International Journal of Natural and Social Sciences
Print: 2617-6637 < ISSN > Online: 2313-4461
IJNSS

Producing Nile tilapia (*Oreochromis niloticus*) on feed supplemented Nebeday (*Moringa oleifera*) leaves

Ibrahima BADIANE[1], Mouhamadou Amadou LY[1]*, Jean FALL[2], Justin KANTOUSSAN[1], Robane FAYE[1]

[1]UFR des Sciences Agronomiques de l'Aquaculture et des Technologies Alimentaires, Université Gaston Berger, Sénégal
[2]Institut Universitaire de Pêche et Aquaculture, Université Cheikh Anta Diop de Dakar, Sénégal

ARTICLE INFO

Article history

Received: 27 April 2021
Accepted: 06 May 2021

Keywords

Feeding, growth, *Moringa oleifera*, *Oreochromis niloticus*

***Corresponding Author**

Mouhamadou Amadou LY
mamaly90@hotmail.com

ABSTRACT

This study was conducted to investigate the effect of fishmeal substitution with *Moringa oleifera* flour leaves in the diet of juveniles Nile tilapia (*Oreochromis niloticus*, Linnaeus, 1758). Nile tilapia with an average weight of 1.5 ±0.2 g was used in this study. Three hundred (300) juveniles were randomly selected and stored in 15 aquariums of 27.3 Lfor 60 days. Five (5) isoproteic diets (30 % of proteins) containing different levels of *Moringa oleifera*'s flour leaves (0 %, 25 %, 50 %, 75 % and 100 %) noted respectively R_1, R_2, R_3, R_4 and R_5 were tested in triplicate. Water physico-chemical parameters were monitored daily throughout the experiment. Fish were fed 8% of their biomass six (6) times per day (8am, 10am, 12pm, 14pm, 16pm and 18pm). The juveniles were weighted each two weeks and growth parameters were calculated. At the end of the experiment, the pH of the water in the five (5) treatments was between 6.8 and 7.1, the temperature was between 20.7 to 27.3ºC and the dissolved oxygen was between 75.3 and 80.3%. The survival rate ranged from 77 and 87 % and showed that *M. oleifera's* flour leaves did not have a negative effect on the survival of the juveniles. The best growth performances and feeding efficiency were obtained with the 25% substitution diet of fishmeal with *Moringa oleifera* (R_2), followed by diet R_1, R_3, R_4 and R_5. In conclusion, the result of this study shows that it is possible to include up to 20% *Moringa oleifera* leaf meal in the diet of juveniles of *O. niloticus*, without compromising their growth. This substitution also reduces food production costs and therefore improves farm profitability.

INTRODUCTION

Fish remains a crucial source of energy, protein, and various easily digestible nutrients with high biological value (Peng et al., 2014). As a result, its consumption has increased from an average of 9.0 kg in 1961 to 20.2 kg per capita in 2015. Thus, it continues to increase to 20.3 kg in 2016 and about 20.5 kg in 2017 (FAO, 2018). In Africa, the annual growth of fish consumption is double the population growth particularly in Senegal where landings reached 496,793 tons in 2016. This consumption is estimated, in Senegal, at 26 kg per capita being above the world average (Bonnin et al., 2016).

However, today, fishing cannot adequately satisfy this additional demand, which is increasing day by day, as it has reached a maximum level of exploitation (FAO, 2018). Nevertheless, aquaculture is an interesting alternative, given the dynamics of the progressive depletion of fish stocks (FAO, 2014). Indeed, in recent years, it has provided half of the fish for human consumption (FAO, 2017). Among the main farmed fish species, *Oreochromis niloticus* is the fourth most produced species in the world. This production is estimated at 58% of the global production in 2016. Thus, it is estimated that by 2030, it will reach 62% of the world production (FAO, 2018).

The failure of aquaculture to meet the challenge of closing the widening gap between fish supply and demand in Senegal, results from a number of factors including lack of quality feeds. In intensive aquaculture, feed represents a significant part of

How to cite this article: Ibrahima BADIANE, Mouhamadou A LY, Jean FALL, Justin KANTOUSSAN and Robane FAYE (2021). Producing Nile tilapia (*Oreochromis niloticus*) on feed supplemented Nebeday (*Moringa oleifera*) leaves. International Journal of Natural and Social Sciences, 8(2): 15-23. DOI: 10.5281/zenodo.4887022

the cost of fish production. The economic interest of this type of farming is therefore dependent on the availability and cost of feed (Hoffman et al., 1997). Thus, reducing these costs for fish and controlling the production costs of farmed fish is one of the priorities of aquaculture (Jauncey and Ross, 1982).

