

## Effects of Dietary Protein Level on Growth Performance of Pre-growing Catfish *Clarias jaensis* (Boulanger 1909) in Captivity

Komguep N. Ronald<sup>1\*</sup>, Efole T. Ewoukem<sup>1</sup>, Defang F. H<sup>2</sup>, Nana T. A<sup>1</sup>, Mube K. H<sup>2</sup>, Tagning Z. P. D<sup>1</sup>

<sup>1</sup>Applied Hydrobiology and Ichthyology Research Unit, University of Dschang, Cameroon; <sup>2</sup>Research Unit in Animal Nutrition and Production (RUANP), University of Dschang, Cameroon

### ABSTRACT

The study of the effects of the protein level on the survival rate, growth performance and the cost of production of pre-maturing *Clarias jaensis* fingerlings was carried out for 90 days at the Teaching and Research farm (5°36'-5°44'; 5°37'-5°44'LN; 9°94'-10°06' and 9°85'-10°06' LE; altitude 1392-1396 m) of the University of Dschang. The aim of this work was to improve the production of this fish by determining its protein requirements. For this purpose, 360 Fingerlings of *Clarias jaensis* with an average weight of  $23 \pm 1.8$  g and Total length  $13.95 \pm 2.90$  cm were divided into 4 batches corresponding to diet containing 30; 35; 40 and 45% crude protein in the feed. The fish were fed twice a day at 5% of the ichthyobiomass and the quantity of feed where readjusted each month after biometrical monitoring. Data collected were analyzed by using SPSS 20.0 to test the effect of protein level on survival, growth characteristics and food production cost. The results obtained revealed that the lowest survival rate ( $80.03 \pm 2.5\%$ ) was recorded with the 30% protein ration and the highest ( $89.23 \pm 1.72\%$ ) with the 45% protein level in the feed. Feed intake and total length were not affected by the protein level in the feed. The highest weight gain ( $89.33 \pm 1.99$  g), mean daily gain ( $0.99 \pm 0.05$  g), specific growth rate ( $1.75 \pm 0.10\%$ ), K factor ( $0.98 \pm 0.23$ ) were recorded with fingerlings fed 45% of crude protein in the diet ( $P < 0.05$ ). The lowest feed conversion ratio ( $3.32 \pm 0.1$ ) and protein efficiency ratio ( $0.67 \pm 0.20$ ) was obtained with the ration containing 45% crude protein and the highest feed conversion ratio ( $4.04 \pm 0.05$ ) and protein efficiency ratio ( $0.84 \pm 0.12$ ) with 30% crude protein ( $P < 0.05$ ). The Lowest cost for the production of a kg of body weight ( $606.03$  FCFA  $\pm 10.44$ ) was obtained with the ration containing 30% protein but no difference was recorded between different feed. The study revealed that in the formulation of feeds for the *Clarias jaensis* fingerlings, 45% of crude protein will optimize survival rate, growth performance and cost production.

**Keywords:** *Clarias jaensis*; Fingerlings; Crude proteins; Growth; Survival; Production cost

### INTRODUCTION

The world's population is expected to reach nearly 9.7 billion by 2050 [1]. This increase in the population leads to an increasing demand for animal protein in general and for fisheries in particular. The supply of the population with fishery resources from the natural environment is increasingly limited due to pollution, climate change, destruction and degradation of habitat by human actions [2,3] and especially overexploitation which threatens nearly 31% of natural stocks [1]. The practice of aquaculture, which continues to grow over the years [4] helps to preserve natural stocks and repopulate continental and marine waters [5]. It is therefore presented as a means of achieving one of the Sustainable Development Goals (SDGs), the aim of which is to ensure a sustainable environment through the preservation and enhancement of biodiversity [6].

