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Integration of Fruit and Vegetables in the Food of Oreochromis Niloticus in the Vakinankaratra Region

Rabarison Rindra[1], Ravelomanantsoa Ramanambe Nicole[1],Rabeharitsara Andry Tahina[2], Rakotomamonjy Pierre[1], Koto-te- Nyiwa Ngbolua[2,3],Robijaona Rahelivololoniaina Baholy[1,4]

[1]*Engineering and Industrial Process, Agricultural and Food Systems, Polytechnic High School of Antananarivo, Madagascar*
[2]*Department of Biology, Faculty of Science, University of Kinshasa, Kinshasa, Democratic Republic of the Congo*
[3]*Department of Environmental Sciences, Faculty of Science, University of Gbado -Lite, Gbado -Lite, Democratic Republic of the Congo*
[4]*Laboratory for the valorization of natural resources, Polytechnic High School of Antananarivo, Madagascar*

Abstract: *In order to promote the nutrition of Tilapia in farming, food has been created from traditional raw materials and contains a quantity of banana flour and carrot flour from local production of 3%. We tested the food, which contains 33% crude proteins and 8% lipids, on carp fry, having an initial weight of 99.56 □1.12 gr during 50 days in the Vakinankaratra region, Madagascar. After 50 days of experiment, the final weights of the fish fluctuated between 187.63g and 188.15g depending on the treatments used. The food containing banana flour, carrot, and the control food showed almost similar growth and food transformation rates, with specific growth rates (SGR) of 3.12 %/d and 3.14%/ j as well as a conversion rate of 1.5 and 1.5. Thanks to this test, we were able to observe the impact of bananas and carrots on the development of Tilapia. We will continue to study the use of local agri-food by-products and waste in feeding this fish.*
Keywords: *Oreochromis niloticus; food; peanut meal; fish meal; banana flour; carrot flour; white chub; corn flour.*

I. Introduction

The Nile tilapia, *Oreochromis niloticus*, is one of the Cichlidae originating from a few African endemic species that constitute the basis of freshwater fish farming in the intertropical belt of the globe (Mélard, 2003-2004). Currently, 3300 species of the Tilapia family are recorded throughout the world (Paperna, 1981; Ballarin and Haller, 1981). Among the species inventoried, only 10 play a primordial role in fish farming, including *Oreochromis niloticus* (Mélard, 2003-2004). Tilapias are raised more cheaply in tropical and subtropical countries which have favorable temperatures for growth. In 2004, Tilapia won eighth place among the most popular edible products in the United States of America. In Madagascar, *Oreochromis niloticus* is one of the most consumed fish despite its quality. The exploitation of living marine resources in the aquatic environment began a very long time ago. But, it was done in the form of picking at the beginning as what happened passed on earth before agriculture was created. Often, there is intensive picking, while in return, man has returned nothing to the sea, and stocks are beginning to run out. (Randriamiarisoa, 2009). Therefore, the management of the daily ratio of Tilapia and water parameters breeding is essential. The use of artificial feed in the form of pellets in Aquaculture worldwide is common today. These are high-performance foods that are manufactured to minimize farm operating costs. (Randriamiarisoa, 2009). Thus, the present work consists of demonstrating the possibility of breeding Tilapia in brackish waters and their growth with food from the Vakinankaratra region.

II. Material and Methods

2.1 Experimental procedure

This study was carried out on the hapas installed in an open circuit in Tomboarivo, in the Antsirabe I District, Vakinankaratra Region, located in the highlands of Madagascar.

Table 1. characteristics of the pond

Location	Area (m2)	Dam height (cm)	Dam thickness (cm)	Depth (m)	Slope (%)
Verezambola	100 m2	50	60	60-110	10

2.2 Particularities of the land

The ponds are located at a low bottom, which makes it easy to control the Water. They benefit from the abundant sun, are more or less inclined, and are protected from flooding. Three ponds are located upstream of the rice field; they are essential for storing harvested fish on the one hand and, above all, to be ready for any situation (such as a temporary water cut).

