E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(4): 264-270

www.fisheriesjournal.com
Received: 01-05-2018
Accepted: 03-06-2018

Tsoupou Kuété Suzy G
Laboratory of aquaculture, IRAD (Institute of Agricultural Research for Development), Limbe, Cameroon, Limbe

Efole Ewoukem Thomas
Department of forestry, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon, Dschang

Tchoumboue
Department of animal production, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon, Dschang

Correspondence
Tsoupou Kuété Suzy G
Laboratory of aquaculture, IRAD (Institute of Agricultural Research for Development), Limbe, Cameroon, Limbe

Reproductive performance of male broodstock *Clarias jaensis* (Boulenger, 1909) fed various dietary energy

Tsoupou Kuété Suzy G, Efole Ewoukem Thomas and Tchoumboue

Abstract
This study aims to investigate the effects of four diets with different energy contents; 3000, 3100, 3200 and 3300 Kcal/kg, on reproductive characteristics of male broodstock *Clarias jaensis*. 360 male and female (97 ± 9 g) were divided into four groups, corresponding to the different diet and were breed during 5 months. Except the FSH and Hepatho somatic index, reproductive characteristics were comparable between diets ($P>0.05$). The higher FSH (1.15 ± 0.27 mlU/ml), LH (1.03 ± 0.18 mlU/ml), testosterone (179.67 ± 5.37 ng/ml), Gonado somatic index (0.33 ± 0.05%) and mature male (87.5%) were recorded at 3000 Kcal/kg followed by 3100 Kcal/kg, while Hepatho somatic index were higher (1.11 ± 0.14 %) at 3100 Kcal/kg. Histological inspections of gonads did reveal that fish fed at 3000 Kcal/kg had heavier and more developed gonads compared to other group. Therefore; 3000 Kcal/kg was found to be optimal for healthy gonad development.

Keywords: *Clarias jaensis*, energy, reproduction, broodstock

1. Introduction
Cameroon has an aquatic biodiversity rich in Claridae, represented in many rivers by different species. Nevertheless, in the rivers of the Mbô Plain, located in the Western Region, there are endogenous species of this family still little known like *Clarias jaensis* [1]. This species is currently suffering from uncontrolled exploitation by peasants for profit and food purposes. However, its domestication could help to preserve it and support sustainable aquaculture development like any other local species [2]. To this end, developing aquatic resource management strategies adapted to this species is important [3, 4]. Preliminary studies have been carried out on the reproduction of *Clarias jaensis* in the wild [5]. However, its use in aquaculture would be a benefit comparable to that of introduced sister species, particularly for the supply of broodstock and fry. However, knowledge of its nutrition and reproduction technics, which are essential for breeding and the factors that influence them are still limited. The reproduction of *Clarias jaensis* as other Claridae could be influenced by nutrition through its nutritional needs such as energy. Indeed, the sperm quality of fish species may be improved through the nutritional quality of broodstock diets [6]. Different researchers have revealed that reproductive performance (egg and sperm quality) are influenced by nutrients like protein, lipids, and rations size in fish such as tilapia, *Oreochromis niloticus* [7, 8], common carp [9] and rohu, *Labeo rohita* [10]. In addition, the work of çek and Yilmaz [11] and Khan *et al* [12] showed that the energy level in the feed affects the reproductive performance of *Clarias gariepinus* and *Rhamdia quelen*. Characteristics reproduction are regulated by gonadotrophins (LH and FSH) [13, 14] and gonadal hormone (testosterone) [14, 15] who can be affected by energy level on food. There has been a few work on the optimal dietary energy for gonad development and growth and that is why the general objective of this work, is to contribute to a better knowledge of claridae by determining their nutritional needs for their preservation and enhancement. More specifically, evaluate the effect of energy level on the reproductive performance of male *Clarias jaensis*.

2. Materials and methods
2.1 Period and zone of the study
The study took place between May and July 2016 in the west region of Cameroon and at the Application and Research Farm of the University of Dschang (LN 5 ° 44'-5 ° 36 'and 5 ° 44'-5 ° 37'; LE 10 ° 06'-9 ° 94 'and 10 ° 06'-9 ° 85' at an altitude of 1392 -1396 m.

2.2 Animal material

A number of 360 post fingerlings of male and female *Clarias jaensis* with an average weight of 97 ± 9g were fished in the natural environment in the Santchou Area Rivers, located in the western Cameroon region and transported in nurseries to the FAR of the University of Dschang. The fish were immediately acclimatized for two weeks in the 1 m^3 concrete tanks. During the acclimation period, a 3A feed containing 40% of protein and consisting of wheat bran, soybean meal and fishmeal (Lacroix 2004) was distributed to them twice a day.