In Cameroon, very few endogenous species have undergone a domestication program yet they have the advantage of adapting better to environmental conditions. It is in this context that an interest was given to an endogenous fishery resource belonging to the family Clariidae and known as *Claria jaensis*. The Clariidae family is marked by its hardiness, omnivorous diet, rapid growth (3 g/day) correlated with its ability to efficiently process compound feed and it's much appreciated flesh [7].

The domestication of the still little known species *Clarias jaensis*, which is the subject of uncontrolled exploitation by farmers for profit and food purposes [8] could like any other local species, make it possible to support sustainable aquaculture development [2].

This domestication requires a mastery of housing, food and feeding, health and reproduction techniques. Among these techniques,

**Correspondence to:** Komguep N. Ronald, Applied Hydrobiology and Ichthyology Research Unit, Faculty of Agronomy and Agricultural Sciences, University. P.O. Box 22, Dschang, Cameroon, E-mail: ronaldkomguep@yahoo.fr

**Received:** October 20, 2021, **Accepted:** November 03, 2021, **Published:** November 10, 2021

**Citation:** Komguep NR, Efole TE, Defang FH, Nana TA, Mube KH, Tagning ZPD (2021) Effects of Dietary Protein Level on Growth Performance of Pre-growing Catfish *Clarias jaensis* (Boulanger 1909) in Captivity. J Aquac Res Dev 12:658.

**Copyright:** © 2021 Ronald KN, et al. This is an open access article distributed under the term of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

food and feeding is the most important because it represents almost 70% of production costs. Also, one of the important aspects of diet is determining nutrient requirements. Among these, energy requirement for physiological stages in *Clarias jaensis* has been studied [9]. However, no work on the protein requirements for the growth of *Clarias jaensis* has yet been identified. Protein requirement study is one of the most important aspects on fish nutrition. Protein provides essential amino acids which are used for tissue repair and growth of the fish [10,11]. Dietary protein has significant importance in aquaculture systems because it represents considerable economic investment and a central factor that determines fish growth so long as other physiological requirements needed for growth are fulfilled [12].

The general objective of this work is to contribute to the improvement of fish production by determining nutritional needs of *Clarias jaensis*.

## METHODS AND MATERIALS

### Study area

This study was conducted at the Teaching and Research Farm of the Faculty of Agronomy and Agricultural Sciences of the University of Dschang (UDs). Dschang, a mountainous city, is located west of Cameroon at latitude 5°26' North, longitude 10°26' East and at an altitude of 1420 m and an average rainfall of 2000 mm per year.

### Animal material

A total of 360 fingerlings of *Clarias jaensis* with an average weight of  $23 \pm 1.8$  g obtained from fishermen in the Mbô floodplain, located in the Western region of Cameroon and transported in to the study site were used. Immediately on arrival, fish were acclimatized for two weeks in concrete tanks. During the acclimatization period, a 3A feed based on fishmeal, soybean meal and middling containing 40% of crude protein were given to them until satiety twice daily between 6-8 a.m. and 4-6 p.m.

### Livestock structures

12 happas of 1 m<sup>3</sup> (1 × 1 × 1m) attached to the four sides to Chinese bamboos firmly embedded in a 100 m<sup>2</sup> pond, of average depth 0.90 m and supplied with water from a water dam located at 150 m distance were used. The pond was equipped with a 5 cm diameter water supply pipe with an average water flow rate of 0.14 m<sup>3</sup>/s and a 10 cm diameter PVC overflow pipe with an average flow rate of 0.14 m<sup>3</sup>/s so as to maintain a water height of 0.80 m. Each happa was also equipped with a circular floating frame 30 cm in diameter placed on its surface and vertically there was placed a 33 cm diameter basin located 0.70 m away to collect uneaten feed.

### Experimental diets

Four isoenergetic experimental diets (Table 1) were formulated with different protein levels, namely 30%; 35%; 40% and 45%. Each diet was made from ingredients previously ground, homogenized manually and wetted with drilling water (0.8-1 liter for 5 kg of food) so as to obtain a homogeneous paste, then granulated using a chopping machine with a sieve mesh diameter of 0.2-0.4 cm. The granules obtained were then dried in an electric dryer at 45°C. for 48 hours and stored in labeled plastic bottles. The Chemical composition of crude protein and metabolisable energy of different diet were obtained by AOAC (2000) method [13].

