

RESEARCH ARTICLE

Influence of Fertilizer Type on Zooplankton Production, Survival Rate and Growth Characteristics in Juvenile *Papyrocranus afer* in Ponds

Jean Paul Makongo Njaka Nloka^{1*}, Paul Zango¹, Jose Fen Ngalle¹, Lucienne Meusse¹, Fabrice Mbih Mbende¹, Alida Dzoyem¹, Thomas Efole Ewoukem¹, Minette Tomedi Eyango¹

¹Institute of Fisheries Sciences of the University of Douala in Yabassi, P.O. Box 7236 Douala in Yabassi, Cameroon.

Received: 12 April 2024 Accepted: 30 April 2024 Published: 06 May 2024

Corresponding Author: Jean Paul Makongo Njaka Nloka, Institute of Fisheries Sciences of the University of Douala in Yabassi, P.O. Box 7236 Douala in Yabassi, Cameroon.

Abstract

Cameroon's coasts are vulnerable to the effects of coastal erosion and climate change, thus affecting fishing through reduced catches and destruction of habitats. Reducing these risks requires mobilizing several sectors, notably aquaculture through the domestication of endogenous species. In order to evaluate the nutrition of *Papyrocranus afer* juveniles their captivity, a diet based on zooplankton production was carried out. This study took place at the Laboratory of Aquaculture and Demography of Fisheries Resources of the Institute of Fisheries Sciences from May to June 2023. 54 juveniles of *Papyrocranus afer* with an average length of 31.92 ± 2.30 cm and an average weight of 173.20 ± 1.20 g was used and divided in to treatments: T₀ (*Papyrocranus afer* + Coppens), T₁ (Chicken droppings without *Papyrocranus afer*), T₂ (chicken droppings + *Papyrocranus afer*), T₃ (pig manure without *Papyrocranus afer*) and T₄ (pig manure + *Papyrocranus afer*). Zooplankton sampling was carried out as well as survival and growth. The results show that water temperature and transparency were higher at T₀ ($27.41 \pm 0.50^\circ\text{C}$, 7.40 ± 0.23 and 60.10 ± 3.59 cm), ammoniac, nitrites and nitrates were elevated at T₃ (6.93 ± 0.15 , 7.97 ± 0.08 and 40.58 ± 0.10) mg/l. Zooplankton density was high at T₃ (2,268 ind/l) and low at T₀ (746 ind/l). SR, WG, DAG and SRG were significantly elevated at T4 (100%, 255.68 ± 0.8 g, 1.25 ± 0.01 g/d and $0.73 \pm 0.52\%$ g/day). It appears that *Papyrocranus afer* can be bred in captivity, providing a sustainable solution to the conservation of this endangered species.

Keywords: Influence, fertilizers, zooplankton, survival, growth, *Papyrocranus afer*, captivity.

1. Introduction

The issue of natural risks in the world today constitutes, through multiple threats, the main environmental, economic and social concern. In Central Africa, and in Cameroon in particular, according to (Mena et al., 2017) the entire Cameroonian coastline suffered, between 1998 and 2016, minor and major disasters (depending on the site and the issues), noting a variation in the levels of exposure and vulnerability of these fishing areas. In Cameroon, fishing is both a source of income for the country, employment and contributes to more than 46% of the nutritional needs of the population in term of animal proteins.

Fish is one of the commonly used and less expensive food sources rich in animal proteins for most of the world's population (Allam et al., 2020; Maulu et al., 2020).

It is a valuable source of essential macronutrients and micronutrients, which strongly contributes to global food and nutrition security (FAO, 2020). Fish is very important in developing countries where it represents 75% of the daily animal protein intake (Willet et al., 2019; Mansour et al., 2021). But in Cameroon, fish contributes approximately 30% of protein intake, and the average consumption per individual per year is 17.9 kg compared to 13.07 kg for meat (Ngok,

Citation: Jean Paul Makongo Njaka Nloka, Paul Zango, Jose Fen Ngalle, et al. Influence of Fertilizer Type on Zooplankton Production, Survival Rate and Growth Characteristics in Juvenile *Papyrocranus afer* in Ponds. Journal of Aquatic Science and Marine Biology. 2024; 5(1):21-32.

©The Author(s) 2024. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

2005). Furthermore, fish production has increased to around 11.8 million tonnes (Muringai et al., 2020). This observed increase in fish production is due to the development of the aquaculture sector, which is recognized as the fastest growing food production sector, overpassing farmed animal meat production and capture fisheries landings (Kumar et al., 2013). Aquaculture recorded a production of 110,200 to 2,196,000 tonnes from 1995 to 2018 with a rate of about 16% per year, and has contribute by weight to total fish production increased from 6.2% to 18, 5% between 2000 to 2017 (Adeleke et al., 2020). This prodigious growth is the result of research and innovations in the control of livestock management and especially in the acquisition of new production techniques. The apparent consumption of fish per capita/year has also increased from an average of 9 kg in 1961 to 20.5 kg in 2018. The first estimates for 2030 fall beneath the 21.5 kg barrier, which still remains well below the 30 kg/capita/year recommended by the FAO (FAO, 2018). Despite this spectacular progress in aquaculture, sub-Saharan Africa countries continues to occupy a minor place (0.16%), despite its natural potential (Pouomogne, 2014). Thus, its per capita fish consumption is the lowest, i.e. 10.5 kg/inhabitant/year in 2014 before falling to 9.9 kg/inhabitant/year in 2017 (FAO, 2020). This low consumption in sub-Saharan Africa results from several interconnected factors, including a population that is growing at a higher rate than fish supplies, stagnant game fish production, and an underdeveloped aquaculture sector (FAO, 2020). In Cameroon, resources from fishing are increasingly reduced due to overexploitation, global warming, destruction of fish habitat, pollution, poor fishing methods and techniques as well as stagnation: In landings (MINEPIA, 2018). To compensate this situation, the Cameroonian state spends more than 120 billion FCFA each year on the importation of frozen fish (MINEPIA, 2018). This situation creates a deficit in the net income of the country. To reduce imports of frozen products, which create dependence on the outside (Marquet, 1985; Imorou, 2007; FAO, 2014), it becomes wise to promote the development of aquaculture (fish farming activities). The development of fish farming in Cameroon is mainly based on four species (*Oreochromis niloticus*, *Cyprinus carpio*, *Heterotis niloticus* and *Clarias gariepinus*). However, the priorities of the Cameroonian government's aquaculture sectoral strategy are nowadays focused on the domestication of new (endogenous) species of fish with specific aquaculture potential. Thus, several

endogenous species such as *Clarias jaensis*, *Labeo barbus batesii* and more recently *Papyrocranus afer* are in the process of domestication. Having been the subject of several researches in Nigeria (King, 1994; Edema, et al., 2007) for its use as an ornamental fish, *Papyrocranus afer* is endemic in Africa. In Cameroon, it is still poorly known in captivity. *Papyrocranus afer* is exploited along the Nkam-Wouri watershed by local fishermen in the Nkam division. It is highly appreciated by the population and by scientists because of its zootechnical advantages such as: diversified diet, strong ecological tolerance, rapid growth, highly appreciated flesh and strong resistance to diseases (King, 1994; Edema et al., 2007; Nack et al., 2016), we nevertheless observe its periodic appearance in the Cameroon markets. However, in terms of species exploited in the Nkam-Wouri basin, it comes in fourth position after *Chrysichthys nigrodigitatus*, *Oréochromis niloticus* and *Heterotis niloticus*.

