Iranian Journal of Fisheries Sciences 19(1) 136-150 2020
DOI: 10.22092/ijfs.2019.118813

An investigation on the effects of different diets on the growth performance of Nile tilapia, *Oreochromis niloticus* (Linné 1758)

Djeziri M.[1, 2]*; Nouri L.[1]; Kacher M.[3]

Received: March 2017 Accepted: November 2017

Abstract

The objective of this study is to investigate the possibility of substituting a diet based on fish meal, for Nile tilapia fish fry (*Oreochromis niloticus*), by another food based agro-industrial by-products. Four plants and animal by-products were selected for the formulation of this diet, namely feathers Poultry flour (FPF), date stones flour (DSF), peas flour (PF) and tomato waste flour (TF). The four above-mentioned by-products were combined to obtain four experimental diets (D_1-D_4) containing isoproteic (29- 39% crude protein) and iso-energetic (15-21 kJ gross energy by g feed), so as to replace completely, fish meal. The fifth diet, based on fish meal was used as control died (CD). The results of livestock and biochemical analyses, such as the specific growth rate (SGR), feed conversion efficiency (FCE), the protein efficiency ratio (PER) and the apparent protein retention (APR) show that D_3 and D_4 give better results compared to the control diet (CD). The least interesting results were obtained with experimental D_1 diet. Finally, for all analytical results obtained, it was highlighted that the diet D_4 is relatively more efficient nutritionally, compared to the other diets formulated, which gives a better weight gain.

Keywords: *Oreochromis niloticus*, Pre-fattening, Nutrition, Agro-industrial products meal, Zootechnic parametrers.

1-Research Laboratory in Food Technology, Faculty of Engineering Sciences, University M'hamed Bougara of Boumerdes 35000, Algeria

2-Center for scientific and technical research in Physico-chemical analysis (CRAPC) BP 384 Bouismail, Tipaza. Algeria.

3-National Centre of Research and Development of Fisheries and Aquaculture (CNRDPA), Bouismail, Tipaza. Algeria.

*Corresponding author's Email: mourad_djeziri@yahoo.fr

Introduction

According to the latest statistics of the global production of freshwater fish, tilapia occupied the second place after carps (Fitzsimmons *et al*., 2014), with an annual growth rate of 6% (2012-2014), which corresponds to a production around 5.576 million tons in 2015 (Fitzsimmons Kevin, 2016), about 80% of the total production comes from the species Nile tilapia *Oreochromis niloticus*. Some prospects classify tilapia as the most likely species in the 21st century to replace some marine species in over-exploitation. Tilapia is known as "aquatic chicken" because of their fast growth, good quality flesh, disease resistance, adaptability to a wide range of environmental conditions, ability to grow and reproduce in captivity and feed on low trophic levels (El-Sayed, 2006; Lazard, 2009). In Algeria, the species (tilapia) have been introduced in 2002 for intensive farming (MPRH, 2014). This allowed, firstly, increasing domestic production of freshwater fish, lakes, and dams to about 2648 tons (FAO, 2012), secondly, this activity can contribute effectively to the valorisation of important water resources of several Algerian regions, while providing a complement food importing to the local population (Burel and Médale, 2014).

In Algeria, fish farming remains relatively less developed compared to some major producing countries, because there is a lack of expertise and knowledge of technical farming for local species and cultured fry. Otherwise, to satisfy the food needs for farming animals, livestock, poultry and fish, Algeria imports more than 50% of the raw materials needed to manufacture foods, such as, corn and soybean meal. (Naïli, 2014).