High cost and fluctuating quality as well as the uncertain availability of fish meal have led to the need to identify alternative protein sources for fish feed formulation. Therefore, in order to attain more economically, sustainable, environmentally friendly and viable production, research interest has been directed towards the evaluation and use of non-conventional sources of plant protein. Researchers of aquaculture industries aim at exploring alternative, cheaper protein sources for use as fish meal replacers in aqua feeds. The decrease in global production of fish meal clearly demonstrates that the sustainability of this industry will depend on the sustained supply of plant proteins for aqua feeds. This has brought about the search for local protein feedstuffs that are cheap and high in quality as alternative protein feed for *O. niloticus* quality.

Therefore, the valorization of agricultural products and agro-industrial by-products for the manufacture of feeds for farmed fish could constitute an alternative better adapted to the African socio-economic context (Liebert and Portz, 2005). Several attempts have been made to utilize easily available and low cost terrestrial vegetable protein sources that have high potentials for supplying fish with required protein needed for their maximum productivity.

Various raw materials of plant origin have been tested in the diet of *O. niloticus*. These include roasted soybean meal, maize bran, rice bran, cassava meal (Wee and Ng, 1986) ; coconut meal (Falaye and Jauncey 1999); cottonseed cake (Mbahinzireki et al., 2001) ; tomato leaf meal (Azaza et al., 2006) ; wheat, maize and rice brans (Liti et al., (2006); Soybean meal (Soltan, 2005) ; *Leucaena leucocephala* leaf meal (Ly et al., 2018) ; *Sesbania aculeata* (Hossain et al., 2002) ; *Sesbania grandiflora* (Firmani et al., 2015) ; Sweet potato, *Ipomoea batata* (Omoregie et al., 2009) ; Papaya, maize meal (Olurin et al., 2006), melon seed (*Citrullus lanatus*) peel (Iheanacho et al., 2018) and Peanut, *Arachis hypogaea* (Agbo et al., 2011).

Recently, researchers have increasingly been paying attention to Moringa (*M. oleifera* Lam). Moringa (*M. oleifera* Lam) is one of the conventional feedstuffs, thus a major source of metabolisable energy in most compounded diets for Tilapia as it is readily digestible by fish. Moringa is an indigenous plant found growing wild in Northern India, Pakistan, Bangladesh and Afghanistan. It was introduced and into South-East Asia, and now cultivated in many ecosystems of the globe with great economic interest especially in tropical and subtropical countries (Doerr and Cameron, 2005). It holds a considerable potential for becoming an ingredient for animal and fish because of its high nutritional quality that is comparable to other feed protein source (Doerr et Cameron, 2005).However higher inclusion levels of *M. oleifera* led to a significant reduction in performance due to high level of antinutritional factors (ANFs) particularly Saponins and to a lesser extent tannin, phytic acid and hydrogen cyanide (HCN).

It is in this perspective that this research work aims at proposing an alternative feed based on agricultural products in order to reduce production costs, to improve the profitability of aquaculture enterprises and to contribute to the sustainable development of aquaculture in Africa, in particular in Senegal.

MATERIALS AND METHODS

Fresh green moringa leaves were collected from UGB farm, sun dried and finely grounded to make the meal. The other ingredients (fish meal, maize meal, groundnut cake meal, soyabeanoil and binder) were purchased at the Ouakam market (Dakar). However, Vitamin/Mineral Complex were obtained at the Aquaculture section.

After feed formulation, five types of feed were ground and pelleted separately using a hand pelletizer fitted with a 2 mm diameter to prepare the final experimental feeds. Then, the pelleted feeds were dried and conditioned in buckets of 05 kg before using in the experiments.

Experimental Diet

Five (5) isonitrogenous diets (30% crude protein) were formulated to contain *Moringa oleifera* meal at 0% (R_1) as control diet, 25% (R_2), 50% (R_3), 75% (R_4) and 100% (R_5) in the diet of the experimental fish.

Pearson's square method was used in feed formulation. Feed ingredients for the experimental diet include Moringa meal, fish meal, groundnut cake, maize meal, soybean oil, vitamin/mineral premix and starch (binder) (Table 2). The formulation was based on gross proximate composition of the ingredients.