2.3 Livestock structures

Twelve polystyrene happas of 1 m^3, attached to four sides chinese bamboo were built in a pond of 100 m² area and depth 0.90 m. This pond was supplied with water from a dam pond located at 150 m. The height of water in each happa was 0.80 m. The food was served in a circular floating frame 30 cm in diameter, placed on the surface water of each happa. Below this frame was placed a basin 33 cm in diameter to collect feed refusals use to estimate food consumption.

2.4 Experimental diet

Four isoproteic experimental diet (Table 1) were formulated with different energy levels 3000, 3100, 3200 and 3300 kcal/kg of food. The chosen energy levels refer to those of *Clarias gariepinus.* The calculated and analyzed chemical composition of different diet were obtained respectively by a formulation table and AOAC [16] method.

Table 1: Composition of expérimental diets

Ingredients (Kg)	R1 (3000 kcal/kg)	R2 (3100 kcal/kg)	R3 (3200 kcal/kg)	R4 (3300 kcal/kg)
Maize	28.00	24.50	22.50	20.30
Wheat bran	6.00	5.10	3.50	3.80
Cottonseed cake	1.50	1.30	1.00	1.50
Soybean meal	3.00	4.40	6.00	4.50
Fish meal	56.70	57.00	56.50	57.00
Shell meal	0.10	0.10	0.10	0.10
Bone meal	0.10	0.10	0.10	0.10
Palm oil	2.60	5.50	8.30	10.70
Premix 2%	2.00	2.00	2.00	2.00
Total	100.00	100.00	100.00	100.00
Calculated chemical composition (% /MS)				
CP (%)	40.12	40.45	40.06	40.00
ME (kcal/kg) (kcal/kg)	3000.21	3102.69	3200.62	3303.65
Calcium (%)	3.80	3.82	3.65	3.82
Phosphorus (%)	2.12	2.12	2.07	2.11
P/E	0.01	0.01	0.01	0.01
Ca/P	1.80	1.80	1.80	1.80
Analyzed chemical composition (% /MS)				
CP (%)	39.76 ± 0.49	40.06 ± 0.75	40.66 ± 0.37	40.56 ± 0.50
CE (kcal/kg) (kcal/kg)	3284.67 ± 25.40	3354.67 ± 39.50	3780.00 ± 22.09	3848.00 ± 28,35
Lipid (%)	7.00 ± 0.00	11.33 ± 0.28	12.00 ± 0.00	15.33 ± 0.57
Ash (%)	2,93 ± 0.05	1.96 ± 0.05	2.70 ± 0.17	2.06 ± 0.05

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

2.5 Experimental set up

Post fingerlings of *Clarias jaensis* were randomly divided into four comparable groups (45 ♂ and 45♀/group) of size and weight with three replication. At each group was randomly assigned one of the experimental diet R1 (3000 kcal / kg), R2 (3100 kcal / kg), R3 (3200 kcal / kg) and R4 (3300 kcal / kg of energy) previously formulated.

2.6 Conduct of the test

The food was distributed twice a day (8 am and 18 pm) at 3% of the ichtyobiomasse. Each month, a check fishery was conducted during which 20% of the fish in each group were individually weighed using a 0.1gram precision electronic scale (OHAUS) and measured with an icthyometer to evaluate growth characteristics. The physico-chemical parameters of the water (temperature, dissolved oxygen, pH and conductivity) were measured weekly just to have the state of water. At the end of the experiment, 12 males from each group were sacrificed to determine the reproductive characteristics.

2.7. Studied Characteristics

Stage of gonad maturity: After fish dissection, maturity stages were determined by eye examination of the gonads based on the maturity scale used by Lalèye [17], inspired by Micha [18].

- Gonado somatic index (GSI) = gonad weight (g) / total weight (g) X 100
- Hépatho somatic index (HSI) = liver weight (g) / total weight (g) X 100

After sacrifice of fish, the pituitary glands and one of the testicle were crushed in a mortar placed on an ice block and containing 0.9% NaCl solution, so as to obtain homogenates 1% for the pituitary gland and 15% for the testicle. The crushed material obtained was centrifuged at 3000 rpm for 30 min. The supernatant was removed and stored in labeled tubes at -20 ° C and were used for the determination of FSH and LH concentration in the pituitary gland and testosterone in the gonads. These assays were performed using kits sold and ready for use, at the Laboratory of Physiology and Animal Health of the University of Dschang.