Soybean and fish meal are the main components of the standard feed for tilapia (Lovell, 1988; NRC, 1993). They are rich in essential macronutrients, but their high purchase price and their dependence to the import don't make possibility of using them in the case of aquacol production with high added value (example: the farm aquaculture of the Pescado Duna in Ouargla, Algeria). It is therefore essential to look for new sources of cheap proteins and alternative local agro-industrial by-products to reduce the cost of fish production (Jackson *et al*., 1982; El-sayed, 1990; Ogunji *et al*., 2008; Fiogbe *et al*., 2009), which provide all required elements for cultured animals growth and survival. For tilapia, several authors have tried to replace the conventional material by agro-industrial substitutes in food formulas, who would support growth and similar food use to those based on conventional ingredients. The most used; includes soy flour (Bergheim and Sveier, 1995; Yapog *et al*., 2012), seaweed meal (Appler and Jauncey, 1983), cottonseed meal and sunflower (El-Saidy and Gaber, 2003), rapeseed meal (Davies *et al*., 1990), peanut meal and copra (Jackson *et al*., 1982), flour legumes (Fagbenro, 1998) and flour poultry waste (Tacon, 1993; Gaber, 1996).

The present study focus on firstly, to formulate diets, protein-based at the least cost, and secondly, to study their nutritional performance for Tilapia feed in pre-fattening.

Material and methods

Formulation of the diets

In this study, four diets (D_1, D_2, D_3 and D_4) isoproteic (29-39%) and isoenergetic (15- 21 kJ g^{-1}) have been elaborated and intended for the supply of tilapia in pre-fattening. The main raw materials used like sources of proteins in the formulation of these diets are as follows the feathers poultry flour (FPF), date stones flour (DSF), peas flour (PF) and tomato waste flour (TF). Feathers poultry were collected from slaughterhouses, they were washed and dried in an oven for 24 hours at 105 °C, then ground and sieved through a sieve of 0.2 mm. The date stones were collected from a date processing plant and then ground using a grinder of IKA Werke M20 and sieved. The tomatoes were recovered as waste from the production of greenhouse cultivation, they have been cut in pieces, dried in the sun and then ground. The peas have been bought from the market and transformed in sifted flours.

Table 1, shows the composition of different used flours in the formulation of diets.

Table 1: Proximate nutritional (% dry matter) and amino acids composition (g 100g^{-1} dietary protein) of the different used flours.

Proximate composition	Poultry feathers Flour (PFF)	Date stones flour (DSF)	peas flour (PF)	tomato waste flour (TF)
Dry matter(1)	93.00	85.94	89.50	80.50
Crude protein	72.00	7.27	23.00	19.50
Crude lipid	3.00	7.01	1.50	7.50
Crude fibre	0.60	18.20	6.50	29.00
Total Ash	3.40	1.93	3.20	4.50
Nitrogen-free extract(2)	14.00	61.53	55.30	20.00
Phosphorus (g kg^{-1})	0.71	0.07	0.45	0.55
Calcium (g kg^{-1})	0.22	0.03	0.13	0.91

(1) - Components (% in dry matter).
(2) - Nitrogen-free extract calculated by difference = [100 % – (% lipid+ % moisture content + % protein+ % fibre + % ash)].

Based on these four flours prepared from other complementary ingredients, four diets (D_1, D_2, D_3 and D_4) have been formulated according to a report of 60% dry water-matter, in order to prepare malleable dough. Diets were processed by a mincer with die into 3 mm diameter, spaghetti-like strands, sun-dried, fragmented to the desired size, stored in air tight containers and stocked at low temperature (- 20 ° C). The compositions of these four diets have given in Table 2. A control diet (CD) based on fish meal was used to compare a possible nutritional performance for formulated diets.

Table 2: Formulation and proximate composition of experimental diets.

Ingrédients (g $100g^{-1}$)	D_1	D_2	D_3	D_4
Flour feathers Poultry (FFP)	20.28	5.00	5.00	5.00
Flour date stones (FDS)		15.00		
Flour peas (FP)			15.00	
Flour tomato waste (FT)				15.00
Corn flour	1.95	2.08	1.43	1.60
wheat flour	2.64	2.80	1.94	2.17
linen flour	5.15	4.86	6.18	5.83
sesame flour	4.98	5.26	5.45	5.40
potato peels flour	10.00	10.00	10.00	10.00
olive waste ₣ flour	12.00	12.00	12.00	12.00
Vitamines and minerals (1)	0.50	0.50	0.50	0.50
Nacl	0.50	0.50	0.50	0.50
Wheat bran	10.00	10.00	10.00	10.00
Sunflower oil	6.50	6.50	6.50	6.50
bread crumb flour	15.00	15.00	15.00	15.00
Cr_2O_3 (2)	0.50	0.50	0.50	0.50
Corn starch (binding agent)	10.00	10.00	10.00	10.00

