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Growth of Clarias Gariepinus Juveniles Reared in Soilless Tanks in the Republic of Congo

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Abstract **Original Research Article**

The present study was conducted to assess the growth of Clarias gariépinus fingerlings introduced in Congo to improve local fish production. Fish farming is part of the concerns of the Congolese government to improve food security and savings of fish farmers. The objective of the study was to evaluate the growth of Clarias gariepinus juveniles reared in above ground tanks. A total of 60 juveniles of Clarias gariepinus of average weight (17±0.5g) were divided into two tanks. The following results were obtained: final average weights, weight gains, daily average gains and specific growth rate of fish from tank 1 (77.78± 21.74g); (61.25g); (2.04g/d); (2.24%g/d); those of fish from tank 2 of (68.45±15.48g); (50.38g); (1.68g/d); (1.93%g/d). As for the survival rates, they were (76.76%) for tank 1 and (66.66%) for tank 2. It was found that the fish in tank 1 had a significantly high survival rate, average final weight and weight gain ($p < 0.05$) compared to the fish in tank 2. The study showed a good level of growth of Clarias gariépinus juveniles in artificial environment with an ability to adapt to the environmental conditions of the country.

Keywords: Clarias gariepinus, growth, tank, juvenile, Congo.

INTRODUCTION

The current demographic context characterized by the growth of the world population imposes the multiplication of the sources of food supply in order to satisfy the needs of the populations. This demographic growth that our planet is experiencing results in a strong pressure on natural resources (FAO, 2020). In this objective, aquatic ecosystems have an important role to play because they contain resources essential to life. Despite their importance, these environments are subject to several pressures of natural and anthropogenic origin, leading to their degradation and loss of biodiversity (Lévêque *et al*., 1990; Mostarih *et al*., 2016; Mikembe, 2020).

Thus, fish, whether from the sea or freshwater, has always been an abundant and inexhaustible food. It consists of proteins of high biological value and essential amino acids (Goog *et al*., 1996). Whether fresh, smoked or dried, fish plays a very important role in the fight against malnutrition and is an important source of animal protein in the human diet. Fish flesh contains less saturated fat and more protein. Fish flesh also has a cardioprotective effect of long polyunsaturated fatty acids, it is much easier to digest and contains little cholesterol. In addition, fish flesh contains other nutrients such as minerals and vitamins A and D that are useful in human nutrition (Lalèye, 2002).

Fish remains the most accessible and least expensive protein for populations. An important source of nutrients, vitamins and minerals, fish taken only with some plant products constitutes a complete food (Baras *et al*., 2002). Also, the breeding of the African catfish Clarias gariepinus has both biological advantages such as a high level of food conversion, a rapid growth rate, it accepts artificial food easily, facilitating its propagation in Africa and is resistant to disease. It is highly valued in societies not only for its affordability, but also for certain physical attributes such as tolerance to a wide range of environmental conditions. Despite these advantages, the breeding of the Clarias gariepinus species is not developed. Yet this fish is typically African and that its domestication occurred in the heart of the continent (Yantalo, 2016).

MATERIAL AND METHODS

Geographic location

The SAPE farm is located in the village of Mbouambé in the Pool Department, about 200 km north of the Brazzaville Department. Its geographical coordinates are S020°55.284' and E015°37.026', with an average altitude of 344 m. Figure 1 shows the study area.

