Ichthyological Communication

Biosci. Biotech. Res. Comm. 12(3): 556-564 (2019)

BBRC Bioscience Biotechnology Research Communications

Feed utilization and growth of tilapia, *Oreochromis niloticus* fingerlings fed with three composed feeds formulated with locally available raw materials

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ABSTRACT

This research was designed to enhance availability of quality feeds for fish farmers to improve growth performance of Nile tilapia *Oreochromis niloticus* fingerlings. Three different isonitrogenous (38% crude protein) composed feeds (SG1, SG2 and G) were formulated with the local available low-cost raw materials of Côte d'Ivoire three agro-ecological fish farming areas. Eight weeks feeding trial was conducted with *Oreochromis niloticus* fingerlings initial mean weight 9.07±1.65 g with the three feeds formulated. Fish were randomly stocked at 6 fish/m2 in three earthen ponds with triplicate on a semi-intensive fish farm and fed at 10-5% of body weight three times per day with feeds produced. At the end of trial, daily weight gain values recorded varied between 0.56±0.06 and 0.91±0.09 g/day and feed conversion ratio values ranged between 1.38±0.14 and 2.06±0.23. The highest growth and feed efficiency performances were observed from the fish fed feeds G and SG2. Highest significantly values of fish carcass crude protein (16.66 – 17.10 %) and gross energy (8.23-8.26%) were recorded from fish fed feeds G and SG2 too. Carcass lipid content of the three fish groups fed ranged between 10.51±0.81 (SG1) and 11.58±0.93% (G) and did not differ significantly. Growth and survival results promote the formulation and the use of local quality feeds to improve the breeding of the tilapia *O. niloticus* in the semi-intensive fish farms.

KEY WORDS: AGRO-ECOLOGICAL AREAS, FEEDS, FEED INGREDIENTS, FINGERLING, GROWTH PERFORMANCE, *OREOCHROMIS NILOTICUS*

ARTICLE INFORMATION:

Corresponding Author: koumirachel@yahoo.fr
Received 10th July, 2019
Accepted after revision 20th Sept, 2019
BBRC Print ISSN: 0974-6455
Online ISSN: 2321-4007 CODEN: USA BBRCBA
Thomson Reuters ISI ESC / Clarivate Analytics USA
Crossref Clarivate Analytics
NAAS Journal Score 2019: 4.31 SJIF: 4.196
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Online Contents Available at: http//www.bbrc.in/
DOI: 10.21786/bbrc/12.3/2

INTRODUCTION

Cichlid fish species such as *Oreochromis niloticus* has many attributes that make him ideal for aquaculture (El-sayed, 2006). So, it's one of the first fish species aquacultured and is still the most farmed freshwater fish in Africa. Today, pond culture of *Oreochromis niloticus* is the most widespread type of aquaculture in this continent (Dereje et al., 2015). In Côte d'Ivoire, the semi-intensive pond system is the main type of commercial fish production of this fish and majority of fish farmers in semi-intensive system are farmers (FAO, 2008; Yao et al., 2017a,b). So, inaccessibility of high cost (1.38 – 2.16 USD/kg) imported commercial adapted fish feeds for *O. niloticus* fingerlings feeding affect growth and production of fish farming (Koumi et al., 2015; Koumi et al., 2016; Yao et al., 2017b).