(1) Vitamins premix (mg où IU. kg^{-1}): Vit. A, 250000 UI; Vit. D3, 62500 UI; Vit. K3, 100 mg; Vit. B1, 41 mg; Vit. B2, 150 mg Vit. B6, 90 mg; Vit. B12, 0.33 mg; Calpan, 175 mg; Ac Folique, 20 mg; Biotine, 2 mg; Choline, 2500 UI.
Mineral premix (mg Kg^{-1}): Fe, 1.5 g; Cu, 0.2 g; Mn, 1.75 g; Zn, 1.25 g; I, 0.01 g; Se, 0.0075 g; Co, 0.008 g; P, 0.082 g Ca, 0.24 g; Na, 0.35 g.
(2) Cr_2O_3 only used for the supplementary experience of the digestibility.

The four formulated diets were analysed and their biochemical composition presented in Table 3.

Table 3: Proximate biochemical composition of control and experimental diets.

Biochemical composition(% DM)	D_1	D_2	D_3	D_4	CD
Dry matter (% of original matter)	86.44	86.44	88.10	85.12	95.70
Crude protein	38.12	29.74	29.55	29.60	63.00
Crude lipid	11.45	12.02	11.23	12.09	11.00
Crude fibre	8.40	10.91	9.24	12.46	0.20
Total ash	5.29	5.08	5.26	5.45	10.90
Nitrogen-free extract	31.28	27.97	32.28	25.52	10.60
Calcium (g Kg^{-1})	0.81	1.01	1.75	1.13	-
Phosphorus (g Kg^{-1})	1.18	1.16	1.19	1.12	1.50
Gross energy (Kj g^{-1})	18.29	16.41	16.80	15.87	21.10

Procedure for testing different experimental diets

The experimental work was carried out at experimental Station of the National Centre of Research and Development of Fisheries and Aquaculture (CNRDPA) situated in Bousmail-Algeria, Nile tilapia (*O. niloticus*) fingerlings obtained from CNRDPA station Fish Hatchery, Ouargla Governorate were used in the present study. The experimental fish were fed with test diets for a week as adaptation period to adapt them to the diets. After the adaptation period has been completed, fish in each aquarium were reweighed, and their initial weights were recorded. 450 fry with initial average weight about 3.18±0.39 g were placed randomly in fifteen glass aquaria with dimensions of 70×35×35cm and 85 l capacity of water per aquarium at 28±1°C. Three replicates per treatment were used in this study to achieve any statistical study. Every share of Alvin was fed to satiation with different formulated diets (D_1, D_4) and (CD), at a rate of four times daily, during 64 days. Every morning, each aquarium was cleaned daily in order to prevent faecal materials accumulation, reduce algae growth, and the same amount of fresh water was used to refill the aquaria.

The physicochemical and biochemical analyses of the four formulated diets were determined using the methods established by (AOAC, 1990). The moisture content of each feed sample was determined after drying in oven at 105 °C for 24 hours. The ash content was obtained by calcining the sample in a muffle furnace at 550°C for 12 hours. The protein content was determined according to the Kjeldahl method, to determinate total nitrogen. Total lipid was determined by the Soxhlet method, using hexane as solvent. The fibre contents were obtained by acid hydrolysis of samples. The carbohydrate content, assimilated to the nitrogen-free extract (NFE), was determined by difference from the values found for the other constituents of the diet (Table 1). The gross energy has been calculated using the nutrient conversion factors defined by (Luquet and Moreau, 1989) (Table 4). Calcium was measured after digestion with nitric acid 1.4 N samples by atomic absorption, type flame spectrophotometer VARIAN 110 (Wolf *et al*., 2003). The phosphorus analysis was conducted by ammonium-molybdate method after digestion with the 1N nitric acid samples has been incinerated at 550 °C.

Table 4: Formulas used to calculate growth performances parameters.