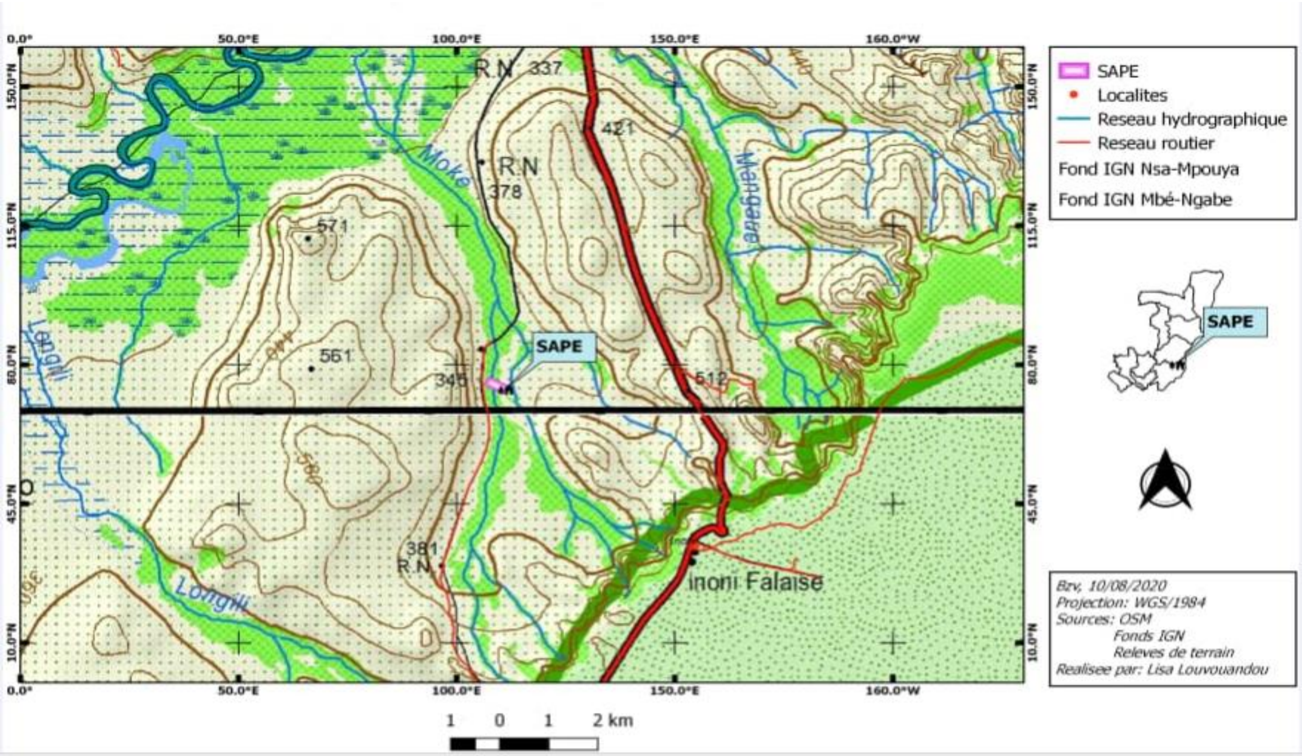

Figure 1: Localisation du site d'expérimentation

Relief and hydrographic network

The Léfini River, which gives its name to the wildlife reserve it crosses from west to east, is one of the tributaries of the immense Congo River. It drains a watershed of 13,500 km2. It is a spillway where the waters of its main tributaries such as the Louna, the Loubilika and the Nambouli come together. The hilly landscapes of the Batéké Plateau alternate between relatively flat plateaus bordered by imposing cliffs and hills cut deeply by a dense network of valleys with intermittent flow (Makany, 1976). The relief of the Bateke Plateau can be described in terms of its subsets: plateaus or tabular surfaces, alluvial plains, and high and low hills. The plateaus have a generally gentle slope and slope to the southwest. The tabular surfaces or plateaus are excluded from reserve and begin at its eastern periphery with the Mbé plateau, separated from the reserve by steep cliffs.

Climate

The Batéké plateaus are subject to the thermal and rainfall regimes of the southern hemisphere. The village of Mbouambé has a sub-equatorial climate and is characterized by rainfall ranging from 1600 to 2100 mm, with a temperature between 23°C and 25°C, and an annual thermal amplitude of 1.5°C. There are two seasons: the rainy season, which generally lasts 8 to 10 months (October-May), and the dry season, which lasts 2 to 4 months (June-September). A period of reduced rainfall, also called the short dry season, is frequently observed between the months of January and February. The climate of the area is very similar to that observed in the department of Brazzaville.