2.8. Gonad histology
Fish testicles were taken from individuals in each group and then, immersed in a fixative (Bouin's solution) contained in labeled tube. These organs were used to perform histological sections at the Animal Physiology Laboratory of the University of Yaoundé I.

2.9. Statistical analysis
The one-way ANOVA was used to test the effect of energy level on reproductive characteristics. When there were significant differences between the means, they were separated by the Duncan test at 5% significance level. SPSS 20.0 statistical software was used for these analyzes.

3. Results
3.1. Effect of dietary energy on weight, total length and weight gain of male *Clarias jaensis*
Table 2 presents some growth characteristics of male of *Clarias jaensis*. It appears that, dietary energy has significantly affect body weight, total length and weight gain. These characteristics were highest at 3100 Kcal/kg and lowest with ration at 3300 Kcal/kg except total length ($P<0.05$).

Table 2: Mean weight, total length and weight gain of male *Clarias jaensis* in function of energy level

	Growth	Energy level (Kcal/kg)		
characteristics	**3000**	**3100**	**3200**	**3300**
W (g)	197,75 ± 37,87[a]	263,00 ± 29,70[b]	206,61±33,14[a]	194,50 ± 10,00[a]
TL (cm)	28,71 ± 3,69[Aa]	32,63 ± 0,85[b]	30,55 ± 1,89 [c]	29,43 ± 0,83 [ca]
WG (g)	96,36 ± 40,03 [a]	160,27 ± 32,17[b]	103,88 ± 36,46 [a]	92,25 ± 12,47 [a]

W= weight, TL= Total length, WG= weight gain

3.2. Effect of energy level on concentrations of FSH and LH
Figure 1 shows that the energy level had a significant effect on FSH ($P<0.05$) but not significant on LH ($P>0.05$). Males fed the ration containing 3000 Kcal/kg of energy recorded higher concentrations of FSH (1.15 ± 0.27 mlU/ml) and LH (1.03 ± 0.18 mlU/ml). On the other hand, these characteristics were lower (0.5 ± 0.16 mlU/ml) and (0.83 ± 0.23 mlU/ml) respectively for FSH and LH in group that received 3200 Kcal/kg of energy.

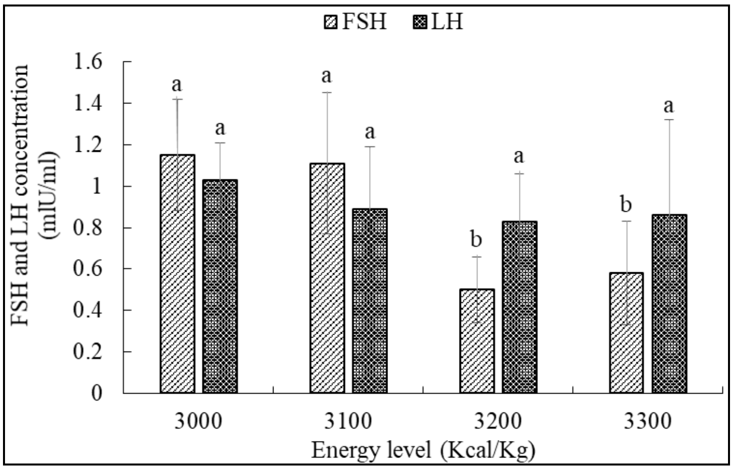

Fig 1: Concentration of FSH and LH in function of energy level

3.3. Effect of energy level on testosterone concentration
The effect of energy level on testosterone concentration in fish is shown in figure 2. It appears that although comparable ($P>0.05$), the males of the group fed at 3200 Kcal/kg recorded lower testosterone concentration (171.09 ± 3.93 ng/ml). However, this hormone was higher (179.67 ± 5.37 ng/ml) with the ration containing 3000 Kcal / kg of energy.