Table 1: Proximate composition (%) of feed ingredients used

Ingredient	Protein	Lipid	Ash	Moisture
Fish meal	45.5	14.63	32	8.02
Maizemeal	8.75	5.51	1.18	10.57
Moringameal	32.6	0.17	15	6.66
Groundnut cake	36.75	15.35	7.35	7.15

Experimental design

The feeding trial was performed at the Aquaculture facility of the Gaston Berger University farm with juvenile *Oreochromis niloticus* averaging 1.5 ±0.2 g initial weight. Prior to the feeding trial, fish were fed a commercial diet for one week to allow for adjustment to the experimental conditions.

A total of three hundred (300) fingerlings with an average weight 1.5 ±0.2 g were randomly assigned to fifteen experimental aquaria tanks of 27.3 L (0.39 m × 0.25 m × 0.28 m). Fish were subjected to five test diets with varying dietary inclusion levels of Moringa meal as treatments. Each treatment contained 20 fish and was triplicated in a completely randomized design.

The fish were fed three times per day, seven days per week. The feeding trial was conducted for 60 days. Aeration was provided to experimental aquaria tanks for dissolved oxygen maintaining at levels near saturation.

Table 2: Gross composition of experimental diets (g/100g) containing Moringa meal fed to *Oreochromis niloticus*

Ingredient	R1(g)	R2(g)	R3(g)	R4(g)	R5(g)
Moringameal	0	7	14	21	28
Fish meal	28	21	14	7	0
Groundnut cake	42,4	45,5	48,8	51,95	55,2
Maizemeal	19,6	16,5	13,2	10,05	6,8
Soybeanoil	2	2	2	2	2
vitamin/mineral premix	4	4	4	4	4
starch	4	4	4	4	4

Water quality parameters

Communal water was used after aeration for 48 hours for dichlorination. Water temperatures were determined two times a day at 8.00 am and 4.00 pm by using a thermometer. Water dissolved oxygen (DO) content and water pH were measured daily at 8.00 pm using a Handyoxyguard dissolved oxygen meter and a digital Hanna pH meter respectively.

Total fish weight in each tank was monitored every 10 days to check growth and adjust feeding rate. Feeding was stopped 16 h prior weighing.

Analyses of crude protein, moisture, and ash were performed by standard procedures (AOAC, 1995). Dietary lipid was determined according to Folch et al. (1957).

At the end of the feeding trial, all fish were weighted and counted to calculate relative weight gain ((final weight gain - initial body weight) / days), specific growth rate (TCS) : ((loge final body weight - loge initial body weight) × 100/ days),feed conversion rate (TCA) : (dry feed consumed / body weight gain), protein efficiency ratio (CEP) : (body weight gain / Protein intake) and survival rate (final number of fish × 100 / Initial number of fish.

Statistical analysis

All results are presented as mean ± standard error of the mean (SEM). Data were subjected to one-way analysis of variance (ANOVA) to test the effect of the Moringa meal inclusion on growth of tilapia. Percentage data were arcsine-transformed before analysis. Where significant differences were found at ($P < 0.05$), a Turkey's test was used to determine which treatment means were significantly different from each other. The statistical analyses were made using XLSTAT (Version 2020: 5.1)

RESULTS

Water quality parameters of each experimental tank were determined and the range of values observed during the experiment was: temperature (20.7-27.3°C), dissolved oxygen (89-90.5%), ammonia-N (0.05-1.05 mg L^{-1}), and pH (6.8-7.1).

Survival rate ranged between 77-87%. Fish fed diet R_2, had the highest survival rate (87%).

Average body weights of fish fed experimental diets during the 60 days period are shown in Figure 1. Fish body weights began to differ in days 30 and become distinctly different between days 40; 50 and 60. At the end of the experiment, fish fed diets containing 50, 70 and 100% Moringa meal exhibited significantly lower final body weight.

