 0,90[a]	62,39 ± 0,83[a]

Not all values showed significant variations from one treatment to another during the entire 45-day experimental period of rearing. The temperature recorded is identical everywhere (27.21°C) in T1 and (27.40°C) in T2. The pH sampled is equivalent to (6.9) in both treatments. The recorded dissolved oxygen is similar (4.9 mg/l) in (T1 and T2). The conductivity sampled is consistent in (T1 and T2) i.e. (18.09 to 18.28 µs/cm). The turbidity and transparency of the water recorded are identical (16.8 to 16.9 NTU) and (61.8 and 62.39%).

It should be noted that the values of the same line, which are expressed as an average ± standard deviation, indexed by the same alphabetic letters, are not statistically different ($p>0.05$). T = Temperature; pH = Hydrogen potential; O2 = Dissolved oxygen; C=conductivity; t=turbidity and Tr=transparency.

3.2 Zootechnical performance of Heterotis niloticus (Cuvier, 1829)

The results of the analyses of the zootechnical parameters are presented in the table below. This table spreads out the different values of Li (initial length); Lf (final length); Wi (initial weight); Wf (final weight); ADG (average daily gain); LSGR (Linear Specific Growth Rate); SWGR (Specific Weight Growth Rate); FC (feed conversion ratio); SR (survival rate) and FCR (feed conversion ratio) calculated to determine the zootechnical performance of the species Heterotis niloticus.

Table 2. Zootechnical parameters of H. niloticus reared for 45 days in happas.

Parameters zootechnical	The different treatements	
	T1	T2
Initial number of fry	60	60
Final number of fry	45	43
Li(cm)	4,29±0,07[a]	4,27 ± 0,16[a]
Lf(cm)	8,38 ± 0,12[a]	7,18 ± 0,47[a]
Wi(g)	6,75 ± 0,24[a]	7,05 ± 0,19
Wf(g)	32,62 ± 0,50[a]	28,07 ± 0,97[a]

ADG(g/J)	0,57 ± 0,01[a]	0,46± 0,02[a]
SGTW (%/J)	0,62 ± 0,43[a]	0,48 ±0,43[a]
SGTL (%/J)	1,53 ± 0,15[a]	1,33 ± 0,13[a]
FC	1,71 ± 0,16[a]	1,70 ± 0,15[a]
SR (%)	75	71,6
FCR (kg)	0,70 ± 0,11	1,24 ± 0,09

At the end of the experiment, the average daily gains (ADG) were 0.57 g/d in Q1 and 0.46 g/l in T2. The linear specific growth rate (in length) is 0.62± 0.43%/d in Q1 and 0.48±0.43%/d in Q2. The specific growth rate by weight is 1.53 ± 0.15 of T1 fish and 1.33 ± 0.13 of T2 fish. Statistical comparison of these values shows no significant difference ($p>0.05$) from one treatment to another. The values of the feed conversion ratios were 1.71 ± 0.16 T1 and 1.70 ± 0.15 T2. As far as the survival rate of the fry is concerned, the values obtained in the two treatments are not quite identical (75% and 71.6%). For the feed conversion ratio, the values obtained are 0.70 ± 0.11 kg (T1) and 1.24 ± 0.09 kg (T2).

We note that the different values of the same line, which are expressed as a mean ± standard deviation, indexed by the same alphabetic letters are not statistically different ($p>0.05$). Li = Initial length; Lf = Final length; Pi = Initial weight; Pf = Final weight; ADG = Average daily gain; SGTW = Specific Growth Rate by Weight; SGTL = Specific Growth Rate in Length; FC = Feed conversion ratio; SR= Survival rate; FC=Food Conversion Ratio