Parameters	Formulas	References
Weight Gain (WG) (%)	[(Final Weight – initial Weight)/ Initial Weight]*100.	(Storebakken,2002)
Daily Weight gain (DWG)	[(Final Weight – initial Weight)/ Days number].	(El-Sayed, 2006)
condition factor K (g cm^{-3})	[Fish weight / (Total length fish) ^{3}].	(Bhosale *et al*., 2010)
Specific growth rate (SGR) (% day^{-1})	[Ln (final Weight) - Ln (initial Weight)/ days number])]* 100.	(De Silva *et al*., 2012)
Survival Rate (SR) (%)	Final number fish /Initial number fish) * 100.	(Suloma and Ogata, 2006)
feed conversion rate (FCR)	Feed ingested (g) / Weight gain (g).	(Rothuis *et al*., 2012)
Protein efficiency ratio (PER) (%)	(final body weight gain/protein intake) *100.	(Obirikorang *et al*., 2015)
Apparent protein retention (APR) (%)	100*(Final fish body protein- initial fish body protein)/crude protein intake]	(Chumlong and Chutinthorn, 2008)
Gross energy (KJ g^{-1})	% Proteins*22.2 KJ g^{-1}+ % lipid*38.9 KJ g^{-1}+ %NFE*17.2 KJ g^{-1}.	(Yapog *et al.*, 2012)

Data analysis

All growth data were subjected to one-way analysis of variance (ANOVA). The significance of difference between means was determined by Duncan's multiple range test (p<0.05) using Statistica software (version 8). Values are expressed as means.

Results

In this part of study we will evaluate the efficiency of formulated diets and their wide application in farming species of fish studied. Noting that these species are appropriate for aquaculture, primarily owing to their strong density under restricted conditions of farming (Yataw and Hettiarachchi, 2006).

Table 5: Weight of *Oreochromis niloticus* juvenile fed with experimental diets.

Parameters	D_1	D_2	D_3	D_4	CD
Average number of fish in the initial state	30	30	30	30	30
Average number of fish in the final state	30	30	30	29	30
Survival rate (%)	100	100	100	96.66 ± 1.91	100
Average initial fish biomass (g)	104.2 ± 5.55 (a)	102.1 ± 6.07 (a)	103.5 ± 4.71 (a)	82.8 ± 6.16 (b)	82.5 ± 5.79 (b)
Average final fish biomass (g)	291.10 ± 6.00 (a)	299.60 ± 7.08 (a,c)	318.10 ± 8.57 (d)	318.50 ± 12.63 (b,c)	380.60 ± 12.42 (e)
Average biomass dead fish (g)	0.00	0.00	0.00	7.11 ± 0.104	0.00
Average gain fish biomass (g)	186.90 ± 8.07 (a)	197.50 ± 2.72 (b)	214.60 ± 8.93 (c)	235.70 ± 16.48 (d)	298.10 ± 28.22 (e)
Average mass of intake food (g)	375.86 ± 7.46 (a)	372.51 ± 6.21 (a)	374.42 ± 6.19 (a)	320.49 ± 7.72 (b)	319.69 ± 2.15 (b)
Food conversion ratio (FCR)%	49.72 ± 1.57 (a)	53.03 ± 0.92 (b)	57.30 ± 1.46 (c)	73.51±3.85 (d)	93.27 ± 9.25 (e)
Condition factor (K) g cm^{-3}	0.031 ±0.0043 (a)	0.022 ±0.0026 (c)	0.022 ± 0.0026 (c)	0.026 ± 0.0041 (a,c)	0.015 ± 0.0015 (b)
Specific Growth Rate (SGR)%	1.60 ± 0.09 (a)	1.68 ± 0.06 (a)	1.75 ± 0.08 (a)	2.11 ± 0.16 (b)	2.39 ± 0.20 (c)
protein efficiency ratio (PER)	1.05 ± 0.05 (a)	1.14 ± 0.06 (c,d)	1.22 ± 0.03 (c)	1.67 ± 0.08 (b)	2.12± 0.03 (d)
Apparent protein retention (APR) %	9.02±0.70 (a)	10.36±0.42 (b)	10.27 ±0.69 (b)	12.94±1.10 (b)	33.28±3.12 (c)
Gross energy (Kj g^{-1})	18.29	١٦.٤١	١٦.٨٠	١٥.٨٧	21.10