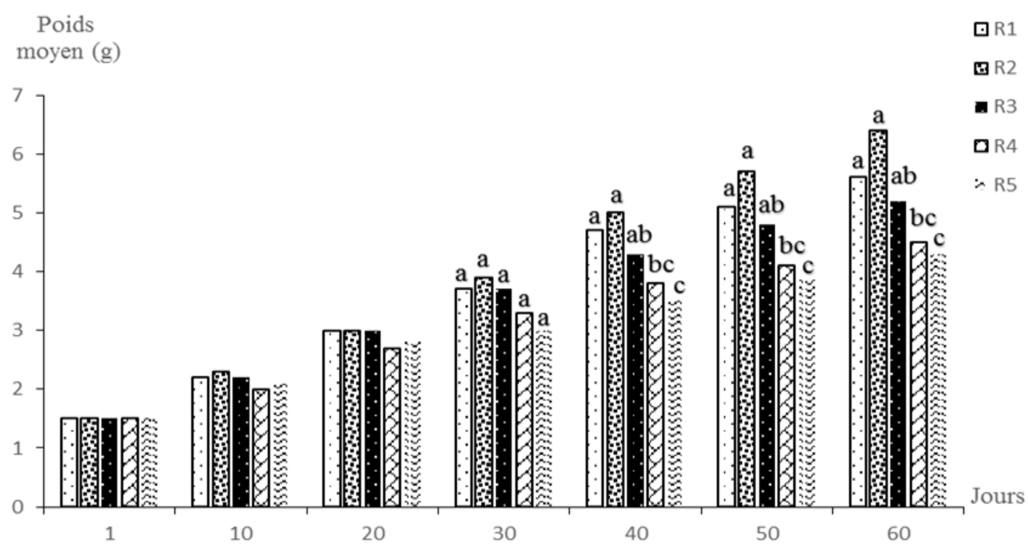

Figure 1: Changes in mean body weight of juveniles *Oreochromis niloticus* fed five different diets (see Table 1 and 2 for descriptions) for 60 days. Values are means of triplicate groups. Diets having different letters are significantly different ($P< 0.05$).

Average body weights (PM)

Relative weight gain was similar between R_1 and R_3 (control and 50% Moringa meal group), but increased significantly ($P< 0.05$) in R_2 (25% Moringa meal group) and decreased significantly ($P< 0.05$) in R_4 (75%) and R_5 (100%). Fish fed diets containing 75 and 100% Moringa meal exhibited significantly lower relative weight gain, compared with fish fed the other diets (Figure 2).

Relative weight gain (GPMQ)

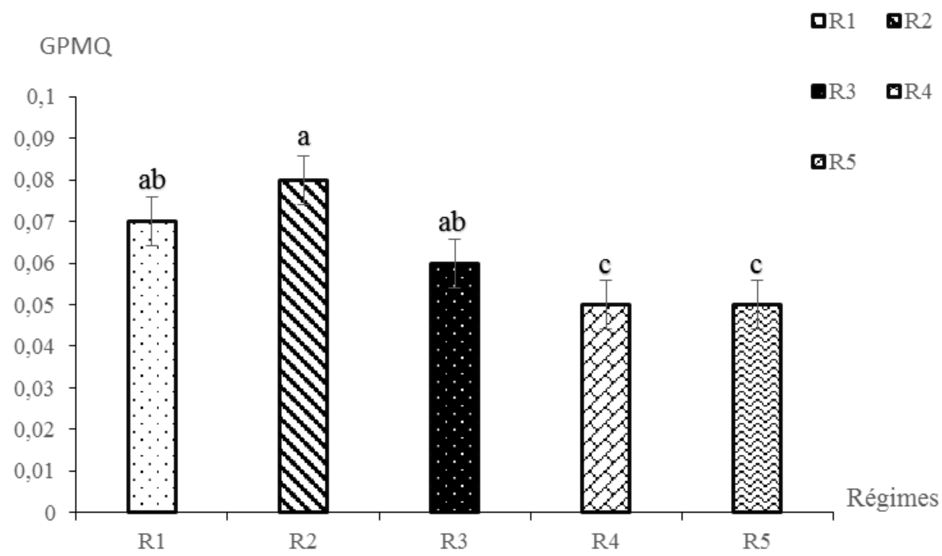

Figure 2: Relative mean body weight gain (GPMQ) of juveniles *Oreochromis niloticus* fed five different diets. Values are means ± SD of triplicate groups. Diets having different letters are significantly different (P< 0.05).