Nutrition fundamentally affects the production performance of fish (Smith et al., 1979; Kjorsvik et al., 1990; Fernandez-Palacios et al., 1997; Adewumi et al., 2005). Several studies on the diet of *Papyrocranus afer* in a natural environment reveal that it is partly made up of zooplankton (King, 1994); knowledge of feeding in a controlled environment is fundamental for the conservation of this species. The use of a natural diet would affect the survival and growth characteristics of *Papyrocranus afer* in a controlled environment. The present study aims to contribute in the preservation and enhancement of the biodiversity of endogenous fishery resources in general and of *Papyrocranus afer* in particular by determining an adequate diet. This was more specifically the influence of the type of fertilizer on zooplankton production, survival rate and growth characteristics in juvenile *Papyrocranus afer* in ponds.

2. Materials and Methods

2.1 Study Site and Period

The study took place at the Laboratory of Aquaculture and Demography of Fisheries Resources (LADRHa) of the Institute of Fisheries Sciences (I.S.H) of the University of Douala in Yabassi in the Nkam Division of the Littoral Region located between 9°50' - 10°10' LE and 4°20' - 4°40' LN (MINEPAT, 2010). (Fig. 1).

Biological Material

A total of 54 juveniles (produce in the laboratory) of *Papyrocranus afer* with an average total length of 31.92±2.3cm and average weight 173.20±1.2g

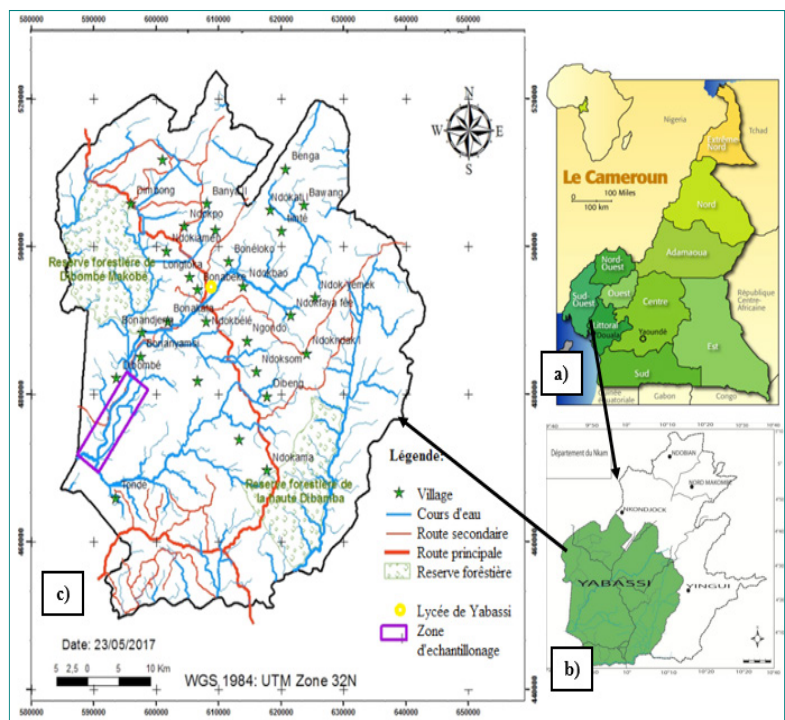


Figure 1. Location of the study area (INC, 2017; adapted)

were used at a density of 2 individuals/m². They were distributed randomly into three groups each containing 18 fish. Each group was submitted to five treatments with two repetitions each.

2.2 Experimental Set up

The *Papyrocranus afer* specimens will be raised in ponds (12), measuring 4.5m³ (length 3m, width 1.5m, depth 1m) at a density of 2 individuals/m². These ponds are gravity fed and equipped with an overflow system. A barrier made of protective net and Chinese bamboo of 1 meter high was erected all along the

experimental ponds. Before the tests, the ponds were left dry for a period of 7 days, aquatic vegetation and all fish and other predatory species were completely eliminated, then the ponds were limed with quicklime at a dose of 400kg/ha (Boyd, 1982; Bogne et al., 2008). A 50 mm mesh net was attached to the supply pipe of each pond to prevent the intrusion of fish and toads from the reservoir (Fig. 2).

2.3 Structure of the Essay

Three groups, each containing 18 fishes and corresponding to five treatments with three replicates