Two diets, such as AT0, were created to feed Tilapia in the growing phase using traditional and unconventional raw materials (and AT1, a control food on the market. In AT0, banana flour and carrot flour are incorporated at rates of 3% (Table 2). The unprocessed ingredients are purchased from the local market and prepared before being crushed and sieved with a 400-micrometer sieve. The ingredients were weighed and mixed for each food until. Until a homogeneous powder was obtained, in which vegetable oil and CMV (mineral-vitamin complex) were added. Subsequently, Water was added to the amount of 60% dry matter in order to obtain a homogeneous powder. 'obtain a paste which can be handled and which, once passed through the die of an extruder, forms filaments of 1.2 mm in diameter (spaghetti). Subsequently, these filaments are divided into small granules. The desired size was dried in a dryer for 45 minutes. Then, they are bagged and stored at room temperature until distributed. **O. *niloticus*** was tested on these foods, with an initial average weight of 99.56 1.12 g (±ES Average Weight). ±The 160 pieces of fish were weighed individually and distributed randomly in 2 hapas of 20 m2, corresponding to 80 fish per batch. This created four triplicate treatments, each given one food item. The fish were stored in the tanks ten days before the start of the experiment in order to adapt them to the new conditions.

Table 2. Biochemical composition of ingredients

Ingredient	Protein	Lipids	Carbohydrates	Humidity	Ash
Fishmeal	58.2	5.02	0.23	8.20	28.35
White chub	61.26	2.07	5.61	11.92	19.14
Peanut cakes	43.01	13.82	27.37	10.23	4.57
Corn flour	8.95	4.02	74.86	11.16	1.01
Cassava flour	1.4	0.59	97.9	1.8	0.019
Banana flour	5.18	0.69	81.78	9.49	2.86
Carrots flour	8.15	1.49	79.55	9.25	1.56

Table 3. Formulation and biochemical composition of diets for Tilapia in magnification

Ingredient	AT0	Ap3
Fishmeal	14.5	unknown
White chub	14.5	
Peanut cakes	30	
Corn flour	19	
Cassava flour	14	
Banana flour	3	
Peanut oil	1.5	
CMV [1]	0.5	
Carrots flour	3	
Nutritional value	**AT0**	**Ap3**
Protein	33.57	34.23
Carbohydrate	40.29	38.94
Lipid	8.14	8.75
Ash	8.66	8.78
Humidity	9.34	9.3
Energy in Kcal	368.7	371.43

1: Mineral and Vitamin Supplement
Vitamin (mg or IU. Kg-1): Vit A, 250,000 IU; Vit D3, 62500 IU; Vit K3, 100 mg; Vit B1, 412 mg; Choline, 2500 IU.
Minerals (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.

During the study, the pond was fed by a water source located 50 meters away and with a temperature of 23.04±1.32°C. The flow rate is 5 to 7 l/min, which means that it is renewed at least once per hour, thus guaranteeing an oxygen level greater than 80% of saturation. The fish were manually fed experimental food at three meals per day, at the times of 9:00 a.m., 12:00 p.m., and 3:00 p.m., for seven days a week. The fish were considered to be satiated when their attention was no longer focused on the pellets. The restriction rates used were 2.8, 2.4, and 2.1% of biomass, depending on temperature. Every ten days, the fish are measured, and the tanks are rotated to remove the effect.

2.3 Biochemical analyzes

Biochemical analyses (proteins, lipids, humidity, cellulose, and ash) were carried out in duplicate according to standard methods at the National Environmental Research Center (CNRE) and concerned with the ingredients *of the four* experimental foods.

- Crude proteins (% NX 6.25) are determined by the Kjeldahl method (Kjel-foss auto-analyzer).
- Fatty acids from lipids are extracted using the hot method (Soxhlet type), extraction by hexane, and distillation.
- The dry matter is determined by measuring the weight loss after drying for 24 hours in an oven at 105°C.
- The ashes are determined after the cremation of the samples in a muffle oven at 550°C for 12 hours.
- The carbohydrate content is determined by the difference in values found for the other constituents of the diets.

2.4 Statistical analysis

For the statistical analysis of the results, the biometric data for each repetition are considered as one observation. These results are compared statistically by one-character analysis of variance (ANOVA) according to the EXCEL software procedure after prior verification of the homogeneity of the variances and the normality of the data to be analyzed. When the ANOVA was found to be significant, the TUKEY test was used for multiple comparisons of means. For these comparisons, the significance threshold of 5% is used. When batches share the same letter (a or b) in the results, this means that there is no significant difference between the batch means. For these comparisons, the significance threshold of 5% is used.

2.5 Water quality monitoring :

The quality of the environment breeding was monitored ***by measuring the*** following physicochemical parameters of Water: pH, dissolved oxygen, conductivity, salinity, and temperature. pH and temperature are measured every day at eight o'clock in the morning and at 2 p.m., respectively, with a pH meter and a thermometer, and the other parameters every three days at 8 a.m. with an oximeter and multifunction thermometer.