Specific growth rate (TCS)

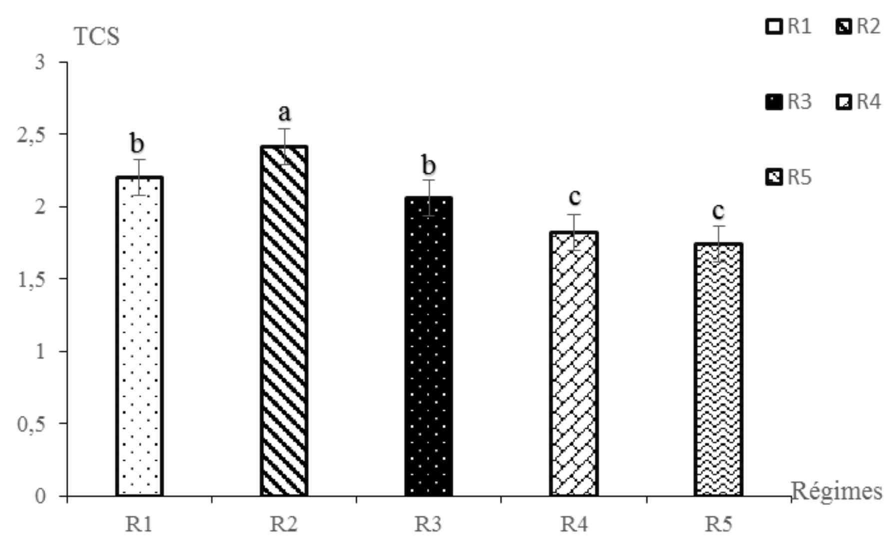

Figure 3: Changes in mean specific growth rate (TCS) of juveniles *Oreochromis niloticus* fed five different diets. Values are means ± SD of triplicate groups. Diets having different letters are significantly different (P< 0.05).

Feed conversion rate (TCA)

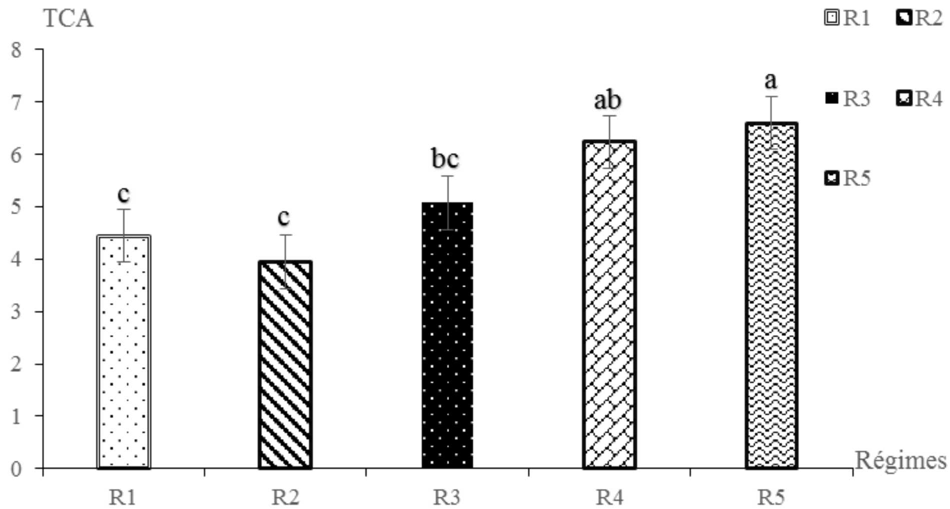

Figure 4: Changes in mean feed conversion rate (TCA) of juveniles *Oreochromis niloticus* fed five different diets. Values are means ± SD of triplicate groups. Diets having different letters are significantly different ($P< 0.05$).

Protein efficiency ratio (CEP)