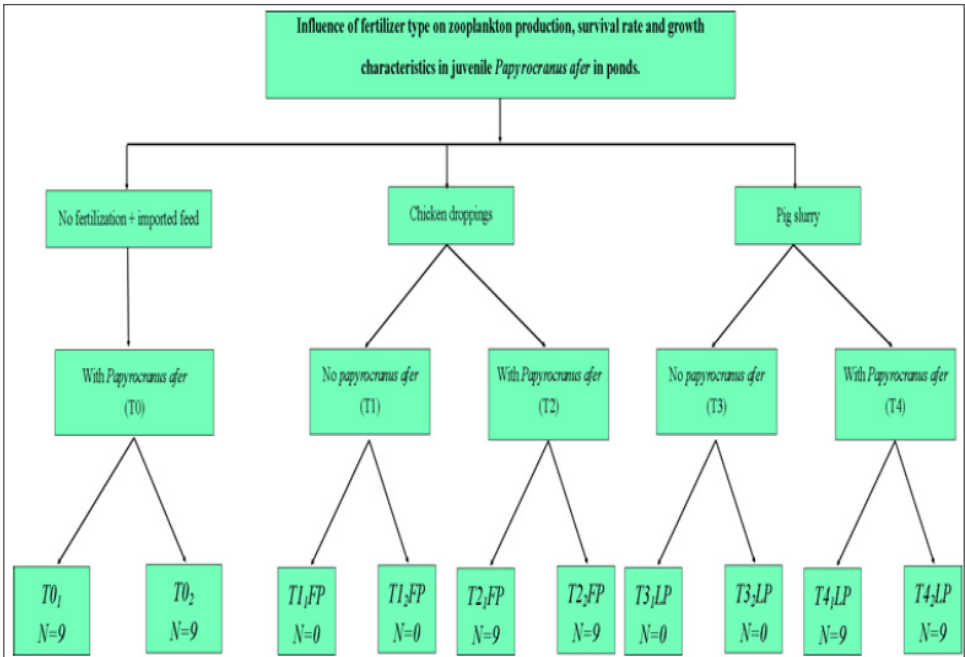


Figure 2. Expeditionary device

each, namely T_0 (*Papyrocranus afer* + Coppens), T_1 (Chicken droppings without *Papyrocranus afer*), T_2 (chicken droppings + *Papyrocranus afer*), T_3 (pig manure without *Papyrocranus afer*) and T_4 (pig manure + *Papyrocranus afer*). The juveniles of *Papyrocranus afer* belonging to T_0 were fed every day at a frequency of 2 times/day (6 a.m. and 6 p.m.) at the rationing rate 9% of the ichthyobiomass for each. The water replenishment in the pond was 1/3 of the volume of the pond all the time. The fertilisation was carried out every two months. Water and zooplankton sampling were carried out every three hours between 6 and 8 a.m to prevent the vertical migration of the zooplankton to the bottom after the sunset. Samples were taken from twenty different points in the water column of each pond using a calibrated 1-litre polyethylene container. The water quality parameters (temperature, DO, Transparency, pH, nitrates and phosphates) were monitored using a multiple parameter of brand HANNA HI 3271. A total volume of 20 liters/pond was filtered through a 40 μm mesh plankton sieve. A 40 ml concentrated sub-sample of zooplankton was collected, fixed by adding 5% formalin in the proportions 25% formalin to 75% sample volume (Nguetsop et al., 2009; Zebazé Togouet et al., 2015) and stored in plastic bottles for quantitative and qualitative analyses.

2.4 Parameters Studied

- Density of individuals (D): $D = (n \times 1000) / V$
- Survival: $SR (\%) = 100 \times FN / IN$ (where IN: initial number and FN: final number);
- Weight gain: $WG (g) = Pmf - Pmi$ (avec Pmf: Poids

moyen final, Pmi: Poids moyen initial);

- Daily average gain: $DAG (g/j) = \frac{(Pmf - Pmi)}{\Delta t}$ (Δt : la durée de l'essai en jours);

- Specific rate of growth: $SRG (\%/d) = \frac{(\ln Pmf - \ln Pmi)}{\Delta t} \times 100$ (ln: logarithme népérien);

- Condition factor K: $K = W \times 100 / LT^3$ with W: weight (g), LT: Total length (cm).

2.5 Statistical Analysis

The descriptive statistics of growth parameters (density, mean $\pm$ standard deviation and as percentages fraction) and curves of results visualization were done using Microsoft Office Excel 2016. The ANOVA test was used to verified the significance level of the descriptive parameters within the different set up.

3. Results

3.1. Influence of fertilizer type on physico-chemical parameters

Parameters varied throughout the test period, with respect to the type of fertilizer and *Papyrocranus afer* (Table 1). Results showed that dissolved oxygen, transparency, nitrite, nitrate and phosphate were significantly affected by the type of fertilizer and the presence or absence of *Papyrocranus afer*, and were significantly higher in ponds fertilized with pig manure (Table 1).

3.2. Effect of fertilizer type on zooplankton production

The richness of zooplankton families as a function of fertilizer type, as summarized in Table 2.

Table 1. Physicochemical characteristics of water as a function of fertilizers and presence of *Papyrocranus afer*

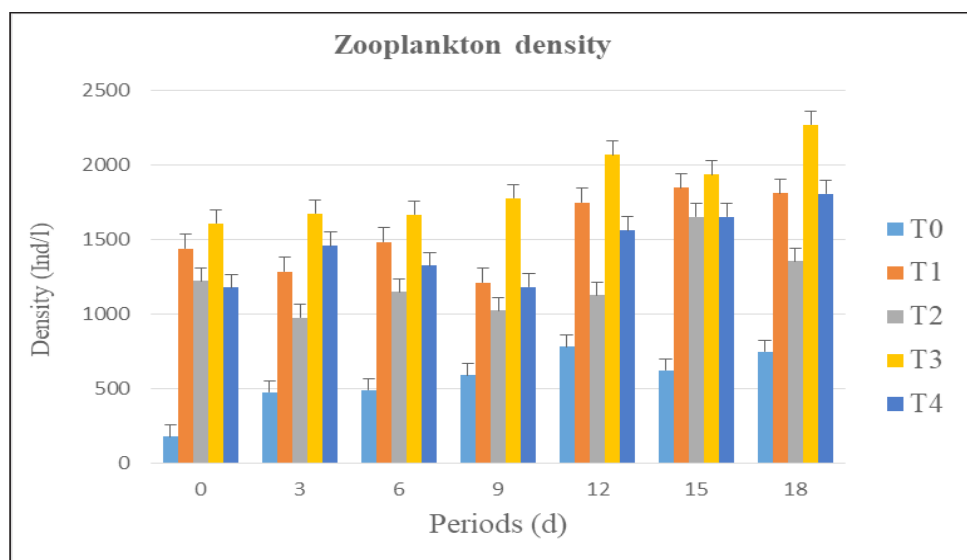
Physicochemical characteristics	Fertilizer types and presence of <i>Papyrocranus afer</i>				
	Control	Chicken droppings (kg/ha)		Pig slurry (kg/ha)	
	T0 (No fertilization + imported feed + <i>Papyrocranus afer</i>)	T1 (No <i>Papyrocranus afer</i>)	T2 (With <i>Papyrocranus afer</i>)	T3 (No <i>Papyrocranus afer</i>)	T4 (With <i>Papyrocranus afer</i>)
Température (°C)	27.41 $\pm$ 0.50	27.02 $\pm$ 0.47	27.00 $\pm$ 0.44	26,92 $\pm$ 0,49	26,66 $\pm$ 0,61
Hydrogen potential (UI)	7.40 $\pm$ 0.23	7.37 $\pm$ 0.14	7.26 $\pm$ 0.26	7,17 $\pm$ 0,13	7,14 $\pm$ 0,16
Conductivity ($\mu\text{S}/\text{cm}$)	34.47 $\pm$ 0.68	37.69 $\pm$ 0.89	36.94 $\pm$ 0.28	42,49 $\pm$ 0,65	37,32 $\pm$ 0,71
Oxygen dissous (mg/l)	5.34 $\pm$ 1.42	3.37 $\pm$ 4.00	4,09 $\pm$ 0,05	3,42 $\pm$ 0.08	3,20 $\pm$ 3.44
Transparency (cm)	60.10 $\pm$ 3.59	48.10 $\pm$ 10.61	32.29 $\pm$ 2.50	54,30 $\pm$ 4,66	47,00 $\pm$ 8,20
NO2-(mg/l)	1.56 $\pm$ 0.15	5.15 $\pm$ 0.10	4.53 $\pm$ 0.11	6,93 $\pm$ 0,15	6,43 $\pm$ 0,17
NO3-(mg/l)	2.44 $\pm$ 0.12	6.15 $\pm$ 0.10	5.53 $\pm$ 0.11	7,97 $\pm$ 0,08	7,48 $\pm$ 0,06
PO43-(mg/l)	35.21 $\pm$ 0.11	37.44 $\pm$ 0.20	36.45 $\pm$ 0.15	40,58 $\pm$ 0,10	38,32 $\pm$ 0,06