Effect of formulated diets on survival fish

Survival, as indicated in Table 5, represents the actual survival rate observed from final and initial fish numbers. Overall, a survival rate of 100% was observed for all fish lots, with exception the fish lot that consumed D_4, is around 96.7%. This very low mortality observed is due to the fish cannibalism behaviour while the size homogeneity of the fish fry is initially selected for this study. The general state of fish at the end of experiment is considered satisfactory and no infection or pathology does not seem affected them for the experiment duration.

Effect of formulated diets on weight

Figure 1 a represents the temporal evolution of the fish average biomass Nile tilapia (*O. niloticus*) fed with different formulated diets (D_1, D_2, D_3, D_4) and the control diet (CD). From this figure, it is clear that during 64 days (faring period), all formulated diets were well assimilated by the fish. Physically, we observed a significant growth in the range of 235.70 g for fish that consumed the diet D_4 against approximately 186.90 g for those who consumed the diet D_1 (Figure 1 b). Nevertheless, this growth rate remains promising but relatively low in fish that consumed control diet (CD).

The analysis of variance ANOVA (Table 6) shows, for a significance level (*P*) less than 5%, there is a significant variation in the average gain of fish biomass corresponding to the various formulated feeds (D_1-D_4). Duncan's test can observe this significant difference between the average biomass earnings for the different diets (D_1-D_4) and the control diet.

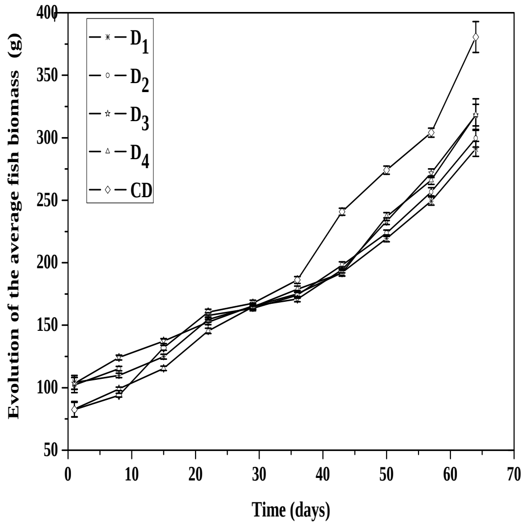

Figure 1 a: Evolution of the average fish biomass (*Oreochromis niloticus*) fed with control and different experimental diets.

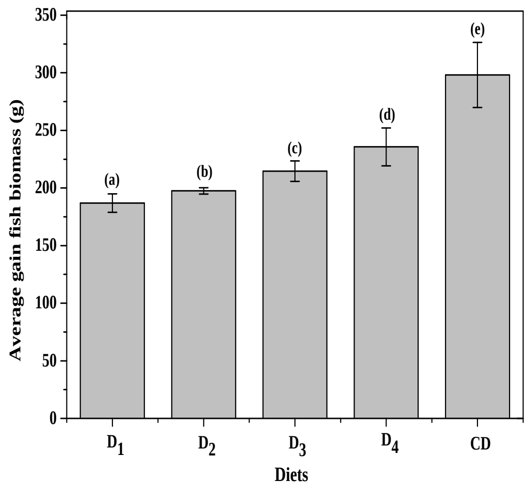

Figure 1 b: Value of gain fish biomass in (g).

Effect ingested feed on fish growth

a/ *The average amount feed consumed*

As Figure 2 shows the average amount feed D_1, D_2 and D_3 consumed by fish during the farming period is relatively more important than food D_4 and control. The statistical study by analysis of variance ANOVA (Table 6) and the test of Duncan shows that there is no significant difference between the amounts of feed ingested D_1, D_2 and D_3, and between the quantities of feed ingested D_4, CD. It supposes that the fish who consumed the ingested feed D_4 is equivalent to those that consumed by controls feed CD.

