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Formulation of Feeds Intended For Livestock of *Cyprinus Carpio* in the Vakinankaratra Region, Madagascar

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Abstract:

To promote the nourishment of carp in farming, four foods have been created from traditional raw materials and contain different quantities of locally produced banana flour 3%, 6%, and 10%. We tested these foods which contain 36% crude proteins and 8% lipids on carp fry with an initial weight of 9g. After 50 days of the experiment, the final weights of the fish fluctuated between 121.53g and 122.45g depending on the treatments used. The food containing 10% banana flour and the control food showed the highest growth and food transformation rates, with specific growth rates (SGR) of 5.18%/d and 5.14% /d as well as a conversion rate of 1.17 and 1.15 while the food with 6% banana flour obtained an SGR of 5.15 and a conversion index (CI) of 1.15 while that the food with 3% obtained an SGR of 5.14 and a CI of 1.16. Thanks to this test, we were able to observe the impact of bananas on the premature development of tilapia. We will continue to study the use of local agri-food by-products and waste in feeding this fish.

Keywords:
Cyprinus carpio; food; Fishmeal; White chub; Peanut cakes; Corn flour; Cassava flour; Banana flour; Peanut oil.

I. Introduction

Global demand for fish has seen a significant increase over the past 50 years (FAO, 2012). Fish is a food of animal origin most appreciated by consumers thanks to its organoleptic qualities (Ranson, 2003) and its values nutritional (Vandeputte, 2009). It has proteins with high nutritional value, lipids especially polyunsaturated fatty acids, vitamins and mineral elements beneficial for the organism (Vandeputte, 2009). Fish farming of the common carp ***Cyprinus carpio*** already existed since the Middle Ages (Kiener & Therezien, 1963). In 2005, global carp production reached 7.75 million tons. It occupies an important place in the production of freshwater fish worldwide (FAO, 2012).

Before the 1800s, fishing was the source of fish species in Madagascar (Kiener & Therezien, 1963). Faced with strong demographic growth, the supply of fish can no longer satisfy demand in the Highlands region. The idea of doing Fish farming began to meet local demand for fish around the 1920s (Kiener & Therezien, 1963).

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In Madagascar, fish farming is a booming sector given the low number of producers with 516 legal fish farmers (APDRA, 2018). Carp were introduced to the island in 1914 by Dr Legendre (Kiener & Therezien, 1963). ***Cyprinus carpio*** is one of the major species of fish farming in the Highlands since the eco-climatic conditions are favourable to its biology and it is easy to raise (Andriamananjara, 2015). According to Ranson (2003), the major problem in livestock farming is the low productivity of livestock. carp with a slow growth rate and low survival rate due to its mode power supply. Previously, kitchen waste and manufactured feed, from simple raw materials available locally, by the fish farmers themselves were used to feed fish (Julian et al., 2016). However, although the carp appears among the highest species, no investigation has been carried out to determine the performance of fruits used by fish farmers on the growth of ***Cyprinus carpio***. This is how this study is carried out to analyze their effects on the growth of the carp. The general objective of this study is to determine the effectiveness of performance zootechnics of carp between quads. To achieve this, two specific objectives were set; the first is to compare the zootechnical performance, namely the survival performance and growth of carp ***Cyprinus carpio*** fed.

II. Reserach Methods

2.1 Experimental procedure

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

Table 1. Pond characteristics

Location	A rea (m^2)	Dam height (cm)	Dam thickness (cm)	Dep th (m)	Slo pe (%)
Verezam bola	1 23	50	60	60-120	10

The characteristics of the pond had to be given to better define the related studies.

2.2 Terrain characteristics

The ponds are located at a low bottom where it is easy to control the water. They benefit from the abundant sun, are more or less inclined, protected from flooding. Two 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).

Four isoprotein diets (36%), such as AC0, AC1, AC2 and AX3, were created to feed pre-growing Tilapia using traditional raw materials (Table 1). In these diets, banana flour is gradually incorporated at rates of 3%, 6% and 10% (Table 2). Unprocessed ingredients are purchased from the local market and prepared before being ground and sifted with a 400-micrometre sieve. The ingredients were weighed and mixed for each food until a homogeneous powder was obtained, to which vegetable oil and CMV (mineral-vitamin complex) were added. Subsequently, water was added at a level of 60% dry matter to 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 of the desired size and dried in a dryer for 45 minutes. Then they are bagged and stored at room temperature until distributed. Juvenile ***Cyprinus carpio*** carp were tested on these foods, with an initial average weight of 9.25±0.37 g (□ ES average weight). The 200 pieces of fish were weighed individually and randomly distributed into 4 hapas of 20 m2, corresponding to 50 fish per batch. This created four triplicate treatments, each given one food item. The fish were stored in the tanks 10 days before the start of the experiment to adapt them to the new conditions.