Table 2. The richness of zooplankton families as a function of fertilizer type

Groups / Families / Genus / Species	T0 (No fertilization + imported feed + <i>Papyrocranus afer</i>)	T1 (Chicken droppings + No <i>Papyrocranus afer</i>)	T2 (Chicken droppings + with <i>Papyrocranus afer</i>)	T3 (Pig slurry + No <i>Papyrocranus afer</i>)	T4 (Pig slurry + with <i>Papyrocranus afer</i>)
Rotiferes					
Brachionidae					
<i>Brachionus</i>	X	X	X	X	X
<i>Keratella</i>	X	X	X	X	X
Lecanidae					
<i>Lecane</i>	X	X	X	X	X
Philodinidae					
<i>Rotaria</i>	X	X	X	X	X
Trichocercidae					
<i>Trichocerca</i>	X	X	X	X	X
Asplanchnidae					
<i>Asplanchna</i>	X	X	X	X	X
Synchaetidae					
<i>Ploesoma</i>	X	X	X	X	X
Copépodes					
Diaptomidae					
<i>Neodiaptomus</i>	X	X	X	X	X
Pseudodiaptomidae					
<i>Pseudodiaptomus</i>	X	X	X	X	X
<i>Larves Nauplius</i>	X	X	X	X	X
Cladocères					
Moinidae					
<i>Moina</i>	X	X	X	X	X
Daphniidae					
<i>Daphnia</i>	X	X	X	X	X

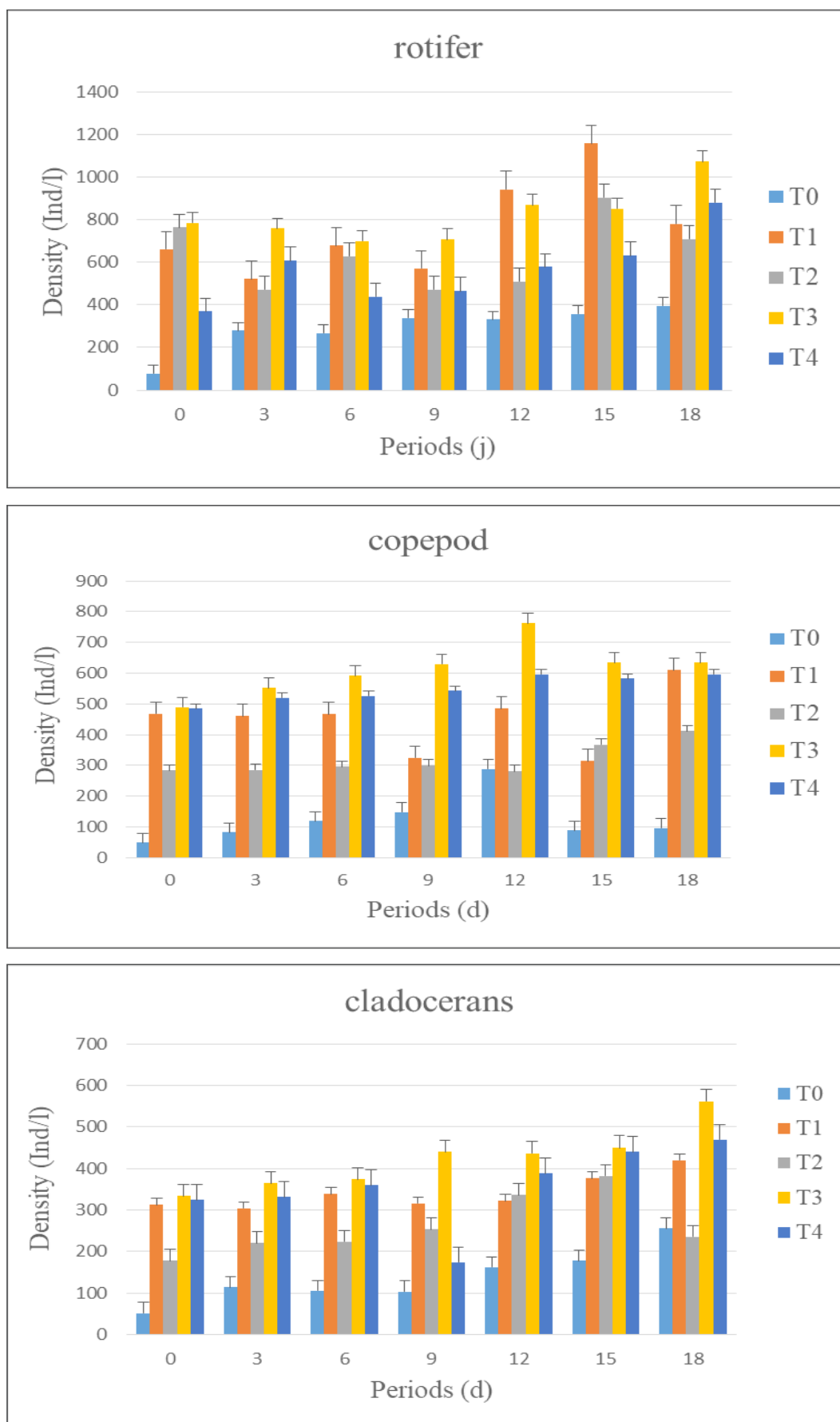
Was highest in the pig manure treatments and lowest in the treatment without fertilization (control) (Fig. 3). Nevertheless, during the trial period, rotifer density was highest in treatment T₁, corresponding to fertilization with and lowest in treatment T₀, then droppings without the presence of *Papyrocranus afer* where no fertilization was applied, while copepod

and cladoceran densities were high in treatment T₃ corresponding to fertilization with hog manure without the presence of *Papyrocranus afer*, and low in T₀. An abundance of the *Brachionus* genus for rotifers, of the *Pseudodiaptomus* genus for copepods and of the *Daphnia* genus for cladocerans was observed during the trial in all treatments (Fig. 4).