### Experimental set up

360 *Clarias jaensis* fingerlings were divided into 4 comparable groups (90 fingerlings/groups) of size repeated 3 times with 30 fish per repetition. Each group was randomly assigned one of the experimental diets R1 (30%); R2 (35%); R3 (40%) and R (45%).

### Conduct of the test and data collected

The feed was distributed twice a day (8 Am and 6 Pm) at 3% of the ichtyobiomasse. Each month, a biometrical monitoring was conducted in each group using a 0.1 g precision electronic scale (OHAUS) an ichthyometer to evaluate growth characteristics

Table 1: Composition of experimental diet.

Ingrédients	R1 (30%)	R2 (35%)	R3 (40%)	R4 (45%)
corn	34	28,5	24,5	20
Cassava	5	4	4	1
Wheat bran	10	7	4	4
Cottonseed cake	6	5,5	2,5	1
Soybean meal	6	6	4	4
Blood meal	3	5	7	10
Fishmeal	28	36	46	52
Shell meal	0.5	0.5	0.5	0.5
Bone meal	0.5	0.5	0.5	0.5
Palm oil	5	5	5	5
Premix 2%	2.00	2.00	2.00	2.00
Total	100.00	100.00	100.00	100.00
Analysed Chemical composition				
CP (%)	29.1	34.2	39.1	44.5
ME (kcal/kg) (kcal/kg)	3118.46	3100.42	3107.96	3104
ME/CP	107.16	90.65	79.48	69.75
CA/P	1.76	1.82	1.87	1.68

CP=Crude protein, ME=Metabolize energy, P/E=Protein/energy ratio, Ca/P=Calcium/phosphorus ratio.

and adjust the amount of food to distribute. Uneaten feed were collected weekly, sun-dried and weighed to estimate feed intake. The physicochemical parameters of the water (temperature, dissolved oxygen, pH) were measured weekly and recorded in (Table 2).

**Studied characteristics**

**Survival rate**

$$\text{Survival rate (\%)} = \frac{\text{initial number of fish} - \text{final number of fish}}{\text{initial number of fish}} \times 100$$

**Growth characteristics and cost of production**

$$\text{Feed intake (FI)} = \text{Feed distributed (g)} - \text{Left over (g)}$$

$$\text{Weight gain (WG)} = \text{Final body weight (g)} - \text{initial body weight (g)}$$

$$\text{Average daily gain (ADG)} = \frac{\text{total weight gain (g)}}{\text{duration of the trial (days)}}$$

$$\text{Specific growth rate (SGR)} = \frac{[\ln(W_f) - \ln(W_i)]}{\text{duration of the assay (day)}} \times 100$$

where,  $W_f$ : final average weight,  $W_i$ : initial average weight

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Feed Intake (g)}}{\text{Weight gain (g)}}$$

$$\text{Condition factor } K = 100 \frac{W}{LT^3} \text{ With } W = \text{Weight (g)} \text{ } LT = \text{Total length (cm)}$$

The cost of a kg of feed was calculated based on the price of each ingredient as practiced in the local market.

The cost of feed consumed was obtained by multiplying the average feed intake by the price of a kg of the corresponding diet. Price per kilogram of food (PFC):  $PFC = \sum (X_i \times P_x)$ ;  $X_i$  = Quantity of ingredient (i) in (Kg);  $P_x$  = Price of the ingredient (i) in FCFA.

The cost of production of a kg of live body weight was calculated by multiplying the cost of the kg of feed by the corresponding feed conversion ratio: Price of kilogram of food consumed (PFC):  $FCP = FCR \times PFC$ ;  $FCR$  = Feed Conversion ratio.