Table 2. Biochemical composition of ingredients

Ingredient	Protein	Lipids	Carbohydrates	Humidity	Ash
Fishmeal	58.20	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	1.40	0.59	97.90	1.80	0.02
Banana flour	5.18	0.69	81.78	9.49	2.86

Table 3. Formulation and biochemical composition of diets for pre-growing carp fry

Ingredient	AC0	AC1	AC2	AX3
Fishmeal	14.5	15.0	14.5	unknown
White chub	14.5	15.0	14.5	
Peanut cakes	30.0	30.0	30.0	
Corn flour	22.0	22.0	18.0	
Cassava flour	14.0	11.0	11.0	
Banana flour	3.0	6.0	10.0	
Peanut oil	1.5	1.5	1.5	
MVS [1]	0.5	0.5	0.5	
Nutritional value	**AC0**	**AC1**	**AC2**	**AX3**
Protein	36.26	36.65	36.4	36.39
Carbohydrate	36.91	36.64	36.79	37.26
Lipid	8.48	8.27	8.83	8.47
Ash	9.84	9.49	9.07	8.78
Humidity	8.57	8.95	8.91	9.10
Energy in Kcal	369	367.59	372.23	370.83

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 4 to 6 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 7 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 the ingredients, the 4 experimental foods

- Crude proteins (% NX 6.25) are determined by the Kjeldahl method (Kjel-foss auto-analyzer).
- Fatty acids from lipids by 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 difference from the 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.

2.5 Water quality monitoring

The quality of the environment breeding was monitored from the measurement of 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 morning and 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 following settings based on zootechnical criteria have been established*:*

- Weight Gain (WG, g) = Final Weight (g) – Initial Weight (g)*;*
- Daily Weight Gain (DWG, g) = (Final Weight (g) – Initial Weight (g)) / Number of days of follow-up*;*
- Specific Growth Rate (SGR, %/d) = [(Fw (Final Weight (g)) – Iw (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 (cm)) $^{3.}$
- Daily Length Gain (DLG, cm/d) = (Final Length (cm) – Initial Length (cm)) / Number of days of follow-up
- Length gain (LG (cm)) = (Final length (cm) – Initial length (cm)
-

III. Results and Discussion

3.1. Results

a. Water quality

Table 3 presents the average values of the physicochemical parameters of the rearing environments.

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

Settings	**Dietary treatments**			
	AC0	AC1	AC2	AX3
Temperature (°C)	23.04 ± 1.32			
Oxygen (mg/L)	6.56 ± 0.34			
pH	7.13 ± 0.47			
Conductivity (µS/cm)	97 ± 0.8			
Salinity (ppm)	152 ± 0.3			
Secchi disk (cm)	39.23 ± 2.61			

Water temperatures average 23.1±1.12°C at 9 a.m. and 25.3±1.3°C at 3 p.m. These temperatures were observed respectively in all hapas. Regarding dissolved oxygen, it is estimated at 6.56±0.34. The pH is 7.13±0.47. The Secchi disk has a depth of 39.23±2.61 and an average conductivity of 97µS/cm, an average salinity of 152±0.3ppm and an average depth of 42 cm. No significant difference is observed between the treatments in the physicochemical parameters of the rearing environments measured during this trial ($p<0.05$).

b. Zootechnical parameters

Table 4 presents the zootechnical and food use parameters of ***C.Carpio*** fry after 50 days of ageing. The survival percentage is 100%. Fish in all 4 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 the condition factors of the fish batches, ranging from 2.47 to 2.49. Fish exposed to ACO and AC2 foods 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, the final mean weights of fish experienced variation, even though the initial mean weights were the same. These dimensions varied from 121.53 ± 1.46 to 122.45 ± 2.51g. It was found that fish subjected to diet AC0 had the lowest weight, while diet AC2 had the highest weight.

From 112.24 ± 1.45 to 113.1 ± 2.8 g/fish, weight gain (WG), specific growth rate (SGR) and daily gain (DWG) experienced respective variations of 5 .14 ± 0.005 to 5.18 ± 0.05% per day, and from 2.24 ± 0.02 to 2.26 ± 0.05 g/day. Fish fed with AC2 and AX3 showed the highest values of these three parameters, while those fed with AC1 showed the lowest values. However, fish that were fed AC2 and AX3 had very similar PMF, GP, TCS and GPQ values ($p >0.05$).