In fact, nutritional quality of feed sellers' commercial feeds, national industrial commercial feeds, fish farmer's feeds and all agro-industrial byproduct used for *O. niloticus* feeding vary greatly and not always met the requirement of all stage of *O. niloticus* growth (Koumi et al., 2015).Moreover, the good growth management and feeding practices of *O. niloticus* fingerling enhance fish growth and is very important in this fish production. It is reported that *O. niloticus* fingerlings feeds must contain 35-40% protein, 4-10% lipid, around 25% carbohydrates, maximum of 8% of fiber with the feed protein energy ratio value ranged between 18-20 mg/kJ for attain indicated growth and good yield on farms (Guillaume et al., 1999; Gabriel et al., 2007; Lazard, 2007; Médale and Kaushik, 2009; Abdel-Tawwab et al., 2010). The high protein requirement (35-40 %) for *O. niloticus* fingerlings feeds has an economic impact on the production of juvenile tilapia, because of expensive cost of most of protein sources ingredients used in aquaculture feeds. Currently, one of the challenges of fish farming is to formulate competitive fish feeds with local available low cost raw materials in order to improve quality feeds use and reduce fish production costs. So, the use of local agro-industrial by-products as components of fish feeds have become increasingly common (Goddard et al., 2008; Agbo et al., 2011; Workagegn et al., 2014; Abarike et al., 2016).

In addition, Côte d'Ivoire, due to its strong agro-economic character and high industrial level has a large variety of products, sub products, agro-industrial by-products and food wastes that could be used in fish feeds manufacturing. Their adequate use in requirement feeds production could be the solution of the high price of first stages fish feeds and difficulty to supply high cost commercial feeds of *Oreochromis niloticus* to the majority of fish farmers.

The purpose of this study is to propose to the majority of fish farmers low-cost compound feeds formulated with local available raw materials of their area which cover requirement needs of *O. niloticus* fingerlings growth.

MATERIALS AND METHODS

Description of the study area: Three Côte d'Ivoire agro-ecological areas were the main basis of choice of fish feeds raw materials and comparison of feeds formulated and their influence on the feed's efficiency and fish growth in this study. Those are Guinean, Sudano-Guinean 1 and Sudano-Guinean 2 areas, which are the main zones of high concentration of fish farmers in Côte d'Ivoire (Yao et al., 2017a). Feeding trial was conducted on a large (two dams, fifty ponds) private fish farm located near of Azaguié town in Department of Agboville and Agneby-Tiassa region located to 40 km from Abidjan, the economic capital of Côte d'Ivoire.

Feed ingredients: Availability, price per kilogram and nutritional composition of the different raw materials usable in fish feeds were evaluated in the preliminary survey in the Guinean, Sudano-Guinean 1 and Sudano-Guinean 2 areas. Based on these parameters, the six different local feeds ingredients were selected for the three feeds formulation and production. So, imported fish meal (55% protein content) and cotton seed oil cake were both used in Sudano-Guinean and Guinean areas, cottonseed oil cake and soybean meal were used in the three selected agro-ecological areas (Guinean, Sudano-Guinean 1 and Sudano-Guinean 2 areas), when local fish meal (42% protein content) was used only in Sudano-Guinean 2 (SG2) area and wheat bran was used in only in the Guinean (G) area too.

Formulated feeds: Three isonitrogenous 38% protein content fish feeds were formulated with the selected raw materials by area used linear programming method based on the *Oreochromis niloticus* fingerlings feeds requirement. The centesimal compositions of the three formulated feeds are shown in Table 1. After formulation, the different levels of selected fish ingredients were weighted, then mixed and the determination of proximate

Table 1. Centesimal compositions of the three feeds formulated with the local available raw materials in Guinean, Sudano-Guinean 1 and Sudano-Guinean 2 areas

Ingredients (%)	Formulated Feeds		
	SG1	SG2	G
Imported fish meal (55 % protein content)	30	-	30
Local fish meal (42% protein content)	-	45	-
Cotton seed oil cake	20	20	15
White rice bran	20	-	15
Wheat bran	-	-	10
Soybean meal	30	35	30

FIGURE 1. a) 38% protein content *Oreochromis niloticus* fingerlings feed presented in fine flour form, b) *Oreochromis niloticus* fingerlings before the feeding trial, c) Earthen ponds on an Azaguié fish farm, d) *Oreochromis niloticus* fingerlings sample, e) Soxhlet extraction with hexane as solvant

compositions of the different mixes was done following the standard methods given by Association of Official Analytical Chemists (AOAC 1995; 2003). All feeds formulated were presented in flour form and stored in labeled bags in a cool dry place and used throughout the experimental period.