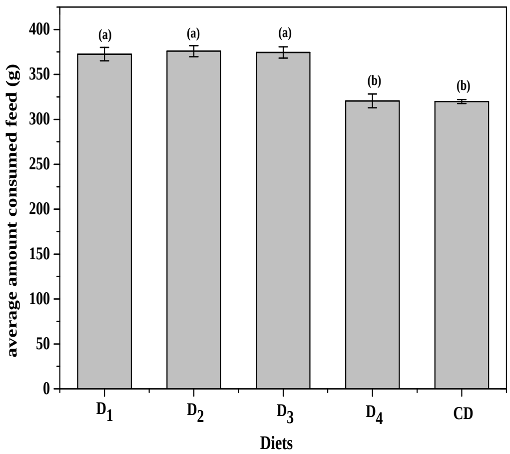

Figure 2: The average amount of consumed feed (g).

b/ Feed conversion rate (FCR)

In order to put in evidence the influence of the amount of each ingested feed on the average weight gain of fish, we determined for each group of fish feed conversion rate (FCR) that characterizes the biomass gain from the amount consumed feed. It is clear from Figure 3 that only D_4 (FCR=74.07%) have an interesting feed conversion rate relative to the CD food (FCR=95.6%). For the other feed D_1, D_2 and D_3, despite the amount of ingested feed, that is relatively more important than the feed D4, their feed conversion rate does not exceed 57.3%. The statistical analysis by ANOVA (Table 6) and Duncan test clearly show the existence of a significant difference between the apparent feed conversion rates for the different diets D_1-D_4 and the control CD.

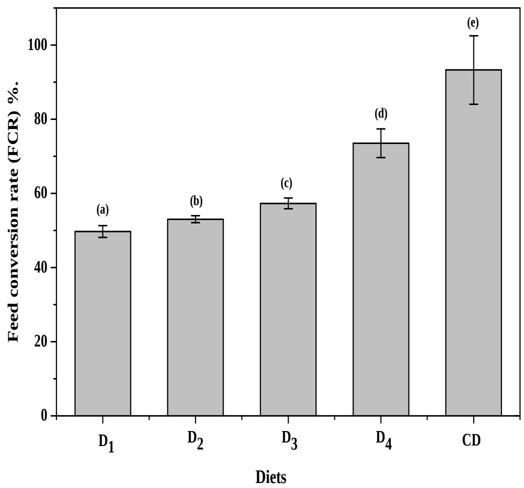

Figure 3: The feed conversion rate (FCR) %.

c/ Specific growth rate (SGR)

The determination of the specific growth rate (SGR) after 64 culture days, allowed us to note, according to Figure 4, that only fish have consumed the D_4 food presents a specific growth rate (SGR=2.11%) is relatively interesting while comparing it to control diet CD (SGR=2.39%). The other foods feed samples (D_1, D_2 and D_3) have relatively low specific growth rate (SGR=1.60, 1.68 and 1.75%) respectively to the D_4 and CD food. The statistical analysis by ANOVA (Table 6) and Duncan test show although there is a highly significant difference between the specific growth rates for different formulated diets.

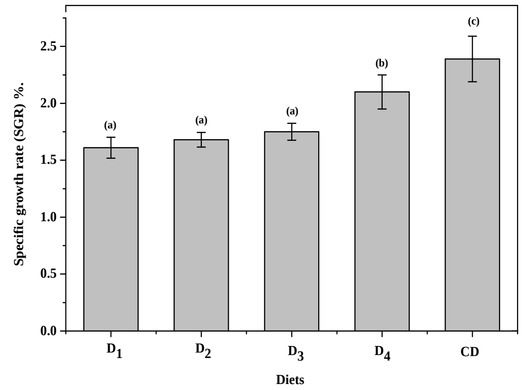

Figure 4: The Specific growth rate (SGR) %.

d/ The condition factor (K)

This factor gives a global indication of the state of overweight fish. According to the tested diets, the values ranged from 0.015 for fish fed with a control diet CD and 0.023 for those fed with the diet D_2, Statistical analysis ANOVA (p<0.05) showed a significant difference between experimental regimes.