**Statistical analysis**

One-way ANOVA allowed us to test the effect of protein level on survival and growth characteristics. When there were significant differences between the means, they were separated by Duncan's test at 5% significance level. SPSS 20.0 statistical software was used for these analyzes.

**RESULTS**

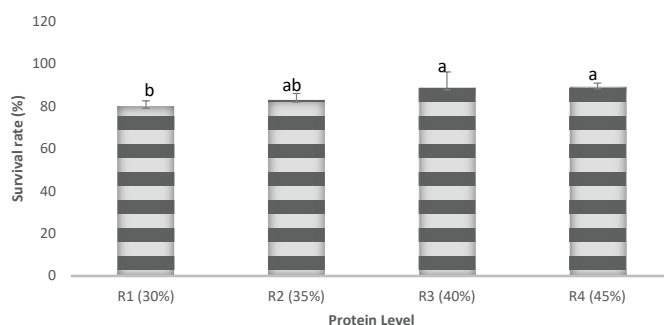
**Effects of protein level on the survival rate of pre-growing *Clarias jaensis***

Figure 1 illustrates the effect of protein level on the survival rate of *Clarias jaensis* in captivity reveals that survival rate tends to increase with the level of protein in the diet. Hence, the highest survival rates were obtained with the diet R4 ( $89.23 \pm 1.72\%$ ) and R3

( $88.73 \pm 7.5\%$ ) rations which were otherwise comparable to the R2 ration ( $83 \pm 3.05\%$ ). The lowest survival rate ( $80.03 \pm 2.5\%$ ) was obtained with the ration at 30% of the protein level

**Effects of protein level on growth characteristics and feed cost production of pre-maturing *Clarias jaensis***

The effects of graded level of crude protein on the growth characteristics and the feed production costs of *Clarias jaensis* fingerlings are presented in Table 3 and illustrated by Figures 2-4. In general, it appears that with the exception of the feed conversion ratio, growth performance increased significantly with the increasing level of protein in the diets. The level of protein in the diet did not have a significant effect on feed consumption.



**Figure 1:** Effects of protein level on the survival rate of *Clarias jaensis*. a and b: histograms with the same letters are not significantly different ( $P > 0.05$ ).

**Table 3:** Effects of protein level on growth characteristics and alimentary Cost production of pre-maturing *Clarias jaensis*

Growth Characteristics and Cost Production	Protein Level (%)				p
	30	35	40	45	
FI (g)	300.44 ± 0.82 <sup>a</sup>	303.99 ± 11.42 <sup>a</sup>	301.17 ± 9.00 <sup>a</sup>	296.77 ± 3.6 <sup>a</sup>	0.71
Wi (g)	23.47 ± 1.78 <sup>a</sup>	23.67 ± 1.81 <sup>a</sup>	23.08 ± 1.7 <sup>a</sup>	23.35 ± 1.80 <sup>a</sup>	0.28
Wf (g)	97.76 ± 5.44 <sup>d</sup>	102.23 ± 2.58 <sup>c</sup>	105.28 ± 3.92 <sup>b</sup>	112.53 ± 4.27 <sup>a</sup>	0
TLf (cm)	24.99 ± 0.98 <sup>a</sup>	24.02 ± 1.00 <sup>a</sup>	23.27 ± 1.31 <sup>a</sup>	22.74 ± 1.67 <sup>a</sup>	0.21
WG (g)	74.30 ± 0.91 <sup>d</sup>	78.56 ± 0.78 <sup>c</sup>	82.20 ± 1.64 <sup>b</sup>	89.33 ± 1.99 <sup>a</sup>	0
DMG (g)	0.83 ± 0.06 <sup>d</sup>	0.87 ± 0.03 <sup>c</sup>	0.91 ± 0.05 <sup>b</sup>	0.99 ± 0.05 <sup>a</sup>	0
FCR	4.04 ± 0.05 <sup>a</sup>	3.87 ± 0.18 <sup>ab</sup>	3.66 ± 0.15 <sup>b</sup>	3.32 ± 0.104 <sup>c</sup>	0.001
PER	0.84 ± 0.12 <sup>a</sup>	0.75 ± 0.36 <sup>b</sup>	0.69 ± 0.28 <sup>c</sup>	0.67 ± 0.20 <sup>c</sup>	0
SGR (%)	1.58 ± 0.11 <sup>d</sup>	1.62 ± 0.08 <sup>c</sup>	1.68 ± 0.09 <sup>b</sup>	1.75 ± 0.10 <sup>a</sup>	0
K	0.63 ± 0.08 <sup>d</sup>	0.74 ± 0.09 <sup>c</sup>	0.85 ± 0.16 <sup>b</sup>	0.98 ± 0.23 <sup>a</sup>	0
FCP	686.15 ± 35.03 <sup>a</sup>	673.49 ± 56.37 <sup>a</sup>	720.53 ± 56.38 <sup>a</sup>	699.71 ± 29.87 <sup>a</sup>	0.61