Fish and feeding trial: The feeding trial was performed with *Oreochromis niloticus* fingerlings initial mean weight 9.07±1.65 g males purchased from tilapia fingerlings fish farmer distributor of Azaguié town. The ponds used were completely drained and exposed to sunlight for dry during one week, then there were refilled with fresh water provided by the dams before fish stocking. *O. niloticus* fingerlings were randomly stocked of 6 fish per square meter in nine similar dimensions (328.67±29.67 m^2) earthen ponds. After the one-week acclimation period of fish, feeding trial was conducted from July to September with the semi-intensive recommended management practices. Figure 1 presents some photographies of the feeding trial. *O. niloticus* fingerlings were fed three times daily 09:00, 13:00 and 17:00 GMT at 10-5 % body weight during two months. Temperature, pH, dissolved oxygen, TDS (total dissolved solids), ORP (Potential redox) and conductivity were monitored every week throughout the feeding period using multiparameter HANNA. Every 2 weeks, a sample of 30 % of fish by ponds were randomly collected, individually weighed and measured, and then monthly total fish biomass of each pond was determined to adjust accordingly the feeding ratio. At the end of feeding trial, all the fish by pond were removed for individual weight and length measured. The total quantity of fish feed used by pond was recorded.

Determination of growth and feed efficiency parameters

Growth and feed utilization parameters were calculated using the following formulas:

Weight gain: WG (g)

$$WG = Final\ mean\ weight\ of\ fish - Initial\ mean\ weight\ of\ fish$$

Mean daily weight gain: MWG (g/day)

$$MWG = \frac{Weight\ gain}{Duration\ of\ feeding\ trial\ in\ days}$$

Biomass gain: BG (kg)

$$BG = Final\ fish\ biomass - Initial\ fish\ biomass$$

Specific growth rate: SGR (%/day)

$$SGR = \frac{Ln\ final\ mean\ weight - Ln\ initial\ mean\ weight}{duration\ of\ feeding\ trial\ in\ days} \times 100$$

Survival rate: SR (%)

$$SR = \frac{Initial\ number\ of\ fish\ stocked - Number\ of\ fish\ died}{Initial\ number\ of\ fish\ stocked} \times 100$$

Feed Conversion Ratio: FCR

$$FCR = \frac{Total\ weight\ of\ feed\ consumed\ by\ fish}{Wet\ fish\ biomass\ gain}$$

Protein Efficiency Ratio: PER

$$PER = \frac{Wet\ fish\ biomass\ gain}{Total\ dietary\ protein\ intake}$$

Analytical method: The chemical composition of samples of fish at the end of feeding trial and the feeds used were determined according to AOAC (1995). Moisture levels of samples were determined after drying the samples in an oven (80°C) until a constant mass. Sample Crude protein level were measured using the Kjeldhal method (N% × 6.25), crude fat was measured using Soxhlet extraction with hexane, Ash content was determined using incineration at 550°C for 24 h in the muffle furnace, and gross energy (GE) content of feeds and fish samples were calculated according to gross caloric values of crude protein (23.7 kJ/g), crude fat (39.5 kJ/g) and carbohydrate (17.2 kJ/g) reported by Guillaume et al. (1999). The mineral contents of the samples were determined by atomic absorption spectrophotometer according AOAC (2003).

Statistical analysis: Statistical analyzes of water quality parameters, feeding trial data and fish nutritional composition determined were performed with STATISCA 7.1 software. All data were expressed as means ± standard deviation. One-way ANOVA analysis of variance was used to compare the different values. Then, Duncan multiple range tests was used to compare differences among means. Differences were considered significant at $p < 0.05$.