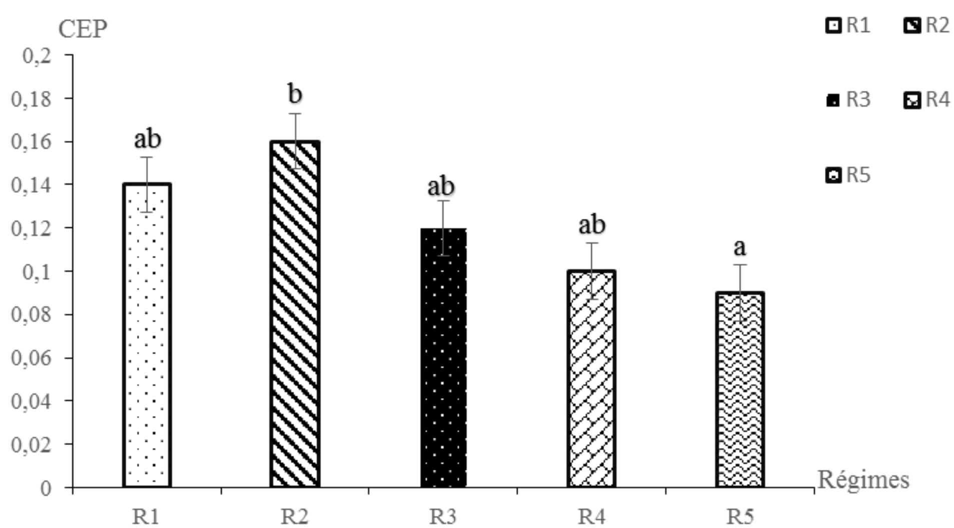

Figure 5: Protein efficiency ratio (CEP) of juveniles *Oreochromis niloticus* fed five different diets. Values are means ± SD of triplicate groups. Diets having different letters are significantly different ($P< 0.05$).

Specific growth rate was similar between R_1 and R_3 (control and 50% Moringa meal group), but increased significantly ($P< 0.05$) in R_2 (25% Moringa meal group) and decreased significantly ($P< 0.05$) in R_4 (75%) and R_5 (100%). (Figure 3)

Fish feed conversion rate was significantly different between diet R_5 compared to diet R_1 and R_2. Fish fed diets containing 25% Moringa meal and the control exhibited significantly lower feed conversion rate compared with fish fed the 100% Moringa meal diet (R_5). (Figure 4).

Protein efficiency ratio decreased from 25% to 50; 75 and 100% but the difference was not significantly (P>0.05). The protein efficiency ratio was significantly different between diet R_2 and diet R_5 (P< 0.05). (Figure 5)

DISCUSSION

Water quality is one of the supporting factors for survival rate andgrowth (Di Maggio et al. 2014).Except the temperature, the water quality parameters measured were in the desirable ranges for Nile tilapia (*Oreochromis niloticus*) farming in this study (Goda et al., 2018). The optimal temperature range for Nile tilapia (*Oreochromis niloticus*) growth is between 25 and 30°C (Benidiri, 2017).

At the end of the experiment, the survival rate varied between 77 and 87%. This rate obtained is acceptable for fish rearing. The observed mortalities were caused by the stress generated during the fish weighing and/or aquaria cleaning, which manifested by the jumping of the fish out of the aquariums. This survival rate shows that the different diets have no negative effect on the survival of *O. niloticus*. Our results are consistent with those of Al Dilaimi (2009), who had survival rates of 90%. These results are also in line with those of Avit et al. (2014). They obtained 80.9% in fish culture and 74.1% in rizipisciculture.

The weight of the Nile tilapia in all treatments increased in line with the experiment time period (Figure 1). Fish fed the R_2 diet (25%) shows relatively final weight

These results are similar with those of Gueye et al. (2018). They performed a substitution of fish meal with Moringa leaf powder and obtained a better relative weight gain at 20% substitution. However, the significant difference observed between R_1, R_2 and R_3 diets compared to R_4 and R_5 diets, reveals that up to 50% inclusion of Moringa meal an acceptable relative weight gain could be achieved.

According to the specific growth rate (TCS) and the Protein efficiency ratio (CEP) a better growth performance was observed in fish fed the R_2 diet. These results are in line with those of Richter et al. (2003). They showed that a 10% incorporation of Moringa leaf meal in the diet of *O. niloticus* does not negatively affect growth performance. The Protein efficiency ratio values obtained in study are lower than those obtained by Mohsen et al. (2010).The poor growth performance observed in R_4 and R_5 diets could be explained by the fact that these diets contain a lot of fiber which would limit the availability of dietary protein.

To avoid these effects, David-Oku et al, (2018), who worked on the substitution of fish meal with Moringa, added shrimp powder to reduce the level of fiber in the diets.

The results shows that, the greater the inclusion of Moringa meal in diets, the greater the feed conversion rate (TCA). The lower its value, the better the food consumed is converted (O'Connor et al., 1985). The feed conversion rate values observed in this study were high and could be attributed to the water temperature. In their study on the incorporation of tomato flour in the diet of Nile tilapia (*Oreochromis niloticus*) reared in the geothermal waters of southern Tunisia, Azaza et al (2006) reported feed conversion rate value between 1.48 and 2.10 which are largely better than ours. In their study, Mélard (1986) reported that *O. niloticus* do not feed in lower temperature and lower dissolved oxygen.