T₀ : No fertilization + imported feed + *Papyrocranus afer* T₁ : Chicken droppings + No *Papyrocranus afer* T₂ : Chicken droppings + with *Papyrocranus afer* T₃ : Pig slurry + No *Papyrocranus afer* T₄ : Pig slurry + with *Papyrocranus afer*

Figure 3. Evolution of zooplankton density as a function of treatment and time



T₀ : No fertilization + imported feed + *Papyrocranus afer* T₁ : Chicken droppings + No *Papyrocranus afer* T₂ : Chicken droppings + with *Papyrocranus afer* T₃ : Pig slurry + No *Papyrocranus afer* T₄ : Pig slurry + with *Papyrocranus afer*

Figure 4. Evolution of zooplankton group density as a function of fertilizers and the presence of *Papyrocranus afer*

3.4 Effect of Fertilizer Type on Survival and Some Zootechnical Parameters

Survival Rate

Figure 5 shows the survival rate of *Papyrocranus afer* as a function of fertilizer type.

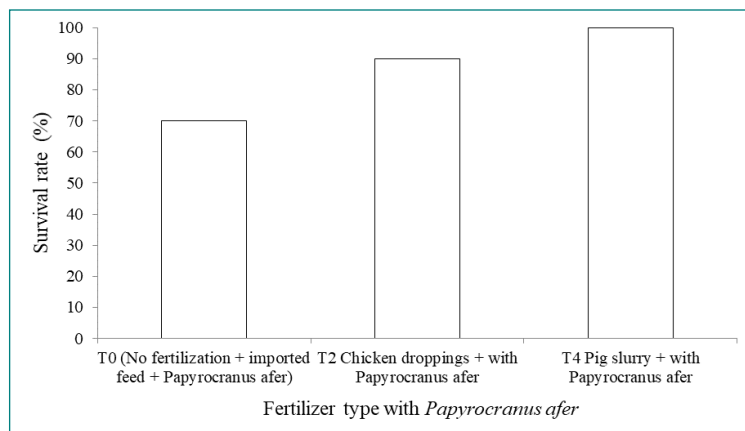


Figure 5. Variation in the survival rate of *Papyrocranus afer* depending on the type of fertilizer

The survival rate of *Papyrocranus afer* was highest at T_4 (100%) and lowest at T_0 (70%).

Weight Gain

Figure 6 illustrates the evolution of the average

weight of *Papyrocranus afer*; it appears that whatever the period, the average weight increased regularly regardless of the treatment. The highest value being obtained for treatment T_4 (255.68g) and low at T_0 (212.54g).

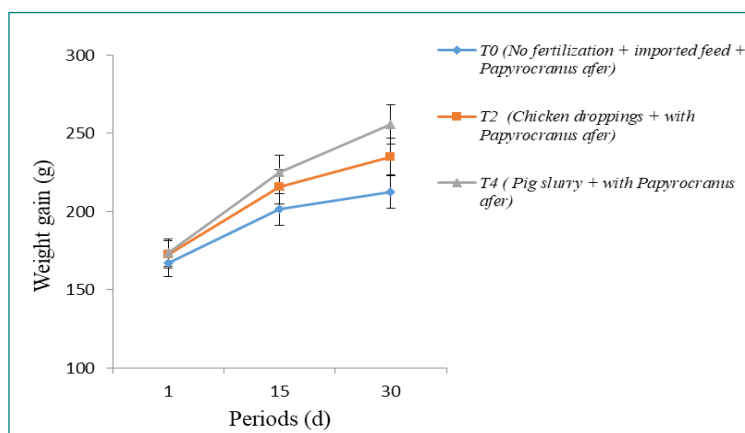


Figure 6. Daily evolution of the average weight of *Papyrocranus afer* depending on the different treatments

Daily Average Gain

Figure 7 illustrates the evolution of the average daily gain of *Papyrocranus afer* according to the different treatments

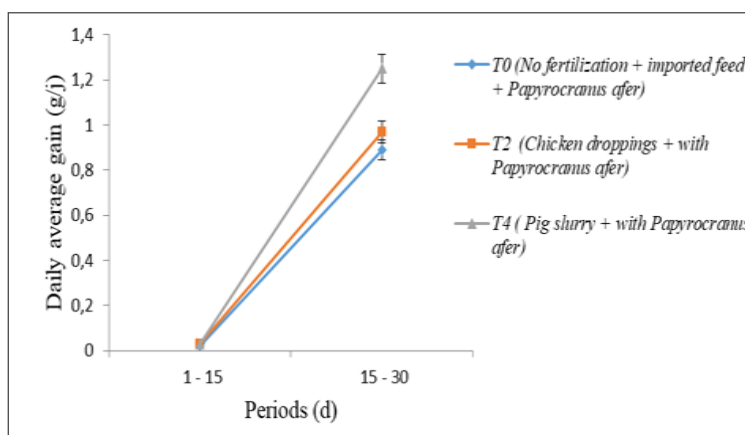


Figure 7. Daily evolution of the average daily gain of *Papyrocranus afer* depending on the different treatments.

It appears that the average daily gain of *Papyrocranus afer* increased throughout the trial. At the end of the trial, the highest values were obtained in treatment T_4 (1.25g/d) followed by T_2 (0.97g/d) and the lowest in T_0 (0.89g/d)

Specific Rate of Growth

Figure 8 illustrates the evolution of the Specific Growth Rate of *Papyrocranus afer* depending on the different treatments

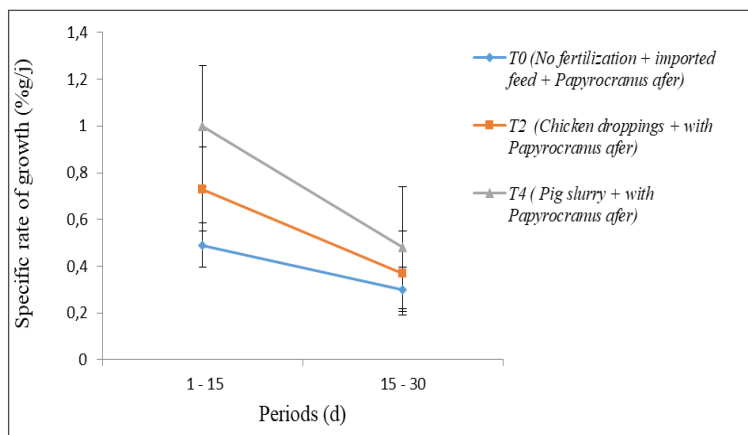


Figure 8. Daily evolution of the Specific Growth Rate of *Papyrocranus afer* depending on the different treatments

Throughout the trial, the Specific Growth Rate highest value was obtained for treatment T_0 followed decreased regardless of the treatment. However, the by T_2 .