Discussion

Overall, the physicochemical parameters collected throughout this study are within the recommended limits for the breeding of the species Heterotis niloticus. According to Jobling, (1997) and Kestemont & Baras, (2001), temperature is the environmental factor that influences feed consumption, energy processing efficiency, growth and logically fish survival. Rombough, (1997) points out that high water temperature affects all biochemical and physiological activity and growth of fish. On the other hand, a low temperature (Our results of the average temperature values are respectively between 27.21°C (T1) and 27.40°C (T2). These values did not have a negative effect on fry growth and survival. However, H. niloticus can tolerate lower temperatures up to 15°C and high temperatures exceeding 35°C (Moreau, 1982; Adite et al., 2006). The mean pH values are identical in both treatments (6.9), these values obtained correspond to those of Amon, (2021) and Adite et al., (2006) between 6.9 and 7.5. In addition, Adite et al., 2006 point out that this species can tolerate water with a neutral pH.

The mean dissolved oxygen values are equivalent in both treatments (4.9 mg/l). This value corresponds to the results obtained by Amon et al., (2021) from 4.21 to 4.51 mg/l. A value that corresponds to the tolerance threshold for breeding the species. Adite et al., 2006 and Arantes et al., (2013) reported that in less oxygenated waters of 0.4 to 4.5 mg/L, H. niloticus can live because of its ability to breathe oxygen from the air. The water conductivity values of the experimental pond range from 18.09 µs/cm T1 to 18.28 µs/cm T2.

As for water turbidity, these values are similar 16.8 and 16.9 NTU and the transparency, these values are 61.8 to 62.39% in both treatments. These different values of the physico-chemical parameters of the water allow us to partially conclude that the mortalities recorded during this study could be attributed to the handling of the fry during the sampling operations and not to the physico-chemical parameters of the water.

The average daily gain value (daily growth rate) obtained is 0.57 g/d for fry fed with T1 feed containing 36.5% protein and the average daily gain obtained of 0.46 g/d with fingerlings fed T2 feed with 38% protein. These values indicate good growth of the species in rearing in the nursery phase. Our values obtained are lower than those of Amon et al., (2021) with 3.46 g/d and Gouré-Bi et al., (2018) values between 3.98 and 4.02 g/d with a feed titrating 35% protein. The difference in growth can be explained on the one hand by the difference in the rearing structures used (concrete tanks and cages) and the duration of the experiment, and on the other hand, by the difference in the composition of the feed ingredients used.

Regarding the survival rate of the fry recorded, our values obtained are between (71.6 and 75% in happas). These values are significantly lower than those obtained by Amon et al., (2021) (94.16 and 93.33%) and Gouré-Bi et al., (2018) (82.22 to 88.89% in cages). This difference could be explained by the difference in the type of feed used, the breeding structures and the number of days of experience. For the feed conversion ratio, the values recorded are identical (1.70 from 1.71). These values reflect that the feed used is good for the growth of the fish. The lower the feed conversion ratio, the better the feed is for fish growth. The feed conversion rates recorded during the experiment ranged from 0.85 to 1.06 kg in both treatments. These values indicate that it takes 1.06 kg of feed (T1) to produce 1 kg of live weight of fish and T1 is better than T2.

IV. CONCLUSION

The objective of this study was to evaluate the growth performance and survival of Heterotis niloticus fry under rearing conditions in Kisangani. At the end of this study, it should be noted that the species can be reared in fish ponds like other fish species, by feeding them with local ingredients incorporated into the formulated feeds. Thus, our results clearly show a daily growth rate and survival rate of 0.57 g/d and 75% respectively (T1) to 0.46 g/d to 71.6% (T2).

These results are satisfactory for his farming, although these results were lower than those obtained in other studies and structures used during the breeding period. The feed conversion ratio (FC) and feed conversion ratio (FCR) obtained ranged from (1.71 to 1.06 kg) to (1.70 to 0.85 kg). Indeed, these values indicate that there is a good conversion of feed into flesh and at more than 1 kg of feed used, 1 kg of live weight of fish can be produced. This species can be bred anywhere in the Democratic Republic of Congo due to its rapid growth and high survival rate using local foods.

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