2.6 Expression of results :

The settings following zootechnical criteria have been determined:

- Weight Gain (WG, g) = Final Weight (g) – Weight initial(g);
- Daily Weight Gain (DWG, g) = (Final weight (g) – Initial weight (g)) / Number of days of follow-up;
- Specific Growth Rate (SGR, %/d) = (*[* Ln (Final weight (g)) – Ln (Initial weight (g))]) / Number of days of follow-up x 100;
- Survival Rate (SR, %) = 100 x Final Number of fish / Initial number of fish;
- Apparent Food Conversion Index (CI) = Quantity of food distributed (g) / Weight gain (g);
- Condition factor (K)= 100 x Final weight (g) / *(*standard length $)^3$ (cm).

III. Results and Discussion

3.1 Water quality:

Table 3 presents the average values of the physicochemical parameters of the rearing environments. Water temperatures average 22.4±1.12°C at 9 a.m. and 25.8±1.2°C at 3 p.m. These temperatures were observed respectively in all hapas. Regarding dissolved oxygen, it is estimated at *6.08±0.44*. The pH is 7.2±0.42. The Secchi disk has an average depth of *46.46±3.15 and, an* average conductivity of 97µS/cm, an average salinity of 154±0.3ppm. No significant difference is observed between the treatments in the physicochemical parameters of the rearing environments measured during this trial ($p<0.05$).

Table 4. Average values of temperature, dissolved oxygen and pH, conductivity, salinity, and water clarity recorded during rearing

Settings	Dietary treatments			
	AT0	AT1	AT2	AP3
Temperature (*°C)*	*24±1.35*			
Oxygen (*mg/L)*	*6.08±0.44*			
pH	*7.2±0.42*			

Conductivity (µS/cm)	*97±0.9*
Salinity (ppm)	*154±0.5ppm*
Dry disk (cm)	*46.46±3.15*

3.2 Zootechnical parameters

Table 4 presents the zootechnical and food use parameters of ***O.niloticus*** fry after 50 days of aging. The survival percentage is 100%. Fish in the two hapas recorded these rates respectively. In addition, the survival rates recorded during this trial did not show any significant difference (p>0.05). The different dietary treatments resulted in a variation in fish batch condition factors of 1.44 and 1.45. Fish exposed to AT1 food recorded these two extreme values, respectively. However, there is a notable disparity between the condition factors of fish that were subjected to different treatments (p < 0.05). By treatment, final mean fish weights varied, even though initial mean weights were the same. These dimensions varied from 187.63 ±1.02 g and 188.15 ±1.29 γ. It was found that fish subjected to diet AT0 had the lowest weight, while diet AT1 had a slightly higher weight. From 88.13 ±1.36 to 88.95 ±0.97 g/fish, weight gain (WG), specific growth rate (SGR), and daily gain (DWG) experienced respective variations from 3.12±0.45 to 3.14 ±0.11% per day, and from 1.76±0.33 to 1.77±0.61 g/day. Fish fed with AT1 show the highest values of these three parameters, while those fed with AT0 show slightly lower values. However, fish that were fed AT0 and AT1 had very similar final average weight, WG, WG, and DWG values (p >0.05).

In addition, fish fed with AT0 had slightly lower growth performance than those observed in fish fed with AT1. Unlike the survival rates and conditions, the results reveal significant disparities (p<0.05) between the growth performances in the batches of fish that received the four dietary treatments. According to the evolution of the weight of the fish exposed to the different forms of food presentation (Figure 1), the growths are practically identical during the 50 days in the fish exposed to the two types of food.