Length progression (LG) and daily length progression (DLG) varied from 8.94 ± 0.53 to 9.11±0.63 cm/fish, respectively; 0.17 ± 0.02 to 0.18 ± 0.01 cm/day. Fish fed AC2 showed the highest values, while those fed AC1 showed the lowest values.

In addition, fish fed with AC0 had lower growth performance than those observed in fish fed with AC1 and AC2, as well as in AX3 controls. Unlike the survival rates and conditions, the results reveal significant disparities ($p<0.05$) between the growth performances in the batches of fish which received the four dietary treatments. According to the evolution of the weight of the fish exposed to the different forms of food presentation (Figure 2), the growths are practically identical during the first 10 days in the fish exposed to the four types of food. However, a slight increase in weight is observed in fish submitted AC1, AC2 and AX3 from the 10th day of rearing.

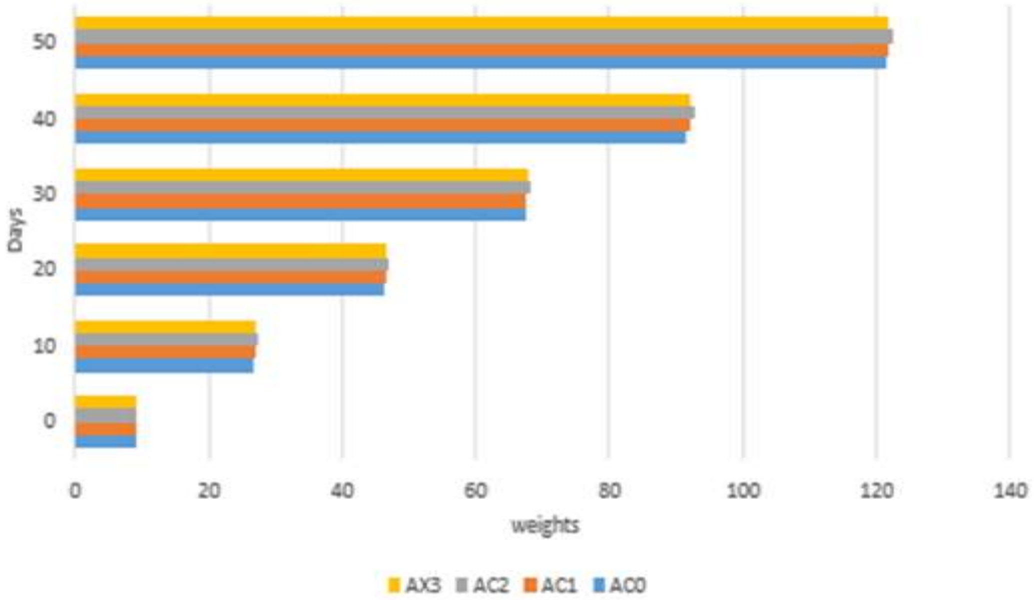

Figure 1. *Change in weight over time*

Regarding the food conversion index (CI), the different values varied from 1.15 to 1.17. Although the ICs of fish subjected to AC1 and AX3 and blocks showed no significant difference, fish subjected to AC2 obtained the highest values, while fish subjected to AC1 obtained the lowest values. 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 2.47 to 2.49, and the values obtained are all different. We obtain the maximum with AC2 and the minimum with AC1.

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

Zootechnical parameters	Food			
	AC0	AC1	AC2	AX3
Initial Weight(g)	9.28 ± 0.26[a]	9.25 ± 0.49[a]	9.35 ± 0.42[a]	9.2 ± 0.30 [a]
Final Weight (g)	121.53 ± 1.46[a]	121.8 ± 1.34[b]	122.45 ± 2.51[c]	121.8 ± 3.64 [b]
WG (g)	112.24 ± 1.45 [a]	112.55 ± 1.65 [b]	113.1 ± 2.8[c]	112.68 ± 3.45 [b]
DWG (g/d)	2.24 ± 0.02 [a]	2.25 ± 0.03[b]	2.26 ± 0.05[c]	2.25 ± 0.06[b]
SGR(g)	5.14 ± 0.05	5.15 ± 0.12	5.14 ± 0.11	5.18 ± 0.05
CI	1.16	1.15	1.17	1.15
SR (%)	100	100	100	100
K	2.47	2.47	2.49	2.47
Initial Length (cm)	8.3 ± 0.26[a]	8.49 ± 0.27[b]	8.56 ± 0.17[a]	8.31 ± 0.20[a]
Final Length (cm)	17.25 ± 0.45[a]	17.43 ± 0.31[a]	17.67 ± 0.61 [b]	17.33 ± 0.42[c]
LG (cm)	8.95 ± 0.53[a]	8.94 ± 0.39[b]	9.11± 0.63[c]	9.02± 0.52[b]
DLG (cm/d)	0.17 ± 0.01[a]	0.17 ± 0.007[a]	0.18± 0.01[a]	0.18± 0.01[a]