RESULTS

Characteristics of feeds: Nutritional composition and cost of the three feeds produced for *Oreochromis niloticus* fingerlings by agro-ecological area are shown in Table 2. The three feeds produced were iso proteïque at 38% crude protein level with similar ($p > 0.05$) content of crude fiber. However, highest moisture level ($p < 0.05$) of feeds was recorded with feed G (8.60±0.30 %) followed by feed SG1 (7.90±0.18 %) when feed SG2 (6.30±0.14 %) recorded the lowest values. Formulated feeds SG1 and G presented the significant ($p < 0.05$) values of Ash (8.86±0.12 - 8.56±0.11 %), carbohydrates (33.23±0.26 - 32.99±1.22 %) and gross energy (18.00±0.85 - 18.18±0.16 kJ/g) compared to feed SG2. Inversely, feed SG2 (24.08±0.10 mg/kJ) recorded the highest level of protein/energy ratio value. Feed SG2 presented also, the high value of calcium (15.38 mg/g) and phosphor (18.99 mg/g) compared to the two other feeds.

Ponds water quality: Results of water quality parameters during the 60-days feeding trial period are shown in Table 3. The average values of the temperature, pH and ORP recorded in the ponds showed no significant difference ($p > 0.05$). The average values of theses parameters varied from 28.98 ± 0.17 and 29.33 ± 0.80 °C for the

Table 2. Nutritional composition and cost of the three feeds produced

Parameters*	Formulated Feeds		
	SG1	SG2	G
Moisture (%)	7.90±0.18^b	6.30±0.14^a	8.60±0.30^c
Crude protein (%)	38.28±0.20^a	38.85±0.13^a	38.56±0.04^a
Crude fiber (%)	5.55±0.42^a	5.45±0.09^a	5.70±0.26^a
Total fat (%)	6.18±0.09^b	5.48±0.09^a	5.59±0.29^a
Ash (%)	8.86±0.12^a	22.71±0.06^b	8.56±0.11^a
Carbohydrate (%)	33.23±0.26^b	21.72±0.06^a	32.99±1.22^b
Gross energy (kJ/g)	18.18±0.16^b	15.92±0.06^a	18.00±0.85^b
Protein/energy (mg/kJ)	21.05±0.04^a	24.08±0.10^b	21.42±0.78^a
Mineral composition			
Calcium (mg/g)	8.79	15.38	7.83
Phosphore (mg/g)	9.85	18.99	9.50
Cost** (USD/kg)	0.65	0.56	0.62

*a,b,c,alphabetical letters on the same line show a significant difference among treatments at p<0.05
**1 USD = 565.64 FCFA based on August 2019 exchange data.

Table 3. Water quality parameters of experimental earthen ponds

Parameters*	Formulated feeds		
	Diet SG1	Diet SG2	Diet G
Temperature (oC)	29.33±0.80a	29.12±0.74a	28.98±0.17a
pH	8.31±1.21a	8.82±0.94a	8.31±0.43a
Dissolved oxygen (mg/L)	10.92±1.49b	9.03±0.76ab	8.59±0.91a
Conductivity (µs/cm)	44.75±11.50ab	35.25±9.95a	59.25±12.28b
TDS (mg/L)	23.25±5.44ab	17.25±5.00a	29.50±5.80b
ORP (mV)	88.50±48.30a	80.40±52.30a	82.65±39.64a
% dissolved oxygen	149.05±23.20b	117.83±9.65ab	110.40±12.51a
Salinity	0.00±0.01a	0.00±0.01a	0.00±0.01a

*a, b, c, alphabetical letters on the same line show a significant difference among treatments at the threshold of α = 0.05

temperature, between 8.31 ± 1.21 and 8.82 ± 0.94 for pH and between 80.4 ± 52.30 and 88.5 ± 48 Mv for redox potential (ORP). Mean values for conductivity (59.25 ± 12.28µs/cm) and total dissolved solids (29.50 ± 5.8 mg/L) were significantly higher (p<0.05) in the ponds where fish were fed with feed G. Conversely, to the lowest (p<0.05) dissolved oxygen (8.59 ± 0.91 mg/L) content and percentage dissolved oxygen values (110.40 ± 12, 51) of the ponds fed with the same feed G.