Geology

The geological series of the Batéké Plateaux is subdivided into two groups: the polymorphous sandstones at depth and the ochre sands or sandy silts that constitute the upper layers. The polymorphic sandstone layer, whose thickness varies between 50 and 300 m, comprises soft sandstones with fine and regular grains. Towards the top of this layer appear discontinuous lenticular banks of silicified and quartzite levels of various colors. The cross-stratification and the microscopic study of these sandstones demonstrate their eolian origin (Mathot *et al*., 2006).

Vegetation

According to White (1986), the vegetation of the Batéké Plateau belongs to the mosaic of lowland tropical forests and secondary grasslands of the Guineo-Congolese region. Because of the nature of the soil, altitude, slope, and the abusive practice of fire by the populations, the most represented plant formation is the shrub layer of the savannahs by: Hyminocardiaacida, Annonaarenaria, Ochnagilletii, Syzygium guineense, Brideliaferruginea, Vitex sppand the herbaceous layer by: Loudetiaspp, Panicum spp, Landolphia spp, Trachypogonthollonii, Cteniumnewtonii, Hypparrheniaspp (Makany, 1976).

Methods

Two (2) tanks were set up with a water inlet and outlet (Figure 2). The water height was maintained at 60 cm.

Figure 2: Rearing tank for juvenile clarias gariepinus

A total of 3 oxygenated bags containing 2500 larvae each from artificial reproduction were used. The larvae were loaded at a rate of 1875 larvae per happa, i.e. 4 happas. During 6-7 weeks the fish were fed on the basis of two meals per day with artificial food until they reached an average weight of 5-10 g. The fish that were contained in the happas were transferred to the tanks. From this lot, 60 fish of similar weight were transferred for the actual study. The 60 clarias juveniles were divided into 30 fish per tank, i.e. two tanks. The experiment lasted 30 days.

Composition of the food

The juveniles were fed with commercial pellets for. clarias of the brand "BioMar, France" and titrating 13% of crude fat and 43% of crude protein were used during the whole experiment. Table 1 presents the chemical analysis of the feed used.

Table I: Chemical analysis of the food used in the experiment

Composition of the feed 4,5 mm	**4,5 mm**
Protéin	43 %
Crude fat	13 %
Crude cellulose	3,9 %
Crude ash	5,8 %
Phosphorus	0,92 %
Calcium	0,99 %
Sodium	0,21 %
Additivss	
3a 671 Vitamin D3	500 UI/Kg
Trace éléments	1,0 mg/ Kg
E4 Cu (Manganese sulfate)	8 mg / Kg
3b 607 Zn (Zinc chelate)	50 mg /Kg
3b 202 I (Calcium Iodate)	1,2 mg /Kg

Ration and feeding time

The fish were fed with BioMar's artificial feed. The feed was distributed twice a day: in the morning at 10 am and in the evening at 5 pm.

Parameters studied

Length-weight relationship of the fish

The couple Length-weight allows to obtain regression curves of the type P= aLSb, where P is the weight of the individual expressed in grams and LS the standard length in centimeters, b determines the type of growth of the individuals and a the initial growth coefficient. After transforming this equation into its logarithmic form (log P = loga + blogLS), the parameters a and b for each of the length-weight relationship equations were estimated by linear regression analyses.

Fulton's condition factor (K)

The Fulton condition coefficient or factor provides information on the overweight status of the fish (Paugy *et al*., 2017). It is considered a good tool for comparing different fish populations at the same time or at two times with different ecological conditions (Lévêque *et al*., 1988). It is used to understand the impacts of changing environmental conditions on species. It is calculated by dividing the mass of the individual by the cube of the length and then multiplying by 103 to have numbers that are easy to manipulate.

K=100*P/Lb (Ricker, 1975)

P: weight of fish in (g);

L: length of the fish in (cm).