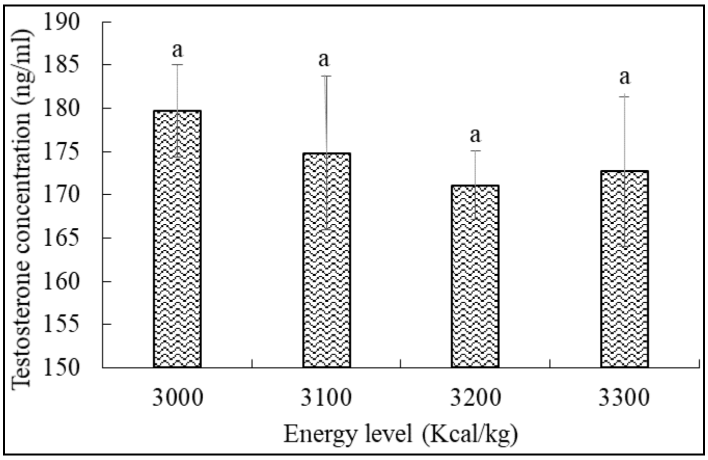

Fig 2: Testosterone concentration in function energy

3.4. Effect of energy level on stage of maturity

The influence of energy level on the maturation of male gonads is illustrated in figure 3. It appears that the majority of males in group fed at 3000 Kcal/kg (87.5%) and 3100 Kcal/kg (62.5%) are at stage III of sexual maturity. In the opposite, those fed diets containing 3200 Kcal/kg (75%) and 3300 Kcal/kg (87.5%) are mostly in stage II.

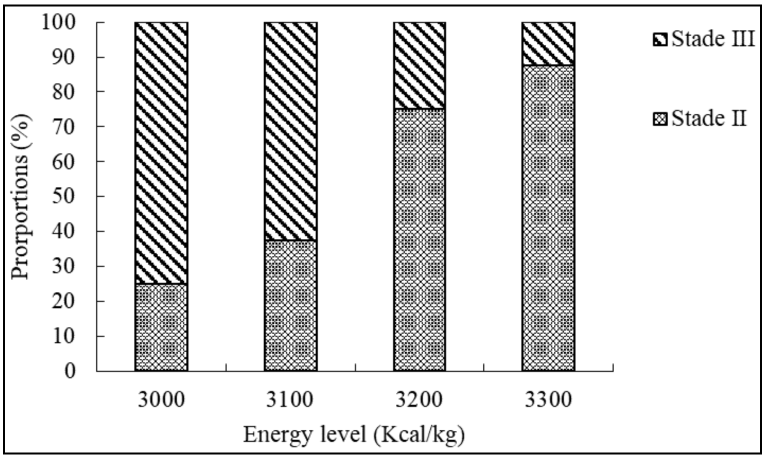

Fig 3: Stage of maturity of gonad in function of energy level.

3.5. Effect of energy level on gonado somatic index (GSI)

Figure 4 show that the effect of energy level on GSI was significant ($P<0.05$). This characteristic was higher (0.33 ± 0.05%) with the ration containing 3000 Kcal/kg and lower (0.22 ± 0.04%) with that having 3300 Kcal/kg of energy.

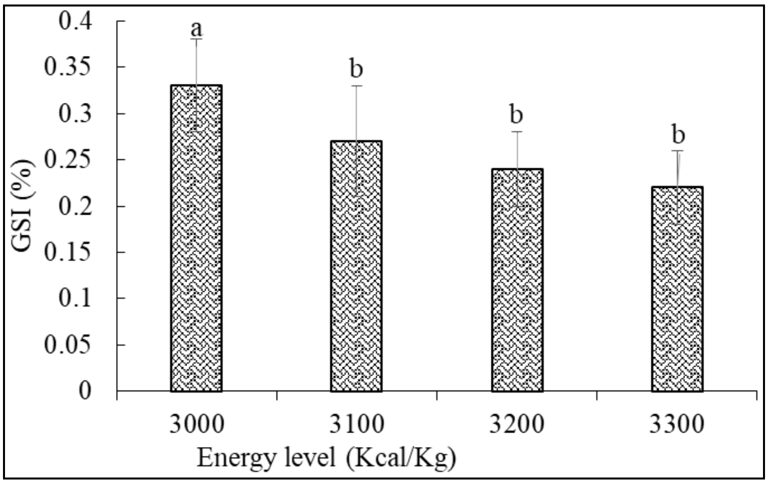

Fig 4: Gonado somatic index (GSI) in function energy.

3.6. Effect of energy level on hepato somatic index (HSI)

The influence of energy level on HSI was not significant ($P>0.05$) (Figure 5). However, Male receiving 3100 Kcal/kg of energy had a higher HSI (1.11 ± 0.14%) and the lower value (0.92 ± 0.19%) were obtained with the ration at 3300 Kcal/kg.