a, b, c and d the means with the same on the same line are not significantly different ( $p > 0.05$ ). FI: Feed Intake; Wi: Initial Weight; Wf: Final Weight; TLf: Final Total length; WG: Weight Gain; FCR: Feed Conversion Ratio; SGR: Significant Growth Rate; FCC: Feed Cost of Consumption; FCP: Feed Cost of Production.

**Table 2:** Physicochemical parameters of the water during the study.

Physicochemical characteristics of water	Month		
	Month 1	Month 2	Month 3
Température (°C)	21.7 ± 0.08	22.6 ± 0.02	19.7 ± 0.02
Oxygène (mg/l)	3.53 ± 0.32	3.48 ± 0.19	3.70 ± 0.15
pH	5.72 ± 0.38	5.35 ± 0.02	5.37 ± 0.02

**Live weight:** It emerges from (Table 3) that the level of proteins in the ration significantly influenced the live weight of the pre-fattening *Clarias jaensis* juveniles. This weight tends to increase with the increasing level of protein in the diet. The highest live weight ( $112.53 \pm 4.27$ ) was obtained with R4 ration (45% of protein) while the lowest live weight ( $97.76 \pm 5.44$ ) was obtained with the R1 ration (30% of protein).

The monthly weight curve illustrated in Figure 2 shows the same trend, and the same profile. However, from month 2, the weight of the fish fed with the ration R4 (45% of protein) is above the other weights followed by that of R3 (40% of protein) and R2 (35% of protein) and the curve the most below is that of fish receiving the ration containing 30% protein in the feed

**Total length:** Whatever the protein level considered, no significant effect ( $P < 0.05$ ) was observed on the total lengths of the fish although the highest ( $24.99 \pm 0.98$ ) was observed with the ration containing the lowest protein level and the lowest ( $22.74 \pm 1.67$ ) was recorded with the 45% protein ration (Table 3). In addition, we note the same pace, the same trend and the same profile in the monthly evolution of this length (Figure 2).

**Weight gain and average daily gain:** The highest weight gain ( $89.33 \pm 1.99$ ) and the mean Daily gain ( $0.99 \pm 0.05$ ) were recorded with the ration containing the most R proteins (45%) and the lowest ( $74.30 \pm 0.91$  and  $0.83 \pm 0.06$ ) with 30% protein (Table 3). Throughout the test, the weight gain of the fish fed the lowest protein level (30%) and remained lower than the other weight gains while that of the fish receiving the 45% protein ratio remained above as shown in Figure 3.