3.2 Discussions

The temperatures recorded during this study vary from 20°C to 26°C with an average of 23.04 ± 1.32 °C in the ponds. Their Maximum temperature is observed at the end of the study. This temperature variation is caused not only by the duration of sunshine but also by its high intensity. According to Lwamba (2015), temperature variations of water in ponds follow the periodicity imprinted by sunrise and sunset. These results are those obtained by Kiener and Therzien (1958) who assert that the variation of water temperature in ponds is closely linked to radiation solar. According to Rabemazava (1986), the fermentation of organic matter increases the temperature. This increase in temperature would have advantages on growth.

Water temperature is the most important parameter for fish life because, in a so-called physiological temperature range, the growth of the carp is important (Brett, 1979). Optimal carp growth is within a temperature range ranging from 20 to 30°C (Billard, 1995). The temperatures recorded in this study are found within the optimal range that allows ***Cyprinus carpio*** to have a good growth rate and to move freely in the water in search of food.

The pH values recorded at the pond level are 6.3 to 8.3 with an average of 7.13 ± 0.47. These pH values between 6 and 7 characterize the continental waters of Malagasy (Lemasson, 1975). Tiwary et al., (2013) showed that pH is one of the factors favoring the development of carp in breeding. The pH of the water during this study is suitable for the development of carp since according to Arrignon (1976), the pH between 6.5 and 8.5 is optimal for life and fish growth.

Barthelemy and Goubier (1991) show that the high oxygen value dissolved from the start of pond rearing would be due to the activity of phytoplankton since the source of the main source of dissolved oxygen in water is related to photosynthesis. However, these minimum dissolved oxygen levels do not affect either the survival or growth of the carp because according to Billard (1995), this species can survive with a level between 1 and 5 mg/l of dissolved oxygen in permanent exposure.

In general, in this study, all physicochemical parameters of water are within recommended optimal value ranges and they do not threaten the growth and survival of carp. According to Bard (1974), the growth of carp placed in good conditions is fast.

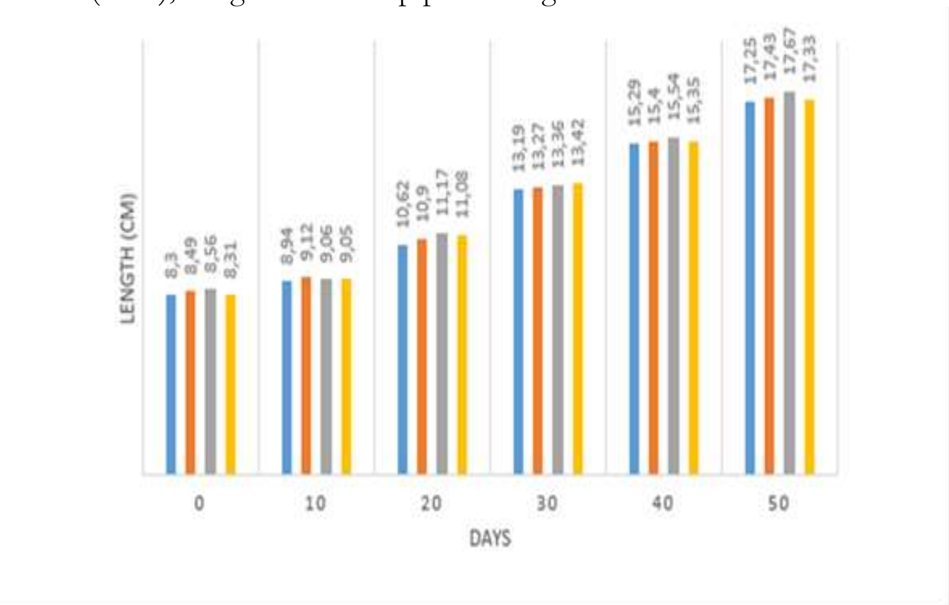

Figure 2. *Evolution of length over time*

According to Rodier et al. (2009), measuring conductivity makes it possible to quickly but very approximately assess the overall mineralization of water and to monitor its evolution. The measured conductivity level varies from 95 µS /cm to 98 µS /cm. According to Rodier et al. (2009), a conductivity lower than 100µS/cm indicates very weak mineralization, characteristic of fresh water. 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.