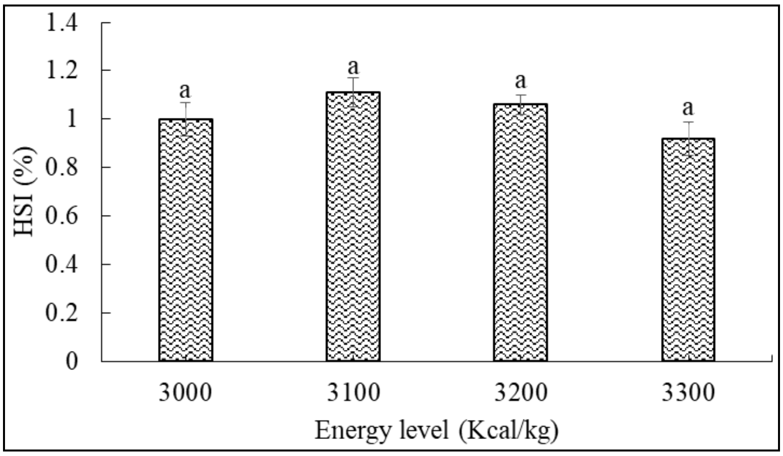

Fig 5: Hepato somatic index (HSI) in function of energy level.

3.7. Histological sections of the gonad of male *Clarias jaensis*

The influence of the energy level on the histology of the gonad of males fed at 3000, 3100, 3200 and 3300 Kcal/kg of energy is illustrated respectively by the pictures a, b, c and d of figure 6. The mature gonad of the male fed at 3000 and 3100 Kcal/kg shows that it consists of a set of seminiferous tubule separated by an interstitial tissue. In these tubes, we note the presence of spermatogonia, spermatocytes and spermatids. The lumen of each seminiferous tubule of fish fed at 3000 Kcal/kg is filled with mature spermatozoa (Figure 6 a) while in the 3100 Kcal/kg group, few seminiferous tubules contain it (Figure 6 b). In addition, the gonad of immature males fed at 3200 and 3300 Kcal/kg have shrunken and empty seminiferous tubules. There is an abundance of spermatogonia included in the Sertoli cell layer lining the seminiferous tubules, spermatocytes and some spermatids (Figure 6 c and d).