Growth performance, feed utilization efficiency and survival rate

The evolutions of growth of juvenile *Oreochromis niloticus* fed 60 days with the three feeds formulated by agro-ecological area are presented in Figure 2. The three growth curves presented the similar growth trend however, fish fed feeds G and SG2 presented significantly (p < 0.05) higher growth rate than fish fed feed SG1. The results from growth and feed utilization parameters of juvenile *O. niloticus* at the end of feeding trial are shown in Table 4. Higher values (p <0.05) of fish final body weight, weight gain, daily weight gain, final body length, final biomass and specific growth rate values were found with fish fed feeds G and SG2 compared to the fish fed feed SG1. Highest (p <0.05) survival rate recorded with fish fed feeds SG1 (100%) and G (100%) when fish fed SG2 recorded 99.94% survival rate value. Feeds efficiency from fish fed were also affected by the type of feed used, significantly highest feed conversion ratio value was recorded with feed SG1 (2.06±0.23) and SG2 (1.75±0.19) with lowest values obtained with those of fish fed feed G (1.38±0.14). Conversely, fish fed feed G presented the higher ratio 1.89±0.20 of protein efficiency ratio than fish fed feeds SG1 (1.28±0.14) and SG2 (1.49±0.16).

Proximate composition of *O. niloticus* fingerlings after two months feeding

Nutritional compositions of *Oreochromis niloticus* fingerlings fed during 60 days with the three feeds pro-

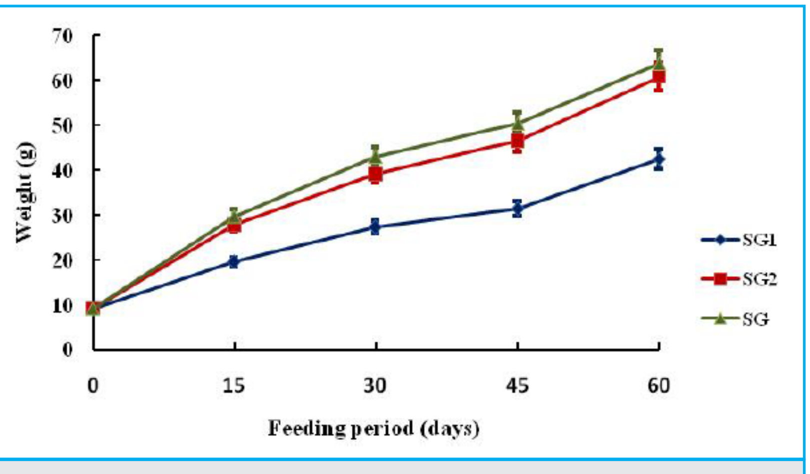

FIGURE 2. Evolution of growth of *Oreochromis niloticus* fingerlings fed 60 days with the three feeds formulated