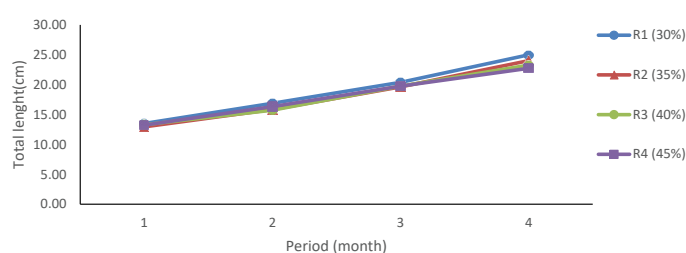
**Condition factor K:** Condition factor K tends to increase significantly ( $P > 0.05$ ) with increasing protein levels (Table 3). Thus the highest condition factor K ( $0.98 \pm 0.23$ ) was obtained with the 45% protein ration and the lowest ( $0.63 \pm 0.08$ ) with the 30% protein ration. Likewise, the monthly evolution curve of the condition factor k of the fish receiving the lowest protein level remained lower than that of the other curves. At the end of the test, the curve of the fish receiving the highest protein level (45%) is higher than the others, followed by that of 40% and 35%.

**Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER):** The FCR tended to decrease significantly ( $P > 0.05$ ) with increasing protein level. The lowest value ( $3.32 \pm 0.10$ ) was recorded with the ration richest in protein R (45%), followed by ( $3.66 \pm 0.15$ ) obtained with Ration R (40%) and the highest ( $4.04 \pm 0.05$  and  $3.87 \pm 0.18$ ) recorded respectively with the rations R (30%) and R (35%) otherwise not significant between them. However, there was no significant difference between the treatments.

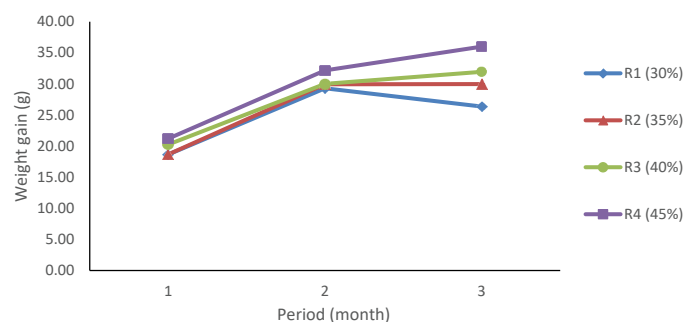
Unlike Feed conversion ratio, the PER tended to decrease significantly ( $P < 0.05$ ) with the level of protein in the food. The lowest PER ( $0.67 \pm 0.2\%$ ) was recorded with the highest protein level (45% of crude protein) and the highest ( $0.84 \pm 0.2\%$ ) was recorded with the ration containing 30% protein in the food

**Specific Growth Rate (SGR):** The specific growth rate increased with increasing protein levels. It was highest with the R4 ration (45%) followed by the 40% protein ration and the lowest value was obtained with the 30% and 35% protein rations respectively.

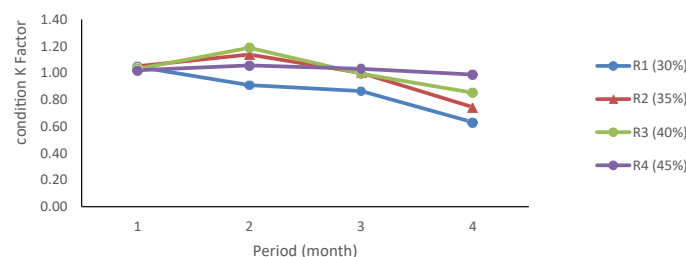
**Food cost of production:** The food cost of production tends to increase with increasing protein levels in the food. However, the highest Food cost ( $720.53 \pm 56.37$  FCFA) was obtained with the 40% protein ration followed by the 45% protein ration ( $699.71 \pm$



**Figure 2:** Monthly evolution of the total length of *Clarias jaensis* juveniles as a function of the protein level.



**Figure 3:** Monthly evolution of weight gain according to the protein level of the food.



**Figure 4:** Monthly evolution of the condition factor K as a function of the protein level of the food.

29.87FCFA). Although the cost of food consumption was higher with the R4 ration ( $210.48 \pm 2.55$  FCFA), and lower with the 30% protein ration ( $169.31 \pm 9.38$  FCFA) the cost of food production did not show any difference between the different feeds.