Condition Factor K

Figure 9 illustrates the evolution of the Condition Factor K of *Papyrocranus afer* according to the different treatments

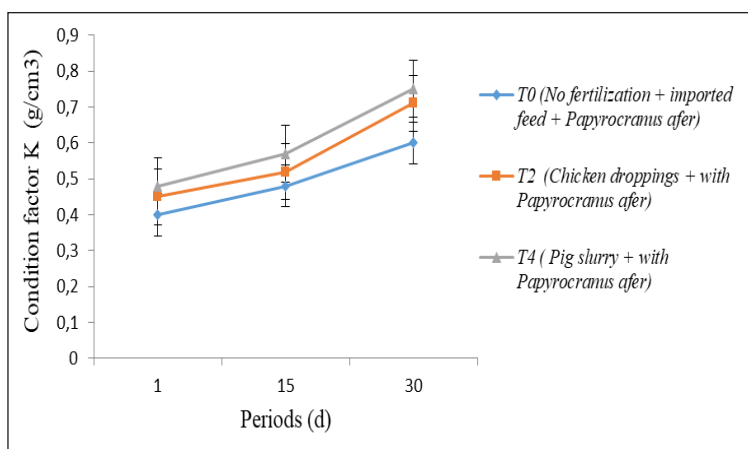


Figure 9. Evolution of the Condition Factor K of *Papyrocranus afer* depending on the different treatments

It appears that the condition factor K increased throughout the test for all treatments. The highest values were obtained in treatment T_4 (0.75g/cm³) followed by T_2 (0.71 g/cm³) and the lowest in T_0 (0.6g/cm³).

4. Discussion

The highest values of physicochemical characteristics (Dissolved oxygen, transparency, nitrate, nitrites and phosphates) and densities were recorded in the fertilized treatments compared to the control (unfertilized). The results obtained in the different treatments for the physico-chemical parameters of the water remained within the optimal ranges

reported by Boyd (1982), namely 24-28°C suggested for optimum development of the natural food. These physicochemical characteristics are nevertheless within the tolerated ranges for the development of zooplankton FAO (2016). We note low concentrations of dissolved oxygen and low transparencies in the fertilized treatments compared to the control treatment T_0 (unfertilized). These results corroborate with the results observed by Njine et al. (2007) and would be linked to the biological activity of the microorganisms which are more abundant there. The levels of dissolved nutrient compounds (NO₂, NO₃-) remain above the threshold of 2.1 mg/l for nitrites and nitrates, 2.3 mg/l; below these values, a proliferation

of phytoplankton to the detriment of zooplankton would be more abundant in concrete tanks (Balarin et al., 1982). The high content of nitrates and nitrites in treatments fertilized with pig manure could be explained by the high nitrogen content in the latter compared to chicken droppings.

Regarding zooplankton diversity, we note the presence of rotifers (07 species), cladocerans (02 species) and copepods (03) in all treatments. We observe throughout the period of the test that rotifers of the genus *Asplanchna* appear most in the treatments (T_1 and T_2) receiving chicken droppings and the genus *Brachionus* compare to treatments (T_3 and T_4) receiving slurry. pig, these results differ from the observations made by Agadjihouédé et al., (2011) with chicken droppings, where *Brachionus sp* species were dominant but corroborate the results obtained by Pouomogne et al., (2022). The densities recorded in this study remain higher than those obtained by Akodogbo et al., (2014), whose value was 1071ind/l in water fertilized with pig manure compared to 145ind/L in unfertilized water. These differences in results would certainly be attributable to the typology of the fertilizer, but more to the intrinsic conditions of the experiment (altitude, breeding system). However, we note during the period of the test with regard to the zooplankton density that it generally decreases with the presence of *Papryrocranus afer* indicating the consumption of zooplankton by *Papryrocranus afer*. Survival rate values were relatively high (>50%) in all treatments. The highest survival rate of *Papryrocranus afer* juveniles (100%) was obtained with the T_4 pig manure treatment. This value is greater than 97% obtained by Agadjihouédé et al., (2012) in larvae of *Clarias gariépinus* and larvae of *Heterobranchus longifilis* fed with zooplankton from pig droppings. The survival rate obtained at T_2 (90.00%) is nevertheless lower than 95.52% in ponds fertilized with chicken droppings and 94.91% in unfertilized ponds obtained by Kouakou Y. et al., (2021) at the fry of *Oreochromis niloticus* after 60 days. This difference could be due to the difference in age, physiological states and the conditions of the test, namely the physicochemical characteristics of the environment and its duration. The highest final average weight (255.68g) recorded at the end of the trial was noted with the treatment with pig manure (T_4), which shows that the juveniles of *Papryrocranus afer* enhance zooplankton. The average daily gains (ADG) varied upwards with the different treatments. However, the values obtained at T_2 (0.97g/d) remain low at 1.04g/d in ponds fertilized

with chicken droppings, but those obtained in unfertilized ponds (0.89g/d) are greater than 0.69g/d. j obtained by Kouakou Y. et al., (2021) in *Oreochromis niloticus* fry after 60 days. As for the highest value 1.25g/d (T_4) it remains higher than 0.29g/d reported by Djikengoue et al., in 2020 among post larvae of common carp *Cyprinus carpio* by fertilization with droppings of chicken. The growth differences observed at the end of the test between these batches could be linked to a difference in physiological states and the conditions of the test, namely the food used in an unfertilized environment. The specific growth rates (SGR) obtained (0.30 to 0.48%/d) at the end of the trial remain lower than those obtained by Kouakou Y. et al., 2021 (4.07 to 4.71%/ j), and also remains lower than those (11.28 to 14.29%/d) obtained by Agadjihouédé et al., (2012) in larvae of *Clarias gariépinus* and larvae of *Heterobranchus longifilis* fed with zooplankton from droppings of pork and 8.07%/d obtained by Djikengoue et al., in 2020 in post larvae of common carp *Cyprinus carpio* by fertilization with chicken droppings.

The low values of this test could be explained on the one hand by the stocking density for the test, and the physicochemical parameters of the rearing environment. The highest condition factor K (0.75) obtained at the end of the test is lower than 0.89 and 1.24 reported respectively by Tonfack et al., in 2020 in the larvae of African cyprinids *Labeobarbus batesii* and Djikengoue and al., in 2020 in post larvae of common carp *Cyprinus carpio* by fertilization with chicken droppings. This difference could be explained by exogenous factors such as the breeding infrastructure, and endogenous factors, namely the size and strain of the fish which were different.