Table 4. Mean values of growth and feed utilization parameters of juvenile O. niloticus fed with feeds formulated			
Parameters*	Formulated feeds		
	SG1	SG2	G
Initial body weight (g)	9.07±1.54^{a}	9.07±1.65^{a}	9.07±1.45^{a}
Final body weight (g)	42.43±3.65^{a}	60.71±5.65^{b}	63.58±5.65^{b}
Weight gain (g)	33.36±3.65^{a}	51.64±5.65^{b}	54.51±5.65^{b}
Mean daily weight gain (g/day)	0.56±0.06^{a}	0.86±0.09^{b}	0.91±0.09^{b}
Initial body length (cm)	7.17±0.29^{a}	7.17±0.29^{a}	7.17±0.29^{a}
Final body length (cm)	13.54±0.51^{a}	15.12±0.58^{b}	15.33±0.58^{b}
Initial biomass (kg)	19.50±3.31^{a}	16.33±2.97^{a}	17.78±2.84^{a}
Final biomass (kg)	91.22±7.85^{a}	109.22±10.16^{ab}	124.62±11.07^{b}
Biomass gain (kg)	71.72±7.84^{a}	92.90±10.16^{b}	106.84±11.07^{b}
Specific growth rate (%/day)	2.57±0.14^{a}	3.16±0.16^{b}	3.24±0.15^{b}
Survival rate (%)	100±0.00^{b}	99.94±0.00^{a}	100±0.00^{b}
Feed conversion ratio	2.06±0.23^{b}	1.75±0.19^{ab}	1.38±0.14^{a}
Protein efficiency ratio	1.28±0.14^{a}	1.49±0.16^{a}	1.89±0.2^{b}
*a, b, c, alphabetical letters on the same line show a significant difference among treatments at p<0.05			

duced are shown in Table 5. No significant (p> 0.05) changes were found in crude lipid content (10.51±0.81 - 11.58±0.93 %) in carcass of fish fed at the different feeds. Conversely, fish carcass Ash, crude protein and gross energy content were affected by feed used. Highest carcass Ash values were recorded with feeds G (4.16±0.31 %) and SG1 (3.87±0.12 %) when highest values of fish carcass crude protein and gross energy were presented by fish fed feeds SG2 (16.66±1.04 %; 8.26±0.01 kJ/g) and G (17.10±1.04 %; 8.23±0.37 kJ/g).

DISCUSSION

Nutritional compositions of feeds showed that feeds formulated at 38% protein level with accessible (available and low cost) raw materials by agro-ecological area were influenced by the quality of the ingredients shoose and their levels of incorporation. The influences were translated by differences observed between the levels of moisture, total fat, Ash, carbohydrate and energy due to the fondamental difference between some ingredients such as the imported fish meal and local fish meal (Guillaume et al., 1999; Goddar et al., 2008). In fact, the higher levels of Ash, fat and carbohydrate in local fish meal compared to the imported high protein fish meal were due to the difference of fish specie, fish-processing (waste, flesh, carcass ...) and fish meals manufacture process (Hardy and Barows, 2002). Despite, the difference reported between nutritional qualities of feeds formulated, there were adapted to the nutritional require-

Table 5. Nutritional composition of carcass *of Oreochromis niloticus* fingerlings fed with three formulated feeds			
Composition	Formulated feeds		
	SG1	SG2	G
Moisture (%)	70.86±0.55^{b}	69.42±0.30^{a}	69.12±0.80^{a}
Ash (%)	3.87±0.12^{b}	3.29±0.14^{a}	4.16±0.31^{b}
Crude protein (%)	14.74±0.03^{a}	16.66±1.04^{b}	17.10±1.04^{b}
Crude lipid (%)	10.51±0.81^{a}	10.92±0.02^{a}	11.58±0.93^{a}
Gross energy (kJ/g)	7.64±0.32^{a}	8.26±0.01^{b}	8.23±0.37^{b}
a, b, c, alphabetical letters on the same line show a significant difference among treatments at p<0.05			

ments of the *O. niloticus* fingerlings. In fact, 35-38% protein level, 25% carbohydrate level, 4-10% lipid level, less of 8% Ash and crude fibre levels are recommended for good growth of *Oreochromis niloticus* fingerlings (Lazard, 2007). However nutritional composition differences between the feeds formulated can influence the fish growth.