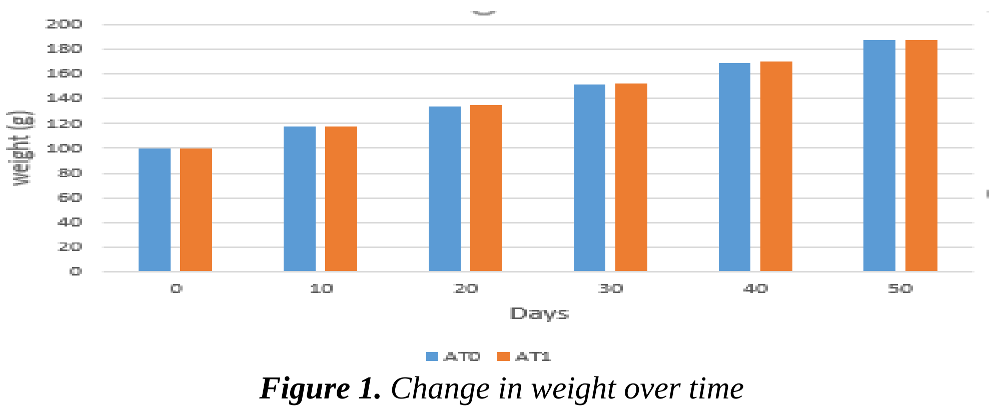

Figure 1. *Change in weight over time*

Concerning the feed conversion index (CI), the values were 1.5 for both batches. The data concerning the feeding parameters of the fry reveal significant disparities (p<0.05) between the foods consumed by the batches of fish fed. It is observed that the K factor varies from 1.44 to 1.45, and the values obtained are all different. We obtain the maximum with AT1 and the minimum with AT0.

Table 5. Zootechnical parameters in juveniles of ***O.niloticus*** subject to different forms of food presentation for 50 days

Zootechnical parameters	**Food**	
	AT0	AT1
Average initial weight (g)	99.57 ±0.68 ^{a}	100.2 ±0.14 $^{\alpha}$
Average final weight (g)	187.63 ±1.02 ^{a}	188.15 ±1.29 $^{\beta}$
WG(g)	88.13 ±1.36 $^{\alpha}$	88.95 ±0.97 $^{\alpha}$
DWG (l/d)	1.76 ±0.33 $^{\alpha}$	1.77 ±0.61 $^{\alpha}$
SGR(g)	3.12 ±0.45 ^{a}	3.14 ± $^{0.11a}$
CI	1.5	1.5
SR (%)	100	100
K	1.44	1.45

On each line, the values (average± ESM, n = 3) assigned by different letters (a, b) are significantly different (P = .05), according to the Tukey test. The presence of the same letter on the same line indicates an absence of significant difference (P = .05).

Discussions

Water temperature is the most important parameter for the life of aquatic fauna, especially fish. The temperatures recorded during this study vary from 24°C to 28°C; this is equivalent to those of hot waters, according to Kiener in 1963. The *thermal tolerance* limit for this species of fish is 6.7°C at 41°C; this is what we call the extreme value of acclimation (Denzer, 1967 and Lee, 1979). So, the temperature values observed during this study are not lethal to fish. The growth of ***Oreochromis niloticus*** depends on the temperature; that is to say, that more the higher the water temperature, the faster the growth of the fish, and they often develop more quickly if the average daily water temperature is between 25 and 30° C (Lietar, 1984). The temperature values recorded during this study are beautiful and well-included in the growth temperature range of ***Oreochromis nilotius.***

The dissolved oxygen content varies from 2.5 mg/l to 4.1 mg/l. This variation is due to the exposure of Water to the sun and the intensity of photosynthesis carried out by plants. Aquatic in ponds during the day. The decrease in oxygen content dissolved is due to the increase in water temperature. The solubility of oxygen in Water is related to several factors, the most important of which is temperature. Indeed, as the temperature rises, the dissolved oxygen content decreases due to its low solubility. Oxygen dissolves less well in hot water than in cold water, whereas fish need more oxygen in warm Water. During the study period, the average oxygen concentration was 6.08 mg/l, and the tolerance limit for fry survival was two mg/l (Welcomme, 1967). The rates recorded for hapas this value of the dissolved oxygen content is greater than the interval from 2 mg/l to 4 mg/l compatible with the survival of aquatic living beings, especially Pisces. However, the required threshold is 2-3 mg/l (Desprez, 2004), which means that the Water used by the Station is suitable for fish farming.