5. Conclusion

At the end of this trial which proposed a lasting solution for the conservation of the endogenous species *Papryrocranus afer* which is in danger of disappearing in Cameroonian waters due to the vulnerability of the Cameroonian coasts, a trial of domestication of this species in a controlled environment. In order to propose a diet, a study focused on the influence of the type of fertilizer on the production of zooplankton, the survival rate and the growth characteristics of juvenile *Papryrocranus afer*. It emerged that the conservation and valorization of this species through the knowledge of its ecology and its diet, the results showed that the physicochemical characteristics of the water have evolved with the type of fertilizers

applied without however being different from those observed in a natural environment. In addition, the density of zooplankton is influenced by the presence of *Papyrocranus afer* and the type of fertilizer. The highest zooplankton density was observed in ponds fertilized without *Papyrocranus afer*, which would indicate that zooplankton provide a food source for *Papyrocranus afer*. Concerning the survival rate and growth characteristics of *Papyrocranus afer*, these were affected by the type of fertilizer. Indeed, the survival rate, average weight, average daily gain, specific growth rate and condition factor K were higher in fish fed with zooplankton from pig manure followed by those having received zooplankton. . made from chicken droppings. This test showed that in a controlled environment, *Papyrocranus afer* better values its living prey. As a result, this study contributes to the preservation of this endogenous species with high aquaculture potential, threatened with extinction due to the deterioration of their living environment due to the vulnerability of the Cameroonian coasts where they develop well. Difficulties were encountered during this particular study; in particular the impossibility of having samples available at any time, hence an un representative number of samples used as well as the duration of the test. However, it would be desirable to repeat this study and extend this analysis to all subsequent stages of development of *Papyrocranus afer*.

Acknowledgments

The study presented here was carried out within the Laboratory of Aquaculture and Demography of Fisheries Resources of the Institute of Fisheries Sciences of the University of Douala in Yabassi supported by its Administration. We thank its Director and Staff. We also thank the Fouban Zootechnical Center for allowing the characterization of our breeding environment through data on Zooplankton.

6. References

1. Agadjihouédé H., Bonou C. A., Montchowui E. and Lalèyè Ph. 2011. Recherche de la dose optimale de fiente de volaille pour la production spécifique de zooplancton à des fins piscicoles. Cahiers Agricultures, 20 : 247-260.
2. Agadjihouédé H., Bonou C. A., Chikou A. & Lalèyè Ph. 2010. Production comparée de zooplancton en bassins fertilisés avec la fiente de volaille et la bouse de vache. Int. J. Biol. Chem. Sci. 4(2) : 432-442.
3. Albaret J.J., 1982. Reproduction et fécondité des poissons d'eaux douces de Cote d'Ivoire. Rev. Hydrobiol.trop, 15, pp347-371.
4. Djikengoue K., Mambe T., Kpoumie N., and Tonfack Achile Peguy 2020. Effects of the Level and Frequency of Fertilization with hen Droppings on Zooplanktonic Density and Growth Performance of Common Carp Post-Larvae (*Cyprinus Carpio*). International Journal of Aquaculture Research and Development issn no: 2691-6622
5. Edema, C. U., Ogbeibu, A. E. and Utunye, M. 2007. Aspects of the biology of *Papyrocranus afer* and *Xenomystus nigri* (Family *Notopteridae*) in the River Osse, southern Nigeria. Tropical Freshwater Biology 16(2) : 9 – 19
6. Efole T. E., 2011. Optimisation biotechnique de la pisciculture en étang dans le cadre du développement durable des Exploitations Familiales Agricoles au Cameroun. UMRs INRA Agro campus Ouest « Sol Agro et Hydrosystème et Spatialisation » et « Ecologie et Santé des Ecosystèmes » à Rennes (France) / Ichtyologie et Hydrobiologie appliquée à la FASA de l'Université de Dschang (Cameroun). Thèse de Doctorat. 164p.
7. FAO., 2014. La situation mondiale des pêches et de l'aquaculture. Pêche, aquaculture, sécurité alimentaire, déperditions de nourriture. ISBN : 978-92-5-208275-0 ISSN : 1020-5497. 255 pp
8. FAO, 2016. La situation mondiale des pêches et de l'aquaculture : Contribuer à la sécurité alimentaire et à la nutrition de tous. Rome 224 pages.
9. FAO., 2020. La situation mondiale des pêches et de l'aquaculture 2016. La durabilité en action. Version résumée. 28 p.
10. Felipe F.B., Petr Ráb., S. Lavoué., E.Tariq., L.A.C. Bertollo., K.Andrzej., S.R. Maruyama., E.A. Oliveira., R.F. Artoni., M.H. Santos., O.I. Jegede.,T. H., A. Tanomtong ., T. Liehr., M.B. Cioffi, 2018. From chromosomes to genome: Insights into the evolutionary relationships and biogeography of old world knifefishes (*Notopteridae*; Osteoglossiformes). Genes, 9, 306, 21p.
11. Hien, T.T.T., N.T.L., Lan L.M., Tu T.L.C., 2013. Évaluation de la possibilité de remplacement de la nourriture pour poisson par de la nourriture au soja pour le poisson en tranches (*Chitala chitala* Hamilton, 1822). Journal of Science Université de Can Tho, (29), pp109-117.
12. Hien, T.T.T., Hoi B.V., Tu T.L.C., 2015. Possibilité de remplacer la farine de poisson par de la farine de viande et d'os comme aliment pour le cobia (*Chitala chitala* Hamilton, 1822). Journal of Science Université de Can Tho, (38), pp101-108.