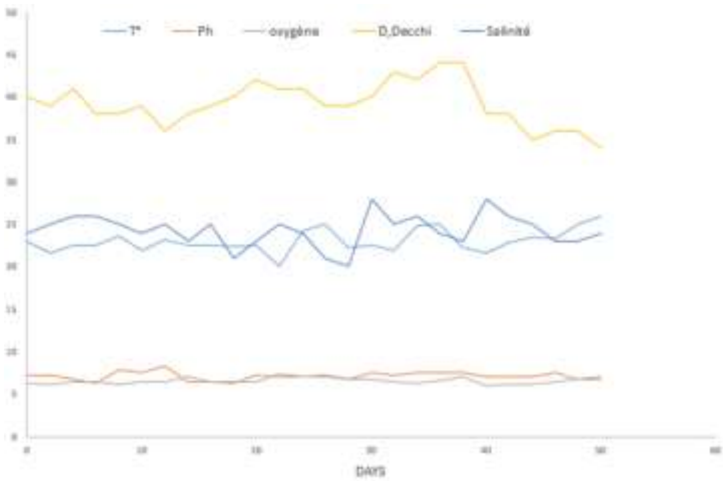

Figure 3. *Change in water quality over time*

The results obtained show a carp survival rate of 100%; There's no mortality encountered during the breeding cycle. A survival rate of 90% is generally accepted in fish farming (Ramorasata, 2007). Rakotoambinina (1997) found a survival rate of 96%. Therefore, our results lie within the accepted standard and are satisfactory compared to other studies. Several factors could explain this very high survival rate. All the breeding conditions for the ***Cyprinus carpio*** carp are well respected, in the occurrence of the stocking density. The Imanpoor Team (2009) shows that rearing density is inversely proportional to carp survival. Their density is linked to the increase in interactions between individuals and the stress they generate; too high a density reduces the distance between individuals below the distance minimum acceptable level leading to repeated attacks between individuals with bites, loss of eye and death (Brett, 1979).

In all ponds, the values of the condition parameter K have a value average of 2.48 (greater than 1) during the complete cycle. That means that the breeding environment presents an optimal living condition for the growth and survival of ***Cyprinus carpio*** (physico-chemical parameters, density, food) and gives body weight fishes. Nantenaina (2013) recorded a value of K = 1.47 lower than that found in this study; she only used rice bran and cassava as carp food. Dietary composition also determines overweight according to Preon (2012).

In fish fed with AC0 feed, the Conversion Index CI = 1.16 means that 1.16 kg of feed A would be enough to produce 1 kg of carp whereas with feed AC1, AC2, AX3, CI = 1.15, it would take 1.15 kg of feed to produce the same weight of fish. New (1987) showed that a CI less than 4 reflects good feed efficiency. According to Vandepute and Launey (2004), the first criterion which interests fish producers is a good Food Conversion Index.

The average daily gains obtained in the present study are higher than those obtained by Pouomogne (1998) who found a DWG of 4.10 g/d in 6 months. The average daily gains of carp according to the FAO (1980) is between 2 to 4% of its weight. So the DWG value of this study exceeds established standards. However, this TCS is higher than that found by Farid et al. (2017) which obtains an SGR of 0.8 g/day. Wahab et al. (2003) suggest an optimal content of 30 to 40% protein in the diet of carp food to stabilize its growth. In the present study, the content of Protein from these 4 sources falls into this interval. Therefore, the growth gap observed could be linked to the different protein levels in the two sources. Mohapatra and Patra (2014) show that food has a very clear influence on fish weight.

Carps fed with the 4 types of feed have positive growth. The values show that the carp have grown much more in live weight than in length; the fish are therefore heavy (Wotton, 1999). This is due to the sufficient availability of food and the population density standard in this study (Moreau, 1988).

IV. Conclusion

According to this study, the use of fruit in food leads to fish production equivalent to that of commercial floating pellets. The use of fruit in carp diets 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. In the future, it would be interesting to further research into other, much more suitable types of fruits and the distribution and formulation technique to maximize the nutritional benefits.

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