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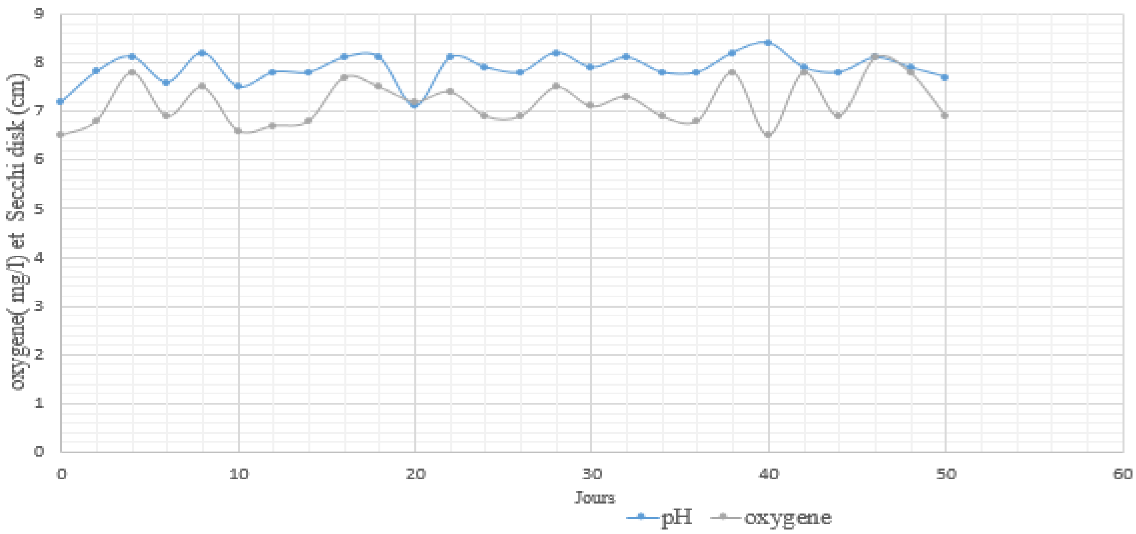

Figure 2*. Evolution of pH and oxygen levels.*

pH is a factor representative of Water's acidity and basicity. According to the values of the results obtained (6.6 to 7.8), the waters in this fish farming station are at neutral pH. In addition, these values are included in the tolerance limit, which is 5 to 11, according to Chervinski (1982). These values are included in the pH range compatible (5 to 9) with the life of aquatic animals such as fish (Schaperclaus, 1962; Rabenandrasana, 1998).

According to Rodier et al. (2009), measuring conductivity makes it possible to quickly evaluate the very approximate way the overall mineralization of Water and to follow its evolution. The measured conductivity level varies from 95 µS /cm to 98 µS /cm. According to Rodier et al. (2009), a conductivity less than 100µS/cm indicates very weak mineralization, characteristic of fresh waters. According to Alcántar-Vázquez et al. (2014), salinity mainly corresponds to the concentration of mineral salts dissolved in Water. The pond has a maximum salinity of 160ppm, while the lowest value is 146ppm. According to March (1999), salinity Water in ponds is normal because all Tilapia are sensitive to salty Water.

According to several authors, the consumption indices obtained are 1.5, unlike those of 1.7 to 3.0 reported for diets that include more than 25% of unconventional protein sources to replace fish meal. It is about even for the *Leacaena* or Copra, as well as for peanut, cotton, or soya (Jackson et al., 1982) and Azolla (Carraro, 1983). In this experiment, a high specific growth rate is observed on *O. niloticus*, ranging from 2.77% d-1 to 3.16%. D-1. In mixed breeding of *O. niloticus* with *C. gariepinus*, the highest growth rate (3.98% d-1) is similar to that observed by Middendorp (1995). However, these particular growth rates are lower than those obtained by Antoine et al. (1987) and Micha et al. (1988).

The survival rates recorded (75 to 94%) are satisfactory. These results (growth and survival) would confirm the good quality and nutritional value of the foods tested. Indeed, Campbell (1978) indicates that some foods rich in carbohydrates would lead to savings in protein utilization.

Figure 3. *Weight control during 10th days of rearing*

The growth recorded in this study is comparable to those obtained by Davis & Stickney (1978). Indeed, these authors did not observe any difference in performance growth in Tilapia *Oreochromis aureus* fed with two foods, one of which contained fish meal and the other without fish meal fish, but containing 74% fish meal soy.

Daily weight gains are low, 0.10 gd-1 on average, but very low compared to those of 1.65 gd-1 obtained by Kanangiré (2001) in a pond with foods comprising plants and the like and those of 0.7 gd-1 obtained by Breine et al. (1995) on *O. niloticus* fed on rice bran in a pond in Cameroon. However, our low values of daily weight gain are largely greater than those of 0.05 gd-1 to 0.02 gd-1 obtained by Fiogbé et al. (2004) in the same breeding systems.

IV. Conclusion

According to this study, the use of fruit and vegetables in food leads to fish production that is equivalent to that of commercial floating pellets. The use of fruits and vegetables in tilapia feeding offers a beneficial approach on several levels. Not only does it diversify their diet, but it also provides essential nutrients for their health, thereby promoting their growth and overall well-being. In addition, this practice helps promote more sustainable aquaculture by using renewable natural resources.

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