Moreover, the protein levels (38%) of feeds SG1, SG2 and G formulated for the breeding of *O. niloticus* fingerlings ranged between protein levels (30 – 57%) of imported high quality industrial commercial fish feeds (Koumi et al., 2015; 2016). Also, protein level of the three feeds formulated were higher than proteins levels of national industrial commercial fish feeds (28 – 30.15 % protein level), feeds sellers commercial fish feeds (16.20 – 24.90 % protein level) and farms made fish feeds (10.95 – 35.90 % protein level) used to feed all stages of tilapia *O. niloticus* included the fingerlings stage in the semi-intensive fish farms in Côte d'Ivoire (Koumi et al., 2015; 2016). The cost price of the three feeds formulated for *Oreochromis niloticus* fingerlings ranged between 0.56 and 0.65 USD/kg and were low cost compared to the prices (1.02 – 2.14 USD/kg) of most quality imported industrial commercial fish feed selled in Côte d'Ivoire (Koumi et al., 2015). Furthermore, difference in cost of raw materials used by feed, also influenced the cost price of feeds. So the use of low cost local fish meal in feed SG2 has resulted to the reduction to 0.06; 0.09 USD of this feed cost price compared to the price of feeds SG1 and G respectively due to the sheaper price of local fish meals compared to imported high quality fish meal. So quality and cost of the three feeds formulated and proposed offer the opportunity of fish farmers to made competitive local low cost fish feeds for *O. niloticus* fingerlings stage to resolve the inavailability of adapted quality fish feeds on the most Côte d'Ivoire fish farms. Despite the difference recorded between ponds water dissolved oxygen, % dissolved oxygen, conductivity and TDS values, temperature, dissolved oxygen, and pH values recorded were ranged between recommanded values for the good conditions of *O. niloticus* fingerlings breeding in earthen ponds (Tepe and Boyd, 2002; El-Sayed, 2006; Makori et al., 2017). Also, ponds water conductivity were above lethal values 3.8 to 10 µs/cm related by Stone et al (2013) and total dissolved solid (TDS) values (17.25±5.00 - 29.50±5.80 mg/L) recorded were less than 500 mg / l, reported as lethal value by Ibrahim and Ramzy (2013). Consequently, ORP values (21.6 ± 0.71 - 88.5 ± 48 mV) recorded in ponds related good oxydation conditions. Water physico-chemical parameters recorded had testified to the very good conditions of fingerlings breeding in earthen ponds with the formulated feeds.

Growth data analyses showed the better gorwth of *O. niloticus* fingerling with the feeds G and SG2 in spite of the difference on the nutritonal quality of the two feeds. In fact, feed SG2 presented highest levels of Ash (22.71±0.06 %) and protein/energy ratio (24.08±0.10 mg/kJ) values when feed G showed highest levels of carboghydrate (32.99±1.22 %) and gross energy (18.00±0.85 kJ/g) contents (Table 2). In addition, feed SG2 recorded higher level of calcium (15.38 mg/g) and phosphore (18.99 mg/g) content compared to the feed G (7.83 mg/g; 9.50 mg/g) although these levels were ranged between or above the recommended levels (6.5 – 9 mg/g) of calcium and phosphore in tilapia *O. niloticus* feeds. Results show that the mixes of ingredients of formulated feeds SG2 and G were better adapted for fingerlings *O. niloticus* growth. However, means daily fish weight gain recorded in this study oxcillated between 0.56±0.06 and 0.91±0.09 g/day were equal or greater than 0.35±0.05-0.86±0.20 g/day reported by Sumagaysay (2007) with *O. niloticus* of 2 to 83 g fed 4.4-10% of biomass of fish per day with the starter cruble and pellet feeds in intensive system. In addition, the specific growth rates (2.57±0.14- 3.24±0.15 %/day) and protein efficiency ratio (1.28±0.14-1.89±0.2) were similar of those recorded by Goddard et al. (2008) with fingerlings in outdoor cicular tanks in intensive fish farming system ranged between (2.7-3.1 %/day) and (1.67-1.92) respectively. When feed conversion ratios (1.38±0.14-2.06±0.23) recorded with feeds formulated presented in flour in this study were almost similar to those (1.3 -1.9) attained by El-Sayed (2013) using pelleted feeds in spite of the influences of feeds presentations forms on the feed conversion ratio in fish farm related by the same author. In fact best feed conversion ratio values were reported with extruded feeds, following by pelleted feeds when feed presented in flour form reported the lowest values in general (El-Sayed, 2013). Otherwise, variations observed in fish growth performance and feed utilization efficiency values with fish fed with feeds proposed by agro-ecological area were due to all differences between the three feeds such as ingredients shosed, and their incorporation levels, macro-and micronutriments compositions and the presence or not of the antinutritional substances (Workagegn et al., 2014). However, results demonstrated the opportunity to use the simple mixed feed formulated according to the recommended requirement, grounded in fine flour in the ponds to feed tilapia fingerlings in semi-intensive fish farm system. Results attest also the possibility to use local low cost fish meal in the formulation of adapted Tilapia *O. niloticus* fingerlings feeds despite the high quantity Ash induce by its use. Also, Abarike et al. (2016), reported good growth of tilapia with feeds contents up to 22.32% Ash and Goddard et al., (2008) reported best growth with of the feeds formulated at 38.9-39.8 % protein levels with local fish meal (16.1-24.4% of Ash). The absence of pathological signs from fish fed and survival rate recorded (99.94 and 100%) during the feeding trial could be attributed to good management procedures during the study, i.e. proper handling of fish during sampling and storage of feeds which avoid mold growth, contamination with rodents.