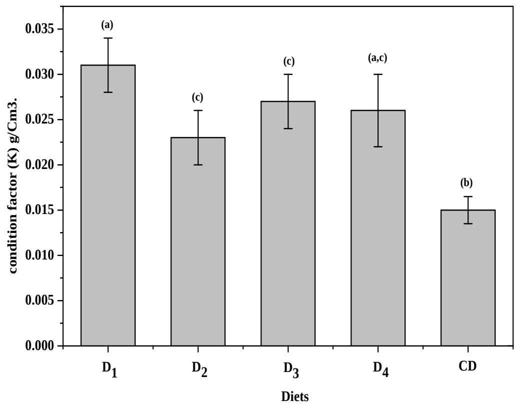

Figure 5: The condition factor (K) g cm^{-3}.

e/ The apparent protein retention (APR)

Figure 6 gives the apparent protein retention (APR) according to different formulated diets as well as the control diet. The figure shows that during the farming period of fingerlings *Oreochromis*, significant influence between the rates of apparent protein retention corresponding to different foods is observed. The highest retention rate recorded, relatively to the control diet is that of feed D_4 (RPA=12.94%) followed by feed D_2 (APR=10.36%), D_3 (APR=10.27%) and D_1 (APR=9.02%). The statistical analysis of variance ANOVA (Table 6) and Duncan test shows that there is a significant difference between the diet D_1 and the D_2 food, D_3 and CD.

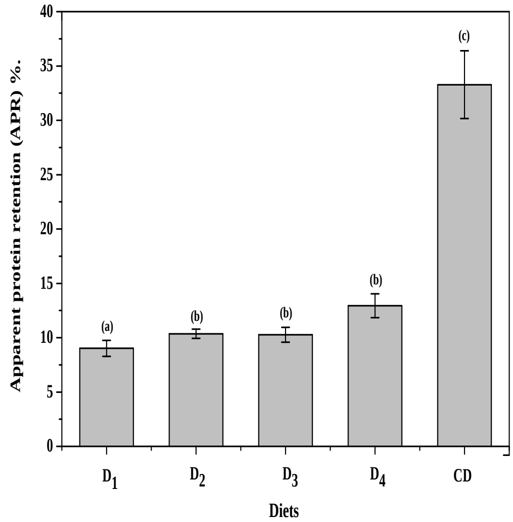

Figure 6: The apparent protein retention (APR) %.

Discussion

In the current study, the first three diets D_1, D_2 and D_3 were consumed by fish in a similar manner, which was noted by (Yones and Metwalli, 2015), which they have formulated four diets containing an average crude protein (30.11±0.07 %). The first diet was formulated without poultry by-product meal and considered as a control diet, the others Diets were formulated to be comprised with partial and total inclusion levels of 50, 75 and 100% poultry by-product meal, They found a value of feed consumed ranging from 70±3 to 71±4 g fish^{-1}. Low values were noted for D_4 and CD diets in our study. The obtained results here are in concomitant with others studies used agro-industrial by products sources to partially or totally replace fish meal for tilapia (Bamba *et al.,* 2007; Sidonie Koco *et al.,* 2014; Obirikorang Kwasi Adu *et al.*, 2015). It was the diet D_4 that is the least consumed compared to the others diets.

By comparing the value of the feed conversion ratio corresponding to the D_4, it remains significantly higher than those obtained by (Gaber M *et al.*, 2012) (FCR varies from 50% to 58.8%) during the testing formulated feed from Rumalato and fry for *O. niloticus*. D_4 also gave a better feed conversion ratio than those obtained by (Fagbenro, 2004) (FCR varies between 44 and 65.8%) and (Giri *et al.*, 2000) (FCR varies between 33.3 and 34.5%) relative to formulated feeds, respectively, to basis of soy flour, rocket, chicken viscera and plant.

The results have been obtained here (SGR from 1.60±0.09 to 2.39±0.20 % day^{-1}) are similar to those, reported by several authors for diets incorporating more than 25% unconventional protein source ingredients. Our results, however, are interesting compared to data reported with more balanced diets (specific growth rate greater than 3%/d, (Jauncey and Ross, 1982). The poor growth performance observed in fish fed with the D_1 diet, composed of 20.28% of poultry meal, could be related to the high level of a complex protein (Keratin).