The survival rate

Survival rate $= \frac{Npf}{Npi} x100$ (Rukera *et al.*, 2005)

Npf= Number of fish at the end of the experiment.
Npi= Number of fish at the beginning of the experiment.

Initial average weight (Pmi)
It is calculated based on the following formula (Etaba *et al.*, 2016):
Initial average weight (g)= $\frac{initial\ biomass\ (g)}{Initial\ number\ of\ fish}$

Final average weight
It is calculated based on the following formula (Etaba *et al.*, 2016): $Pmf\ (g) = \frac{final\ Biomass\ (g)}{\text{final number of fish}}$

Average weight gain
From Etaba *et al.*, 2016:
Weight gain (g)=Pmf-Pmi

Average daily gain
According to Rukera *et al.*, (2005):
ADG=(Pmf-Pmi)/Δt
Δt=Duration of the experiment

Specific growth rate
This criterion is expressed as a percentage per day.

$$TCS = (100\ \frac{\ln Pmf - \ln Pmi}{\Delta t}$$

Sampling of the physicochemical parameters of the tanks

The physico-chemical parameters, namely the temperature and the pH, of the water are taken in the tanks twice (2) a day (morning at 8:30 am and afternoon at 4 pm), by means of an aquatic thermometer, and the pH, was measured using the multi parameter probe of waterproof brand. The water was renewed twice a day (early in the morning before the first feeding and in the evening before the last feeding). To sample the pH, the display mode of the probe is adjusted according to the type of variable that we want to sample. Then the end of the probe carrying the cell is immediately immersed in the water until the value of the chosen parameter displays a stable number. Then, we switch to another parameter for example if it is the temperature by simply changing the display mode, so on (Boukou, 2016). To collect the geographical coordinates of the study area we used the Garmin brand GPS.

Data Analysis

The evolution of the physico-chemical parameters and the different times observed were carried out using an Excel 2013 spreadsheet. Summary tables of the means, minima, maxima and standard deviations of the different parameters are presented. The parameters a and b for each of the equations of the Length-Weight relationship (P=aLSb) were estimated by linear regression analyses following Mostarih *et al.*, (2016) growth is said to be isometric when b is strictly equal to 3, and it is said to be positive or negative allometric when b is greater or less than 3, respectively (Shingleton, 2010). The statistical ference between the value of b for each species and the isometric value (b = 3) was obtained using Student's t test performed according to Sokal and Rohlf (1987): ts = (b - 3) ⁄ ESb, where ts is the value of Student's t test, b is the slope of the regression line, and ESb is the standard error of b. All tests were significant at the 5% level (p <0.05). The 95% confidence intervals for the constant a and the slope of the regression line b were found using Stat View software version 1992-98 (SAS Institute INC).

RESULTS

Evolution of the sizes and weights of the fish in the different tanks during the experiment Tables 2 and 3 give information on the evolution of the size and weight of the fish according to the tank, respectively. Table 2 shows that the initial size during loading varies around 5.42 to 9.72 cm with an average of about 7.46 cm for both tanks. At the end of the experiment, the final size varies from 12.5 to 17 cm with an average of 14.62 cm for bin 1 and that of bin 2 is between 12.4 and 16.22 cm with an average of 13.79 cm. The coefficient of variation of size is between 9.49% and 12.65% for bin 1 and that of bin 2 is between 7.8% and 12.65%.