Based on the ingredients price and the estimated cost for the Moringa meal. We expect that 45 CFA/kg of juvenile *O. niloticus* feed could be saved if 20% of Moringa meal is included in the diet.

In conclusion, our findings suggest that the Moringa mealcould be included up to 20% in diets for juveniles *O. niloticus* without adverse growth effects for up to 60 days. In addition, the use of Moringa meal in *O niloticus* feed reduces feed production costs.

REFERENCES

Agbo NW, Adjei-BoatengD andJaunceyK (2011).The Potential of Groundnut (*Arachishypogaea L.*) By-Products as Alternative Protein Sources in the

Diet of Nile Tilapia (*Oreochromis niloticus*). Journal of Applied Aquaculture, 23:4, 367-378.

Al Dilaimi A (2009). Détermination de la ration lipidique optimale chez les alevins du tilapiadu Nil (*Oreochromis niloticus*). Mémoire pour l'obtention du diplôme de Magister en Gestion des Ressources Aquatiques, Faculté des Sciences, Département de Biotechnologie, 52p.

AOAC (1984). Official method of Association of official Analytical Chemists, 14th Edition, AOAC, Arlington, VA, USA.

Avit JBLF, Bony YK, Konan FK, Kouassi CN, Traoré S andYté WA (2014). Paramètres environnementaux du grossissement de *Oreochromis niloticus* (Linne, 1758) (cichlidae, perciformes) en association avec le riz Djoukèmin (*Oryzasativa*) en étang. 14 p.

Azaza MS, Toko I, Mensi F,Dhraief MN, Abdelmouleh A and Brini B (2006). Effet del'incorporation de la farine de tomate dans l'alimentation du tilapia du Nil (*Oreochromis niloticus*, L., 1758) en élevage dans les eaux géothermales du sud tunisien. 12p.

Benidiri R (2017). Création d'un projet piscicole. Mémoire. In : Faculté de Technologie Département de Génie Electrique et Electronique. 79 p.

Bonnin M, LY I, Queffelec B andNgaido M. (eds) (2016). *Droit de l'environnement marin et côtier au Sénégal*, IRD, PRCM, Dakar, Sénégal,532 p.

David-Oku E, Anani EE, Ntaji OE, Edide RO, Obiajunwa JI and Ene-Obong HN (2018).

Growth performance and nutritional impacts of *Moringa oleifera* Leaf and shrimp meals supplemented diets on *Clarias gariepinus* (African Catfish). International Journal of Fisheries and Aquatic Studies 6(5): 23-30

DiMaggio MA, Ohs CL, Broach JS and Sink TD (2014). Effects of stocking density on growth, survival, and stress physiology of pigfish. North American Journal of Aquaculture, 76, 201–210.

Doerr PB and Cameron L (2005). ECHO (Note Technique): Poudre de feuilles de moringa. 6p. http://www.echonet.org/

Falaye AE and Jauncey K (1999). Acceptability and digestibility by tilapia *Oreochromis niloticus* of feeds containing cocoa husk. Aquaculture Nutrition, 5 (3): 157-161.

FAO (2018). The State of World Fisheries and Aquaculture 2018-Meeting the Sustainable Development Goals; FAO: Rome, Italy, 2018.

FAO (2017). FAO Fisheries & Aquaculture - Cultured aquatic species fact sheets-*Oreochromis niloticus* (Linnaeus, 1758). Consulté le 12 août 2017, à l'adresse http://www.fao.org/fishery/culturedspecies/Oreochromis_niloticus/fr

FAO (2014). La situation mondiale des pêches et de l'aquaculture 2014. Rome, 275p.

Firmani U, Cahyoko Y and Mustikoweni (2015). Utilization of Turi Leaf Flour in Feed (*Sesbania grandiflora Pers*.) on Growth of Black Nile Tilapia (*Oreochromis niloticus*). Aquaculture Indonesia 16 (2) : 69-72.

FolchJ, Lees M and Stanley GHS (1957). A simple method for the isolation and purificationof total lipides from animal tissues. Journal of Biological Chemistry. 226 (1):497-509.

Goda AM, Omar EA, Srour TM, Kotiet AM, El-Houron E and Davies SJ (2018). Effect of dietssupplemented with feed additives on growth, feed utilization, survival, body composition and intestinal bacterial load of early weaning European seabass, *Dicentrarchus labrax* post-larvae. Aquaculture International, 26: 169 – 183.