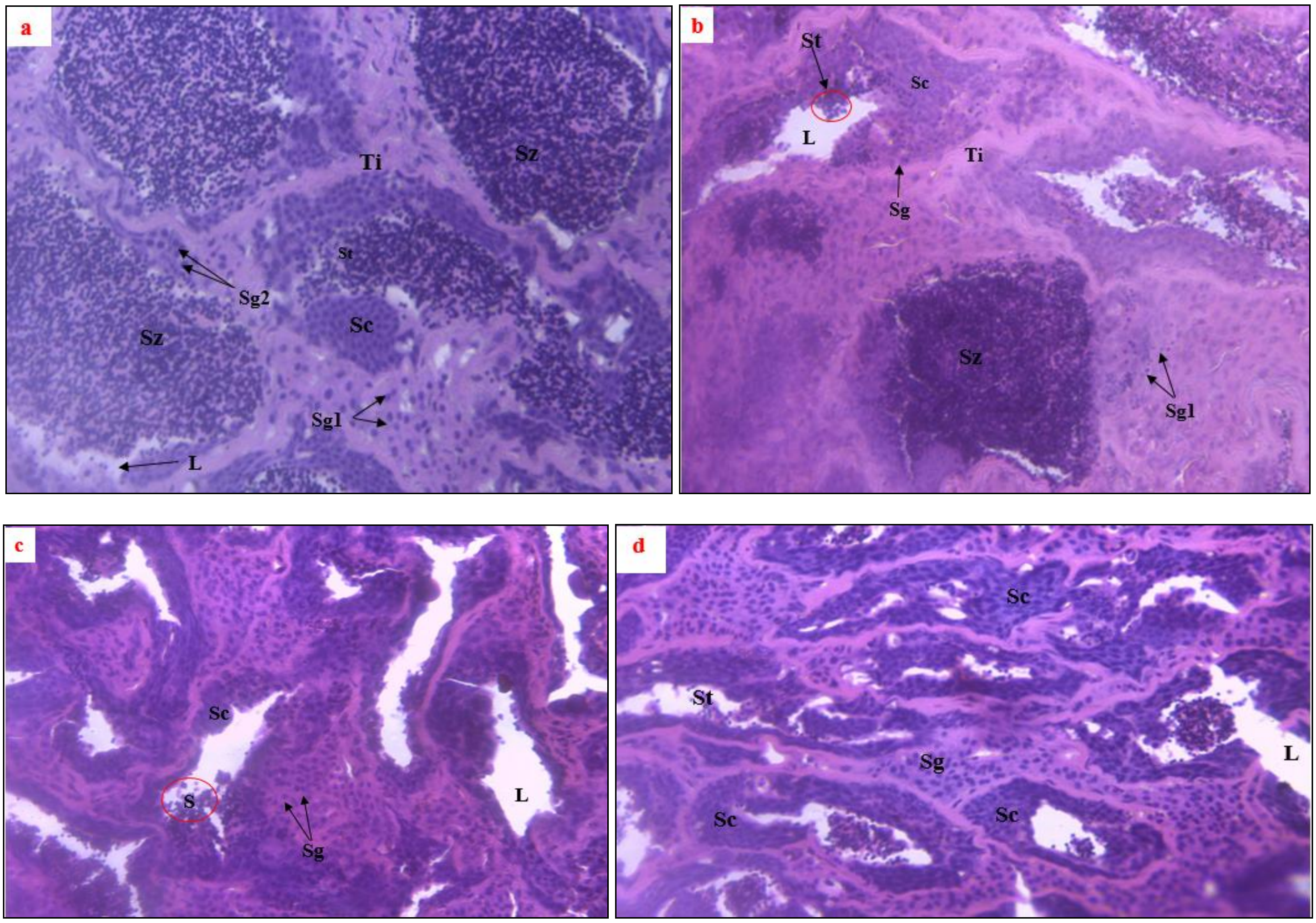

Fig 6: Histological sections of the testicles of *Clarias jaensis*. a, b, c and d present the testicles of the males who received the rations containing respectively 3000, 3100, 3200 and 3300 Kcal/kg of energy. Sg = spermatogonia, Sc = spermatocyte, St = spermatid, Sz = spermatozoa, L = lumen, Ti = seminiferous tube. (Magnification: 40X)

4. Discussion

The higher growth characteristics (weight, total length and weight gain) were recorded with the lowest energy level (3000 Kcal/kg). Çek and Yilmaz [11] found similar results in *Clarias gariepinus* fed various diatary energy.

The energy level had an influence on the reproductive characteristics of *Clarias jaensis*. In fact, reproduction consumes energy that the animal obtains from its food. Maturation is therefore not carried out in emaciated fish that do not have sufficient mobilizable reserves [19]. FSH and LH are key reproductive hormones. They are involved in gonadal development and steroidogenesis [20]. The FSH and LH concentrations of the males were higher with the diet containing the least energy (3000 Kcal/kg). We don't have information about the effect of dietary energy on the synthesis of sex hormones in fish, but, this result may be explained by the fact that male fish *Clarias jaensis* need a low energy level for the production of FSH and LH. Besides, it is well known that onset of sexual maturity in fish is directly accompanied by elevated energy storage [21, 22]. However, testosterone was also higher with the diet ration (3000 Kcal/kg). Regardless of the diet considered, testosterone concentrations were higher than those obtained in *Clarias macrocephalus* (15-25 ng/ml) by Josepha *et al.* [23] and in *Oreochromis mossambicus* (3.64-12.30 ng/l) by Cornish [24] in the wild. This difference would be related to the species and the fact that the first author performed their analyzes in the plasma and not in the tissue. High concentrations of LH would have led to a high production of testosterone. According to some authors, the production of androgens including testosterone, which is implicated both in gametogenesis and in the development of secondary sexual characteristics [25], is reported to be under the control of LH [26]. The gonado somatic index (GSI) is a characteristic that accounts for the progression of gametogenesis in fish. A high GSI at certain period indicates that the gonads are mature and spawners are ready to breed [27, 28, 29]. The GSI recorded in this study varied significantly in function of energy level and was higher with the diet containing the least energy level (3000 Kcal/kg). This result is similar to that of Çek and Yilmaz [11] on *Clarias gariepinus*.