Table 2: Minimum and maximum values, mean, standard deviation and coefficient of variation of the size of juveniles of Clarias gariepinus according to the tank

Variables	**Tankss**			
	Tank 1		**tank 2**	
	Initial	**Final**	**Initial**	**Final**
Number	30	23	30	20
Minimum size (cm)	5,42	12,5	5,42	12,4
Maximum size (cm)	9,72	17	9,72	16,22
Average size	7,47±0,94	14,62 ± 1,39	7,46±0,94	13,79± 1,08
CV Average (%)	9,49	12,65	7,86	12,65

Table 3 shows that the initial weight during loading varies around 5.42 and 9.72 g with an average of about 7.46 g for both bins. At the end of the experiment, the final weight varies from 12.5 to 17 g with an average of 14.62 g for bin 1 and that of bin 2 is between 12.4 and 16.22 g with an average of 13.79 g. The coefficient of variation of the weight is between 27.95% and 32.15% for treatment 1 and that of treatment 2 is between 21.31% and 38.76%.

Table 3: Minimum and maximum values, mean, standard deviation and coefficient of variation of juvenile Clarias gariepinus weight according to the tank

Variables	Tanks			
	tank 1		tank 2	
	Initial	Final	Initial	Final
Number	30	23	30	20
Minimum weight (g)	10	50	10,23	52
Maximum weight (g)	28	120	36,85	98
Average weight (g)	16,53±5,32	77,78±21,74	18,07±7,01	68,45 ±14,58
CV Weight (%)	27,95	32,15	21,31	38,76

The length-weight relationship of the fishes according to the tanks

The length-weight relationship of the form P= aLb was as a function of the fish in each tank. Figure 3 shows the length-weight relationship of the populations in tank 1 with a size distribution ranging from 12.50 cm to 17 cm with a calculated mean of 14.62±1.39 cm. Their weight ranges from 50 g to 120 g. The average weight is estimated at 77.78±21.74 g. The relative growth coefficient b= 2.97 reveals an isometric growth, i.e., the growth in weight is proportional to the growth in length.

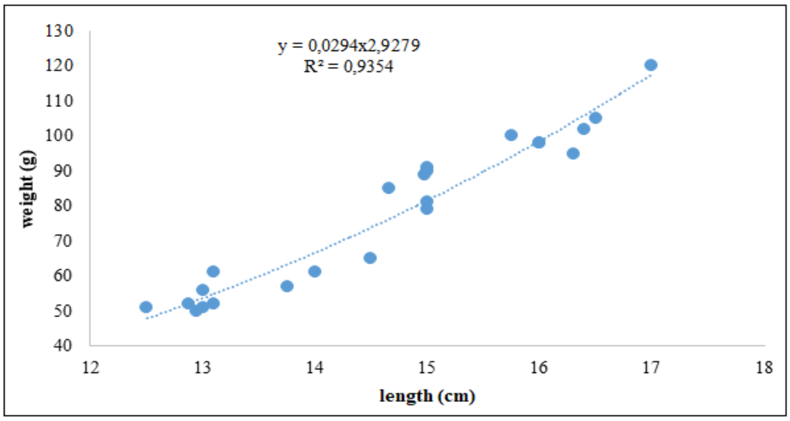

Figure 3: Length-weight relationship of fish in tank 1

Figure 4 shows the length-weight relationship of the populations in tank 2 showing a size distribution ranging from 12.40 cm to 16.2 cm with a calculated mean of 13.80±1.08 cm. Their weight ranges from 65 g to 98 g. The average weight is estimated to be 68.45±14.58 g. The relative growth coefficient b= 2.582 reveals isometric growth i.e., growth in weight is proportional to that in length. Table 4 presents the length-weight relationship of the fish according to the tanks.