At the end of feeding trial, differences were found in the moisture, ash, crude protein, and gross energy values of fish fed carcass. Similar results were also found by several authors (Goda et al., 2007; Agbo et al., 2011; Workagegn et al., 2014; Xiao et al., 2017). These differences were reported due to the nutritional value of feeds. Indeed, according to Elagba and Al-Sabahi (2011) and Navarro and al. (2012) the fish feeds influences the nutritional profile of fish. However, it is observed of lot of times, similar protein levels feeds used not influenced *O. niloticus* carcass protein levels (Koumi et al., 2009; 2011). But, in this study, for the fingerslings of *O. niloticus* at this fisrt stage of growth, the feeds G and SG2 which recorded the best growth were also recorded the high fish carcass protein levels. The carcass nutritional composition was must be influenced by the growth rate which can influence the level of flesh and bone of fish.

CONCLUSION

The local availability of raw materials used in the feed formulated had influenced the quality and the price costs of the feeds, but also the growth and quality of the carcass of fish fed in the context of the formulation of feeds adapted to the nutritionnal requirement of the fish. At the end of feeding trial, growth and survival results promote the formulation and the use of local quality feeds to improve the breeding of the tilapia *O. niloticus* in the semi-intensive fish farms. However, the presentation and the digestibility of these local feeds produced for fingerlings could be improve by the current production technologies such as extrusion.

ACKNOWLEDGMENTS

This work was carried out within the framework of the project to Support the Recovery of Agricultural Sectors in Côte d'Ivoire (PARFACI) financed by the National Inter-professional Fund for Research and Agricultural Council (FIRCA; Abidjan-Cocody Deux Plateaux, 7ème Tranche, 01 BP 3726 Abidjan, Côte d'Ivoire, 01/ tel :(225) 22.52.81.81/82 Fax: (225) 22.52.81.87; e-mail: firca@firca.ci). The authors express their gratitude to the FIRCA for the funding of the project of the development of the local competitive feeds adapted to agro-ecological fish farming areas. The authors thank the fish farmers and their partners for their contribution in the project realization. Authors also thank the Ivorian Association of Agronomic Sciences (AISA; Abidjan, Yopougon-Banco, 20 BP 703 Abidjan, Côte d'Ivoire, 20, tel: (225) 30 63 39 12 Fax: (225) 20 21 67 05, Cel. (225) 03 77 50 29, e-mail: president6aisa@gmail.com) for the good management of the project funds.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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