Indeed, the high testosterone concentration of the fish in this group would have favored a rapid maturation of the gonads, hence their high GSI. Regardless of the diet, it was as weak as those recorded by Wango [5] on *Clarias jaensis* in wild. The hepatic somatic index (HSI) did not significantly change with energy level (P>0.05). The general trend shows that it decreased with the increasing level of energy and was higher with the diet at 3100 Kcal/kg. Çek and Yilmaz [11] reported similar results in *Clarias gariepinus* fed diets with different dietary energy. Note that, the diet containing the lowest level (3000 Kcal/kg) of energy recorded a higher GSI and a lower HIS in this study. So, this could mean that males of this group have drawn the necessary reserves for the maturation of their gonad in the liver. The results observed in males are similar to those reported by Bedoui *et al*. [30] who found that in the wild, the GSI of *Liza aurata* increases while HSI declines. Fish fed at 3000 and 3100 Kcal/kg of energy were classified as mature compared to those receiving higher energy levels. These results are similar to those reported by Çek and Yilmaz [11] who obtained mature male of *Clarias gariepinus* with diets containing the lowest energy levels. These results are confirmed by the examination of histological sections of the gonad, who reported that, the diet containing 3000 Kcal/kg yielded mature testicles, whose seminiferous tubules are filled with spermatozoa. In contrast, the diet with the most energy (3300 Kcal/kg) produced immature testicles with empty, shrunken seminiferous tubules. These results are comparable to those reported by Çek and Yilmaz [11] and Reidel *et al* [12], who found that low energy levels favor the maturation of the gonad of *Clarias gariepinus* and *Rhamdia quelen*, in contrast to high levels. Also, mature testicle in diet 3000 Kcal/kg may be due to the high level of LH and testostérone in this group. In fact, Kumar and Panchanan [31] explain that, the beginning of formation of first spermatocytes in male is regulared by gonadotrophins (LH and FSH) [13, 14] and testosterone [14, 15].

5. Conclusion

Growth and some reproductive characteristics were significantly affected by the energy level in the diet. The best body weight, total length and weight gain were observed from the fish fed diet 3100 Kcal/kg. Except the FSH and HSI, other reproductive characteristics were comparable between diets. However, the higher FSH, LH, testosterone, GSI and the high frequency of mature male were recorded at 3000 Kcal/kg and the HSI were higher at 3100 Kcal/kg. Therefore, on the basis of the present results among energy levels tested, 3000 Kcal/kg was found to be optimal for healthy gonad development, despite the fact that the best growth characteristics were obtained with diet at 3100 Kcal/kg.

6. References

1. Mfossa MD, Mikolasek O, Tomedi EM. Valorisation des savoirs faire locaux dans les pratiques piscicoles. Cas de l'exploitation des étangs traditionnels dans la plaine de de santchou (Ouest Cameroun). Edition Universitaire Européennes, 2006, 77.
2. Lazard J, Lévêque C. Introduction et transfert d'espèces de poissons d'eau douce. Cahier Agriculture. 2009; 18(2-3):157-163.
3. Lazard J, Legendre M. La pisciculture africaine: enjeux et problème de recherche. Cahier agriculture. 1994; 3(2):83-92.
4. Cacot P, Lazard J. La domestication des poissons du Mékong: enjeux *et le*. potentiel aquacole. Cahiers Agricultures. 2009; 18(2-3):125-135.
5. Zango P. Caractéristiques de la reproduction de deus espèces de poisons-chats *Clarias gariepinus* (Burchell, 1822) et *Clarias jaensis* (Boulenger, 1909) en milieu naturel de la zone équatoguinéenne du Cameroun. Thèse de *master of science* en Aquaculture. Université de Dschang, 2009, 82.
6. Bromage N, Jones L, Randall C, Thrush M, Davies B, Springate J. Brood stock management, fecundity egg quality and timing of egg production in Rrainbow trout *Oncorhynchus. mykiss*. Aquaculture. 1992; 100:141-166.
7. Gunasekera RM, Lam TJ. Influence of dietary protein level on ovarian recrudescence in Nile tilapia, *Oreochromis niloticus*. Aquaculture. 1997; 149:57-69.
8. Siddiqui AQ, Al-hafedh YS, Ali SA. Effect of dietary protein level on the reproductive performance of Nile tilapia, *Oreochromis niloticus*. Aquaculture Research. 1998; 29:349-358.
9. Manissery JK, Krishnamurthy D, Gangadhara B, Nandeesha MC. Effect of varied levels of dietary protein on the breeding performance of common carp *Cyprinus carpio*. Asian Fisheries Science. 2001; 14:317-322.
10. Khan MA, Jafri AK, Chadha NK. Effects of varying dietary protein levels on growth, reproductive performance, body and egg composition of rohu, *Labeo rohita*. Aquaculture Nutrition. 2005; 11:1365-2095.
11. Çek S, Yilmaz E. The effect of varying dietary energy on gonad development at first sexual maturity of the Sharptooh catfish (*Clarias gariepinus* Burchell, 1822). Aquaculture International. 2009; 17:553-563.
12. Reidel A, Boscolo WR, Feiden A, Romagosa E. The effect of diets with different levels of protein and energy on the process of final maturation of the gametes of *Rhamdia quelen* stocked in cages. Aquaculture. 2010; 298:354-359.
13. Dufour S, Lopez E, Le Menn F, Le Belle N, Baloche S, Fontaine YA. Stimulation of gonadotropin release and of ovarian development, by the administration of a gonadoliberin agonist and of dopamine antagonists, in female silver eel pretreated with estradiol. Geneneral and Comparative Endocrinology. 1988; 70:20.
14. Gur G, Melamed P, Gissis A, Yaron Z. Changes along the pituitary-gonadal axis during maturation of the black carp, *Mylopharyngodon piceus*. Journal of Experimental Zoology. 2000; 286:405.
15. Tiwary BK, Kirubagaran R, Ray AK. Testosterone triggers the brain-pituitary-gonad axis of juvenile female catfish (*Heteropneustes fossilis* Bloch) for precocious ovarian maturation. Geneneral and Comparative Endocrinology. 2002; 126:23.
16. AOAC. Association of official analytical chemist. Official method of analysis, 15th edition. AOAC. Washington D.C, 2000.
17. Lalèye P. Ecologie compare de deux espèces de Chrysichthys, poisons siluriformes (Claritoidae) du complexe lagunaire Nokoué-Lagune de Porto-Novo au Bénin. Thèse de doctorat en science (Zoologie). Université de liège (Laboratoire de démographie des poisons et d'aquaculture), 1995, 199.
18. Micha JC. Etude des populations piscicoles de l'Ubangui et tantatives de selection et d'adaptation de quelques espèces à l'étang de pisciculture. Centre technique forestier tropical paris, 1973, 110.
19. Barnabé G. Bases biologiques et écologiques de