Gueye O, Gueye MT, Djiba A, Ndiaye PI andAgbogba C (2018). Un aliment d'origine vegetalpour l'aliment du poisson d'élevage *Oreochromis niloticus*, Tilapia du Nil. In: ECHOS, 12-13.

Hoffman LC, Prinsloo JF andRukan G (1997). Partial replacement of fish meal with either soybean meal, brewers yeast or tomato meal in the diets of African sharptooth catfish *Clarias gariepinus*, Water SA, 23, 181-186.

Hossain MA, FockenU and Becker K(2002). Nutritional evaluation of dhaincha (*Sesbaniaaculeata*) seeds as dietary protein source for tilapia *Oreochromis niloticus*. Aquaculture Research, 2002, 33 : 653-662.

Iheanacho SC,Ikwo N, Igweze NO, Chukwuidha C, Ogueji EO, Onyeneke R (2018). Effect ofDifferent Dietary Inclusion Levels of Melon Seed (*Citrullus lanatus*) Peel on Growth, Haematology and Histology of *Oroechromis niloticus* Juvenile. Turkish Journal of Fisheries and Aquatic Sciences, 18: 377-384.

Jauncey K and Ross B (1982). A guide to Tilapia feed and feeding. Institute of Aquaculture, University of Stirling, Scotland. 111p.

Liebert F and Portz L (2005). Nutrient utilization of Nile tilapia *Oreochromis niloticus* fed with plant based low phosphorus diets supplemented with graded levels of different sources of microbial phytase. Aquaculture, 248: 111-119.

Liti DM, Mugo RM, Munguti JM and Waidbache RH (2006). Growth and economic performance of Nile tilapia (*Oreochromis niloticus L*.) fed on three brans (maize, wheat and rice) in fertilized ponds. Aquaculture Nutrition 12: 239-245.

Ly MA, Niang AS, Ndiaye D and Ba CT (2019). Influence de la farine de feuille de *Leucaena* *leucocephala* dans l'alimentation des juvéniles de *Oreochromis niloticus* au Nord du Sénégal. Afrique science 15(2): 156-165.

Mbahinzireki GB, Dabrowski K, Lee KJ, El-Saidy D and Wisner ER (2001). Growth, feed utilization and body composition of tilapia (*Oreochromis sp*.) fed with cottonseed meal-based diets in a recirculating system. Aquaculture Nutrition 7 (3):189-200.

Mélard C (1986). Recherche sur la biologie de *Oreochromis niloticus* (Tilapia) L. (piscies Cichlidae) en élevage expérimental : reproduction, croissance, bioénergétique. Thèse de doctorat en sciences Zoologiques, Université de Liège. 192p.

Mohsen AT, Mohammad HA, Yassir AEK and Adel MES (2010). Effect of dietary protein level, initial body weight, and their interaction on the growth, feed utilization, and physiological alterations of Nile tilapia, *Oreochromis niloticus* (L). Aquaculture, 298, 267-274.

O'Connor TP, Roebuck BD, Peterson F and Campbell TC (1985). Effect of dietary intake of fish oil and fish protein on the development of L-azaserine-induced preneoplastic lesions in the rat pancreas. Journal of the National Cancer Institute, 75: 959-62.

Olurin KB, Olojo EAA andOlukoya OA (2006). Growth of African catfish *Clarias gariepinus* fingerlings, fed different levels of cassava. International Digital Organization for Scientific Information, 1(1): 54-56.

Omoregie E1, Igoche L, Ojobe TO, Absalom KV and Onusiriuka BC (2009). Effect of varyinglevels of sweet potato (*Ipomea batatas*) peels on growth, feed utilization and some biochemical responses of the cichlid (*Oreochromis niloticus*). African Journal of Food Agriculture, Nutrition and development. 9(2): 700-712.

Richter N, Siddhuraju P and Becker K (2003). Evaluation of nutritional quality of moringa (*Moringa oleifera Lam*.) leaves as an alternative protein source for Nile tilapia (*Oreochromis niloticus L*.): Aquaculture, 217: 599-611.

Soltan MA (2005). Partial and total replacement of soybean meal by raw and heat treated linseed meal in tilapia diets. Egyptian Journal of Nutrition and Feeds, 8 (1), Special Issue, 1091-1109.

Wee KL and Ng LT (1986). Use of cassava as an energy source in a pelleted feed for the tilapia, (*Oreochromis niloticus L)*. Aquaculture and Fisheries Management, 17(2):129-138.