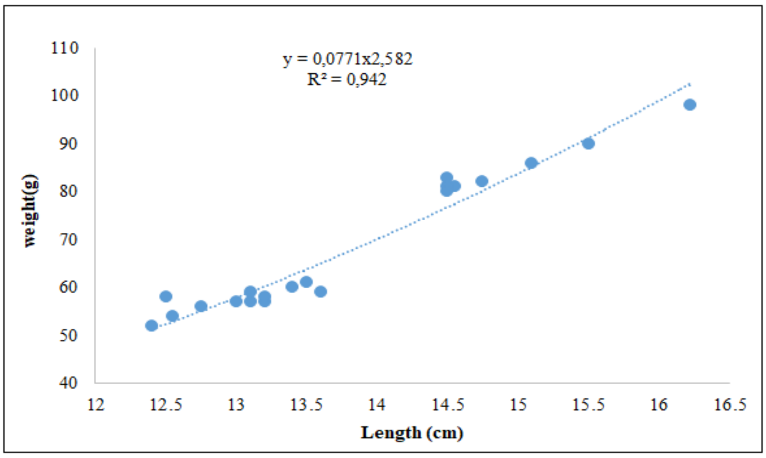

Figure 4: Length-weight relationship of fish in tank 2

Table 4: Parameters of the fish length-weight relationship according to the tanks

Bac	N	Length (cm)		weigth (g)		a	b	growth
		Min	Max	Min	Max			
1	23	12,50	17	50	120	0,029	2,927	Isométric
2	20	12,40	16,22	52	98	0,077	2,582	Isométric

Determination of the condition coefficient (k) of the fish in the different tanks

Table 5 shows the average values of the condition coefficient (k) of the tanks. It is found that the average values of (k) are different for the tanks. The values of K obtained in this study reflect the characteristic overweight state of the fish during rearing.

Table 5: Length-weight regression and condition factor K of fish from different tanks

				Condition factor	
Tank	N	Regression equation	R^2	Moyenne	Ecart-type
1	23	$P = 0{,}029\ L^{2{,}927}$	0,935	2,429	0,18
2	20	$P = 0{,}077L^{2{,}582}$	0,942	2,580	0,15

Table 6 shows the growth and survival performance of fish in the two tanks. The difference in average initial weight in grams (g) between tank 1 (16.57± 5.36) and tank 2 (20.00± 0.94) can be seen. Also, the growth rate inside the tanks is 2.041 g for tank 1 and 1.68 g for tank 2.

Table 6: Growth and survival performance of Clarias gariepinus according to Bins

	Tank	
	Tank 1	Tank 2
Size and weight		
Average initial size (cm)	7,54 ± 1,0	7,54 ±1,0
Average initial weight (g)	16,57± 5,36	20,00± 0,94
Average final size (cm)	14,62± 1,39	13,80 ± 1,08
Average final weight (g)	77,78 ± 21,74	68,45 ±14,58
Weight gain (g)	61,25	50,38
Characterization of the growth		
Average daily gain (GMQ) (g/j)	2,041	1,68
Specific growth rate (%g/J)	2,241	1,93
Survival		
Survival rate (%)	76,67	66,66

Physico-chemical parameters of the water in the different tanks

Information on the physico-chemical parameters measured during the experiment is provided in Table 7. It reveals that during the experiment the temperature varies around 25 to 29°C with an average of 27°C, the pH is between 6 and 7 with an average of 6.5.

Table 7: Average physico-chemical parameters of the water in the tanks

Parameters		Bac 1	Bac 2
Temperature	Minimal	25,5	25,5
	Maximal	28,5	29
	Average	27,07±1,09	27,14±1,43
PH	Minimal	6	6
	Maximal	6,5	7
	Mean ± Standard deviation	6,46±0,19	6,5±0,29

Figure 3: Clarias gariépinus fingerlings

Figure 4: Clarias gariépinus

DISCUSSION

The length-weight relationship of the fish according to the tanks

The coefficient b (or the slope of the regression line) of the length-weight relationship of the fish in the different tanks is 2.977; 2.582. It expresses the relative shape of the body of a fish. When it is equal to 3, the growth is said to be isometric. When it is different from 3, the growth is allometric. A coefficient b greater than 3 indicates better growth in weight than in length and vice versa (Micha, 1973; Ricker, 1980). The values (2.977; 2.582) of the slope of the regression line are consistent with the values 2.5 to 3.5 recommended by (Froese, 2006; Calander, 1969). But the values of b can indeed be influenced by sex, growth phase, stomach contents, level of gonad development (Hossain *et al*., 2006) and environmental conditions (Baby *et al*., 2011).