13. Hien, T.T.T., Nguyen Thi Linh Dan, Tran Le Cam Tu and Lam My Lan 2022. Utilisation d'aliments pour poissons en tranches (*Chitala chitala*). Journal scientifique de l'Université de Can : pp166 174
14. Hussain, H. A. Shakir, S. Ali* and J. I. Qazi, 2015. Growth coefficient and fecundity of *Chitala chitala* (osteoglossiformes: *Notopteridae*) from the river ravi, Pakistana. The Journal of Animal & Plant Sciences, 25(2): 2015, Page: 401-405 ISSN: 1018-7081
15. IUCN, 2012. International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges. Annual Report.
16. Idodo-Umeh, G., 2003. Freshwater Fishes of Nigeria. Taxonomy, Ecological Notes, Diet and Utilization, Publishers Ltd., 19-20.
17. Inoue, J.G., Y. Kumazawa., M. Miya., M.Nishida, 2009. The historical biogeography of the freshwater knifefishes using mitogenomic approaches: A Mesozoic origin of the Asian notoptyrids (*Actinopterygii*: Osteoglossomorpha). Mol. Phylogenet. Evol. 51, pp486–499.
18. King, R. P. 1994. Seasonal dynamics in the trophic status of *Papyrocranus afer* (Gunther, 1868) (*Notopteridae*) in a Nigerian rainforest stream. Revista de Biologia Tropical 27: pp143 -215
19. Kouakou, Y. Nicolas, A. Y., André, C., and Akpolët, K. N., (2021). Effet de la fertilisation organique des étangs à partir des fientes de poulets sur la survie et la croissance des alevins de *Oreochromis niloticus* (Linnaeus, 1758). European Scientific Journal, ESJ, 17(14), 246.
20. Kwame Akpaglo P., 2012. The potential of *Heterotis niloticus* (African Bony –Tongue) as aquaculture candidate in Ghana. Kwame Nkrumah University of Science and Technology Kumasi. Thèse de Doctorat. 93p.
21. Lavoué S., J.P. Sullivan, 2004. Simultaneous analysis of five molecular markers provides a well-supported phylogenetic hypothesis for the living bony-tongue fishes (Osteoglossomorpha: *Teleostei*). Mol. Phylogenet. Evol. 33, pp171–185.
22. Lazard J., Lecomte Y., Stomal B., Weigel J.Y, 1991. Pisciculture en Afrique Subsaharienne : situations et projets dans des pays francophones propositions d'action. Rapport d'étude, Ministère de la coopération et du developement, 158p
23. Legendre M., J.J. Albaret, 1984. Protocole d'identification des espèces autochtones présentant un intérêt potentiel pour l'aquaculture en milieu lagunaire. Centre de Recherches Océanographiques, Abidjan, NDR 07/84, 4p.
24. Lévêque C., D. Paugy, 1981. Flore et faune aquatiques de l'Afrique Sahelo-Soudannienne. Tome II. Convention ORSTOM-OMS, ORSTOM, Paris, 873 p.
25. Lévêque C., D. Paugy, 1984. Guide des poissons d'eau douce de la zone du programme de lutte contre l'onchocercose en Afrique de l'Ouest. Convention ORSTOM-OMS, ORSTOM, Paris, 393 p.
26. Lévêque C., D. Paugy, 1999. Les poissons d'eau douce continentale Africaine, Diversité, écologie, utilisation par l'homme. Convention ORSTOM-OMS, ORSTOM, Paris, 521 p.
27. Luquet P., Y. Moreau, 1989. Energy-protein management by some warmwater finfishes. In: Advances in tropical Aquaculture, Tahiti Feb. 20 - March 4 1989, Actes du Colloque n°9, AQUACOP, IFREMER, pp751-755.
28. M. A. Samad, M. Farjana, S. K. Chatterjee M. M. Rahman and S. C. Barman. 2017. Culture technique of endangered *Notopterus chitala* (Hamilton, 1822) with *Oreochromis niloticus* for domestication in pond habitat Bangladesh J. Sci. Ind. Res. 52(3), 187-194, 2017
29. Mena, M.S., Tchawa, P., Amougou, J.A., Tchotsoua M. & Tsikam Mba, C., (2017). Les changements climatiques à travers les événements météorologiques et climatologiques extrêmes et leurs impacts dans le processus de développement des systèmes de sociétés : Cas du Cameroun. Rev. Ivoir. Sci. Technol., 29 (2017) 159-180ISSN 1813-3290. Repérée par l'URL <http://www.revist.ci>
30. Minepia., 2020. Plan stratégie de développement durable de l'aquaculture au Cameroun. 43P.
31. Muhammad Hafeez-ur-Rehman, Muhammad A. and Khalid Javed I. 2013. Body Composition of Feather Back *Notopterus notopterus* and *Rita rita* from Balloki Headworks-Pakistan Farzana Abbas. Journal of Agri-Food and Applied Sciences Vol. 1(4), pp. 126-129
32. Nack J., Bitja Nyom A., Pariselle A., 2015. New evidence of a lateral transfer of monogenean parasite between distant fish hosts in Lake Ossa, South Cameroon: the case of *Quadriacanthus euzeti* n. sp. Journal of Helminthology pp 1-5.
33. Nana T.A., Songmo B., Efole Ewoukem T., Fonkwa G., Kom M. Francis, Tchoumboue., 2020. Effet comparé de la dose de lisier de porc utilisé comme fertilisant en étang sur la richesse et la distribution des taxons phytoplanctoniques. Journal of Applied Biosciences 152: pp. 15630 – 15639.
34. Nayyar, R.P., 1965. Karyotype studies in the genus

- Notopterus* (Lacepede). the occurrence and fate of univalent chromosomes in spermatocytes of *N. Chitala*. *Genetica*, 36, pp398-406.
35. Nell M. C. C., 2018. Diet Variation and Prey Composition of Exotic Clown Featherback, *Chitala ornata* (Gray 1831) (Osteoglossiformes: *Notopteridae*) in Laguna De Bay, Luzon Island, Philippines. *Asian Fisheries Science* 31, pp252–264
36. Roberts, T.R., 1992. Systematic revision of the old-world freshwater fish family *Notopteridae*. *Ichthyol. Explor. Freshw.* 2(4), pp361–383.
37. Sarkar U.K., Deepak P.K., 2009. The diet of clown knife fish *Chitala chitala* (Hamilton-Buchanan) an endangered *Notopterid* from different wild population (India). *Electronic Journal of Ichthyology* 1:11–20.
38. Svensson, G. S. O. 1933. Freshwater fishes from the Gambia river (British West Africa). Results of the Swedish expedition 1931.K. *Sven. Vetenskapsakad. Handle* 12(3): 1 – 102
39. Taverne L., J.G. Maisey, 1999. A *Notopterid* Skull (Teleostei, Osteoglossomorpha) from the Continental Early Cretaceous of Southern Morocco; *American Museum Novitates* No. 3260; American Museum of Natural History. New York, NY, USA.
40. Tonfack A., Kpoumie N., Ngoula F., Djikengoue K., Tiogué T., Njoukou S., Efole E., and Tchoumboue J., 2020. Survival rate and growth performances of post-larvae of the African *Cyprinidae* *Labeobarbus batesii* (Boulenger, 1903) with different type of food. *International Journal of Aquaculture Research and Development* 8(3): 128-134
41. Tran Thi Thanh Hien, Lam My Lan, and Tran Le Cam Tu, 2022. Effects of dietary protein and lipid levels on growth, feed utilization and meat quality of clown knifefish (*Chitala chitala*). *Can Tho University Journal of Science* Vol. 14, No. 2.
42. U.K. Sarkar, W.S. Lakra, P.K. Deepak, R.S. Negi, S.K. Paul, A. Srivastava, 2006. Performance of different types of diets on experimental larval rearing of endangered *Chitala chitala* (Hamilton) in recirculatory system. *Science direct Aquaculture* 261 (2006) 141 – 150
43. Yanwirsal, H., Bartsch, P. and Kirschbaum, F., 2017. Reproduction and development of the asian bronze feather back *Notopterus notopterus* (Pallas, 1769) (Osteoglossiformes, *Notopteridae*) in captivity *Zoosystematic and Evolution* 93(2): 299-324.