## DISCUSSION

The survival rate was significantly affected ( $P > 0.05$ ) by the level of protein in the food. This rate varied from 80.03% with the 35% protein ration to 89.23% with the 45% protein ration. These results are similar to those of [14] in which the survival rate increases significantly with the protein level of the food in the catfish *Clarias macrocephalus*. Indeed, this author obtained a protein rate of 67.5% with the 25% protein ration and 100% with the 45 to 50% protein rations. When the protein level is insufficient and does not cover the needs of the fish, it uses its body proteins to maintain its minimal functions for survival [14].

Protein level in the food had no on effect feed intake. These results are similar to those of [15] but differ from those of [16,14], obtained respectively with the fingerlings of catfish *Horabagrus brachysoma* and *Clarias macrocephalus*. The observed difference may be due to the methodology used (feed formulation), the species as well as the breeding environment.

In this study, the protein level affected significantly ( $P < 0.05$ ) weight, weight gain, Daily weight gain, specific growth rate and condition

factor K which tended to increase with increasing rate of protein in the food. Of all these characteristics, the values obtained with the 30% protein ration were the lowest, followed by the 35% protein ration. The best results were recorded with 45% protein in the feed.

These results are different from those of [15-18] in whom the best weights, Weight gain, specific growth rates were recorded with protein levels of 42.5%, in *Clarias gariepinus*, 40% in *Silurus asotus*, and 35% in *Horobagrus brachysoma* and *Clarias gariepinus*. Insufficient protein content in food induces poor weight gain due to insufficient supply of amino acids necessary for tissue production [19].

The ADG varied from  $0.83 \pm 0.06$  for fish fed the feed with 30% protein to  $0.99 \pm 0.05$  for fish fed the feed with 45% protein. This ADG is close to  $0.90 \pm 0.10$  and  $1.01 \pm 0.16$  obtained by Tsoupou in determining the energy requirements for the same species. In general, in other claridae, the ADG is around 3 g/day, a difference of around 2 g when compared with our results. This difference could be due to environmental conditions. Indeed, Warm temperatures of 25 to 32°C accelerate metabolism and stimulate growth in fish [20]. Conversely, cold temperatures slow down metabolism and therefore growth.

The protein efficiency ratio has tended to increase with the growing level of supplemental protein. These results are similar to those of [14] the effectiveness of proteins is high in low protein foods because fish will maximize the use of the protein source for making body tissues. This same trend has also been recorded at *Oreochromis niloticus* in whom the use of food proteins has decreased from 2.35 to 1.58 at the fry stage and from 1.92 to 1.19 at fingerlings stage and from 1.53 to 0.99 at the Growth Stage reported that fish often have their best when they are fed with concentrations of food proteins lower than those producing maximum growth and a The lowest consumption index.

## CONCLUSION

With the exception of food consumption and survival rate, growth characteristics and cost of production were significantly affected by the level of protein in the food. The best body weight, weight gain, average daily gain, specific growth rate, consumption index and K condition factor were obtained with the food containing the highest protein level. This ration was also one of the least economical.