The Fulton condition coefficient (k) of the fishes according to the tanks

The results of (K) obtained in this study that report the overweight state of the fish with respective values of 2.429 and 2.580 for tank 1 and 2. These results are higher than those obtained by (Rukera *et al*., 2005) (0.79 to 0.83%) in Clarias geriepinus reared at different stocking densities and fed artificial feed, and by Ekoué (2013) (0.06 to 0.74) who replaced fish meal with Néré seed meal (Parkiabig lobosa) and soybean meal (Glycine maxima) on growth and survival of Clarias gariepinus juveniles. These differences would be due to the fact that this parameter varies according to biotic and abiotic factors (Tiogué *et al*., 2010).

Average daily fish gain by tank

The average daily juvenile gains obtained in this study were 2.041 for tank 1 and 1.68 for tank 2. These values are interesting compared to that of Gandaho (2007) with moringa leaves (0.19g/day), and 0.45g/d obtained by Ekoué (2013) who replaced fish meal by Néré seed meal (Parkiabig lobosa) and soybean meal (Glycine maxima) on growth and survival of Clarias gariepinus juveniles, but remains lower than 3g/d obtained by Micha (1974) and Lacroix (2004). These results can only be explained by the well-known aggressive behavior of Clarias gariepinus (Baras *et al*., 2001).

Specific growth rate of the fishes according to the tanks

The specific growth rates of the different bins were 2.241%/d for bin 1 and 1.93%/d for bin 2. These differences can be justified by the environmental conditions of the study and these results are higher than 0.004 and 0.18%/d obtained by Pouomogne (2013). However they are lower than 3.60%/d as presented by Ekoué (2013), and the values obtained by Kanagire (2001) which are 4.26%/d and 3.85%/d.

Survival rate of the fishes according to the tanks

The survival rate observed at the end of this experiment varied overall between 76.67% for tank 1 and 66.66% for tank 2. These survival rates are higher than those obtained by (Rukera *et al*., 2005) in simulated ponds (21.47 to 39.3%) and (21.67 to 31.77%) for polyester tanks, and that observed by Kambashi (2006) (between 55 and 63%) in non-permanent water replenishment tanks. These results are lower than those obtained by Pouomogne (2013) who recorded a maximum survival rate of 96.66%. It should be noted that the largest decreases in numbers were observed at the end of the experiment and this is directly related to cannibalism since the fish found dead showed traces of aggression. Proof that they were attacked by their fellow fish. For some authors, this cannibalism would be a special form of self-regulation within the populations that practice it (Wakano *et al*., 2002; Begon *et al*., 2006). This cannibalistic behavior in Clariidae is mainly linked to a morphological difference within the same cohort (Appelbaum *et al*., 2000). This morphological difference results in variation in growth rate and behavior among individuals, with some growing faster and developing a morphology adapted to cannibalism, and others developing normally (Wakano, 2004; Solomon *et al*., 2011).

Physico-chemical parameters of the water in the different tanks

In relation to the results obtained on the physico-chemical parameters of the water measured, it turned out that the average temperature was 27°C, that of the pH was 6.5 (slightly acid). These values are within the range of values recommended by Baras *et al*., (2002), which states that the optimal temperature for growth of this species is between 26 and 30°C. However, our pH results are similar to those obtained by Kanangire, (2001) which range from 6.5 to 9, and those of the Indian Standards Institute [ISI], (1974) which range from 6 to 8.

CONCLUSION

The major concern of any fish farmer is to increase the productivity of his farm while improving the quality of the fish. The study of juveniles of clarias gariépinus in artificial environment showed that they are able to adapt to the variations of the environmental conditions. In view of the results of this experiment and in order to improve the growth, survival and thus the production of juveniles of Clarias gariepinus, it would be judicious to continue the studies, while developing the practice of artificial reproduction above ground in order not to depend any more on the supplier laboratory located abroad.

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