l'aquaculture. Lavoisier, 1991, 520.
20. Yadetie F, Male R. Effect of 4-nonylphenol on gene expression of pituitary hormones in juvenile atlantic salmon. Aquatic toxicology. 2002; 58(1-2):113-29.
21. Thorpe JE. Age at first maturity in Atlantic salmon, *Salmo salar*: freshwater period influences and conflicts with smolting. In: (Ed. Meerburg, DJ), Canadian Special Publication Fisheries and Aquatic Science, 1986, 7.
22. Rowe DK, Thorpe JE, Shanks AM. Role of fat stores in the maturation of male Atlantic salmon (*Salmo salar*) parr. Canadian Special Publication Fisheries and Aquatic Science. 48:405.
23. Josepha D, Tan-Fermin, Takeshi M, Hiroshi U, Shinji A, Kohei Y. Testicular histology and serum steroid hormone profiles in Hatchery-bred catfish *Clarias macrocephalus* (Gunther) during an annual reproductive Cycle. Fisheries Science. 1997; 63(5):681-686.
24. Cornish DA. Seasonal steroid hormone profiles in plasma and gonad of the tilapia, *Oreochromis mossambicus*. Water SA. 1998; 24(3):257-264.
25. Borg B. Androgens in teleost fishes. Comparative biochemistry and physiology. 1994; 109: 219-245.
26. Miwa S, Yan L, Swanson P. Localization of two gonadotropin receptors in the salmon gonad by *in vitro* ligand autoradiography. Biology of reproduction. 1994; 50:629-642.
27. Heidari B, Roozati S, Yavari L. Changes in plasma levels of steroid hormones during oocyte development of Caspian Kutum (*Rutilus frisii kutum*, Kamensky, 1901). Animal Reproduction. 2010; 7:373-381.
28. Abdolhay HA, Daud SK, Rezvani S, Pourkazemi M, Siraj SS, Abdul-Satar MK. Fingerling production and stock enhancement of Mahisefid *(Rutilus frisii kutum)* lessons for others in the south of caspian Sea. Review Fish Biology and Fisheries. 2011; 21:247-257.
29. Taghizadeh V, Imanpoor MR, Mehdinejad N. Study the seasonal steroid hormones of common carp in Caspian Sea, Iran Springer Plus. 2013; 2:1.
30. Bedoui RF, Gharbi H, Abed EL. A. Période de reproduction et maturité sexuelle de *Liza aurata* (poisson Mugilidae) des côtes Est et Sud Tunisiennes. Bulletin de l'Institut National des Sciences et Technologies de la mer de Salammbô. 2002; 29: 11-15
31. Subir KJ, PN. Time requirement for sexual maturity of the African catfish *Clarias gariepinus* (Burchell, 1822) in captivity. Indian Journal of Experimental Biology. 2018; 56:75-82.