## REFERENCES

1. FAO. La situation mondiale des pêches et de l'aquaculture. Contribuer à la sécurité alimentaire et à la nutrition de tous. Rome. 2016;224
2. Lazard J, Et Levêque C. Introductions et transferts d'espèces de poissons d'eau douce. In Lazard J et Lésel R. Pisciculture: Poisson de demain. Cahier Agricole.2009;18(3): 157-173.
3. Domwa M. Prévalence et intensité d'infestation de *Clarias jaensis* (Boulager, 1909) et *Clarias gariepinus* (Burchell, 1822) par Eustrongylides et Contraeaeum dans la plaine des Mbô au Cameroun. Thèse de Master. Université de Dschang.2012;71.
4. FAO. La situation mondiale des pêches et de l'aquaculture, Rome. 2014;255.
5. Boujard T, Gélineau A, Denis C, Corraze G, Gilbert D, Eric G, et al. Regulation of feed intake, growth, and nutrient and energy utilization in European sea bass (*Dicentrarchus labrax*) fed high fat diets. Aquaculture living ressources. 2004;5:529-545.
6. OMD. Objectifs du millénaire pour le développement. Rapport des Nations Unies, New York. 2014; 59.
7. Lacroix. Pisciculture en zone tropicale. GFA Terra Systems Eulenkrugstraße 82 22 359 HamburgAllemagne. 2004;231.
8. Zango P. Caractéristiques de reproduction comparées en milieu naturel *Clarias gariepinus* et *Clarias jaensis*. Université de Dschang. Mémoire de fin d'études. 2009;98.
9. Tsoupou Kuété Suzy G, Efole Ewoukem T, Moussala Ottoko J, Tchoumboue J. Effect of various levels of metabolize energy on growth performance of *clarias jaensis* fingerlings (boulenger, 1909). Int J Res Granthaalayah. 2018;6(5). DOI: 10.5281/zenodo.1254567 Vol.6 (Iss.5): May 2018.
10. Amoah YT. Effect of dietary protein levels on growth and protein utilization in juvenile arctic char (*Salvinus alpinu*). United Nations University Fisheries Training Programme, Iceland [final project]. 2012.
11. Nwanna LC, OMOJOLA I, Nwanna E, ABIODUN E, ABIODUN. Effect of protein deficient diets on the growth and carcass protein ash ratio of African catfish *Clarias gariepinus* (Burchell 1822), J Appl Sci Enviro Manag. 2014.
12. Buttle LG, Uglow RF, Cowx IG. Effect of dietary protein on the nitrogen excretion and growth of the African catfish, *Clarias gariepinus*. Aquatic Living Resources. 1995;8:407-414.
13. AOAC (Association of Official Analytical Chemists) In: Official Methods of Analysis (Helrick, K. ed.) AOAC, Arlington, VA, USA. 2000;69-78.
14. Tran TTH, Lu T, Tran LCT, Bui MT. Dietary protein requirement of bighead catfish (*Clarias macrocephalus* Gunther, 1864) fingerling. Int J Sci Res Publ. 2018;8(11):2250-3153.
15. Effiong MU, Esenowo IK. Effects of varying protein levels on *Clarias gariepinus* (Burchell, 1822) growth, Proteinutilization and yield in Hapa system. Asian J Biol. 2018;5(1):2456-7124.
16. Girri S, Sahoo S, Paul B, Mohanty S, Sahu AK. Effects of dietary protein level on growth, feed utilization and carcass composition of endangered bagrid catfish *Horabagrus brachysoma* (Gunther 1864) fingerlings. Aquaculture Nutrition. 2011;17:332-337.
17. Kyoung-Duck Kim, Sang Gu Lim, Yong Jin Kang, Kang-Woong Kim, Maeng Hyun Son. Effects of Dietary Protein and Lipid Levels on Growth and Body Composition of Juvenile Far Eastern Catfish *Silurus asotus*. Asian-Aust. J. Anim. Sci. 2012;25(3):369-374.
18. Keremah R, Beregha O. Effect of varying dietary protein levels on growth and nutrient utilization of african catfish *clarias gariepinus* fingerlings. Journal of Experimental Biology and Agricultural Sciences. 2014;2(1):86-94.
19. Halver JE, Hardy RW. Fish Nutrition, 3rd edition. Academic Press, New York, U.S.A. 2002;143-175.
20. Kemp JOG. Effects of temperature and salinity on resting metabolism in two South African rock pool fish: the resident gobiid *Caffrogobius caffer* and the transient sparid *Diplodus sargus capensis*. African Zoology. 2009;44:151-158.