In this regard, Tacon *et al.* (1983), and many others recommend a feather meal content of less than 30% for tilapia feed. On the other hand, the acceptable average performances obtained with the D_4 diet allow us to think like Pouomogne (1994) that in the formulation of tilapia feed, the use of a range of by-products as varied as possible would reduce the harmful effects of anti-nutritional factors present in high levels in isolated ingredients. The specific growth rates observed in our study were higher than those reported by (Tacon *et al*., 1983). This, in part, could be due to the source of the feather meal, other components in the diet, and the conditions during the rearing phase of the fry or the origin of brood stock.

The values of condition factor are similar to those found by (Ogunji *et al*., 2008), who found the three foods formulated for Tilapia, the first lacking magomeal (K=0.0247), the second with a rate of 15% (K=0.0289) and the third with a rate of 30% (K=0.0266), they are also near as those found by (Murtaza and Tiraykiodiu, 2006) where the condition factor K is around 0.0167 and 0.0176 for food formulas intended for tilapia containing between 20 and 100% of Virginiamycin. By consequence, they are significantly lower than those found by (Suphada *et al*., 2012) which are between 0.0055 and 0.0061 for a rate of proteins understood between 32 and 44%.

Concerning apparent protein retention, our values are lower than those found by (Li *et al*., 2013) who found values between 36.7 and 50.7%

for nine (09) diets formulated with fish meal, soya and maize 20, 25 and 30% protein and 2.6, 2.8 and 3.0 Kcal / Kg . The same thing for (Amanat *et al*., 2001) found the APR between 27.26 and 36.45% contenting 38% protein. On the other hand they are similar to those found by (Suphada and Anut, 2012) who found an APR between 20.10 and 27.87% for 32 to 44% proteins.

This study underlined the importance of the use of agricultural by-products in the diet of Nile tilapia (*O. niloticus*) during the pre-fattening phase in glass aquariums. The different populations of fry fed foods made from agricultural by-products present a growth performance distinctly similar to those of populations subject to commercial diet (control). Compared to the commercial food industry, the feed samples tested have reduction ratio of 11.47, 20.24, 35.66 and 12.05% respectively at densities of 30 ind./85.10^{-3}m^3. Diets developed in this study have the advantage of being locally available, accessible and relatively less expensive (financially) to farmers, unlike the commercial industrial food. These results should be confirmed in large scale and over a significant time to ensure their long-term reliability and production breeding conditions.

Table 6: variance analysis of *Oreochromis niloticus* juvenile growth performance.

	variations Source	squares Sum	liberty Degree	Average squares	$F_{observed}$	Probability	$F_{critical}$
Initial biomass.	Between groups	1537.16	4	384.29	11.91	0.000804	3.48
	Inside groups	322.68	10	32.27			
	Total	1859.84	14				
gain biomass	Between groups	23285.86	4	5821.46	23.86	0.000042	3.48
	Inside groups	2440.14	10	244.01			
	Total	25726.00	14				
Food intake.	Between groups	10581.06	4	2645.27	67.26	0.00034	3.48
	Inside groups	393.30	10	39.33			
	Total	10974.37	14				
food conversion ratio (FCR)	Between groups	3921.75	4	980.44	46.36	0.00000202	3.48
	Inside groups	211.50	10	21.15			
	Total	4133.25	14				
Specific growth rate (SGR)	Between groups	1.309	4	0.327	19.65	0.0000995	3.48
	Inside groups	0.167	10	0.017			
	Total	1.476	14				
Condition factor (K) (g cm^{-3}).	Between groups	0.000426	4	0.00001066	10.47	0.00134	3.48
	Inside groups	0.000102	10	0.00001018			
	Total	0.00053	14				
Protein Efficiency ratio	Between groups	0.364	4	0.091	9.900	0.002	3.478
	Inside groups	0.092	10	0.009			
	Total	0.455	14				
Apparent protein retention (APR) %.	Between Groups	1145.42	4	286.35	44.95	0.000002327	3.47
	Inside groups	63.69	10	6.36			
	Total	1209.12	14				

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