Original Research Article

Influence of fish farming on the fish growth in five farms of the Central-Western of Côte d'Ivoire.

ABSTRACT

This is a comparative study of the management of 5 fish farms in the main production area of Central-Western in Côte d'Ivoire. Farms have been visited on september 2017 and all fish farmers sexing fish late. The farmers are all over 45 years old men. The by-products (rice bran and low flour) are used for feeding on all farms, but only Bahompa 2 farm, makes a supplement with the industrial food. Fish growth parameters have been taken with 200 findividuals of *Oreochromis niloticus* per farm (1000 fish). The best performance of the fish was recorded on the Bahompa 2 farm (DWG = 1.54 ± 0.47g/day, SGR = 2.04 ± 0.36%/day and K = 1 ± 0.01. In Yopohoué farm, a DWG = 1.18 ± 0.31g/day, with SGR = 1.81 ± 0.3%/day, and K = 1 ± 0.01 were obtained. DWG= 0.89 ± 0.72 g/day, with SGR = 1.15 ± 0.46%/day and K = 0.99 ± 0.04 were recorded in Bahompa 3 farm. In Bahompa 1 farm, DWG = 0.68 ± 0.19 g/day, SGR = 2.02 ± 0.41%/day and K = 1 ± 0.1 were observed. A DWG = 1.11 ± 0.18g/d, with a SGR = 1.21 ± 0.11%/day and then K = 1 ± 0.98 were observed in Sanepa farm. The allometric coefficients (b <3) reflect a slow growth of these fish. These low parameters indicate living stress of *Oreochromis niloticus* fishes during their breeding.

Keywords: *Oreochromis niloticus*, allometric coefficient, fish farm, Côte d'Ivoire.

1- INTRODUCTION

In developing countries, fish is often the only source of animal protein accessible to the most disadvantaged populations [1]. In Côte d'Ivoire, average per capita fish consumption is estimated at 15 kilograms per year [2]. However, annual fish production estimated at 70 000 tonnes (of which 1. 57% by aquaculture) covers barely 23% of requirements, hence the need for a massive import of frozen fish to satisfy national needs [3].

Because of the difficulty of supplying fish, fish farming has emerged as an unavoidable path through the intensification of tilapia farming to reduce animal protein deficiency [4]; [5]. Indeed, tilapias are the predominant species of commercial fish farming in Africa [6]; [7] and have great economic and ecological importance on African waterways [8]; [9]; [10]; [11]. They also represent the highest and most valued species by fish farmers and consumers [12]; [13] because of its hardiness, its ease to be raised in fresh water.

However, [14] and [15] indicate that the major constraints to the emergence of fish farming are high cost nutrition and the lack of national fish farming policies. In fact, fish farmers are confronted with certain problems, in particular the low yields of fish farming activities linked to the difficulties of feeding fish and the lack of fry, the weakness of technical supervision and the low funding of the sector [16].

As part of this dynamic, this study aims to evaluate the management methods of fish farms in the main production region of Central West of Côte d'Ivoire and the fish growth parameters, for improving the productivity of tilapia *Oreochromis niloticus*.

2- MATERIAL AND METHODS

The work was carried out from August to September 2017 through fact sheets used to collect informations on the socio-economic profile of the farmers, fish feed and aquaculture practices of the five fish farms studied. Data were collected from five farms in the Goh region where farms visited are located in the Bahompa, Sanepa and Yopohoué villages.

A 6 mm mesh seine was used to catch 200 fish at each farm (total of 1000 fish) that were weighed to the nearest gram and measured to the nearest mm and used to determine the fish growth parameters such as the daily weight gain (DWG), average weight gain (AWG), specific growth rate (SGR) and relative condition factor (K).

Subsequently, thirty (30) fish selected from each farm for a total of 150 fish were sent to the laboratory of the Oceanologic Research Center (CRO) in Abidjan. They were weighed with a precision 0.01 g KERN electronic scale and measured with a 0.01 mm precision graduated icthyometer to study the length-weight relationship.

2-1. Farms caracteristics

The technical characteristics concerning the socio-economic profile of the farmers, fish feed, aquaculture practices and aquaculture facilities of each farm have been raised.

2-2. Fish growth parameters

The zootechnical parameters calculated below let to evaluate the growth of fish according to their age in the different farms visited.

a. Daily Weight Gain (DWG)

The daily weight gain expressed in gram per day (g/d), indicate the daily weight growth rate; DWG = (Final weight (g) - Initial weight (g))/Feeding duration (d).

b. Average Weight Gain (AWG)

The average weight gain expressed in gram (g), indicates the weight gain of the fish of the different farms after any breeding period through the formula:

AWG = Final average weight - initial average weight.

c. Specific Growth Rate (SGR)

The specific growth rate expressed as a percentage (%/d), also indicates the daily weight growth rate: SGR = [(ln (Pf) - ln (Pi) / Breeding time in days)] × 100 ;

With ; Pf: final weight and Pi: initial weight.

d. Length-weight relationship

The length-weight relationship that express the growth relationship between fish weight (p) and standard length (Ls) is estimated by the mathematical expression: $P = a.L^b$; where **a** expresses a constant in the growth equation and **b,** the growth allometry.

The student's statistical test t was used to test the differences between the values of **b** and the theoretical value 3.

e. Relative condition factor (K)

The relative condition factor (K) that allows to determine the physiological state of fish, including it's reproductive capacity and the influence of habitat on the species is used.

$K = [W / Ls^3] \times 100$; W: weight of the fish ; Ls: standard length of fish

Statistical treatments were carried out on Average Weight Gain (AWG), Daily Weight Gain (DWG), Specific Growth Rate (SGR) through a one-way analysis of variance (ANOVA 1) with the R 3.2.1 software.

3- RESULTS AND DISCUSSION

3-1. Farm characteristics

Only Bahompa 2 Farm is owned by a cooperative, composed of 38 members, with average age of 40 years. This farm is 11 years old, spread over 3 hectares area and includes a dam and eight (08) ponds. The other 4 farms are individual, 2 are properties of agricultural producers and the 2 others are for retired civils. The bahompa 1 farm is 8 years old of existence, covers an area of 2.5 hectares with 2 dams and 4 ponds and is managed by a farmer aged 50 years old. Similarly, the Bahompa 3 farm is 26 years old and has spread over three (3) hectares, made up of four (4) dams and ten (10) ponds, and is managed by a 57 year-old farmer. The Yopohoué and Sanepa farms, respectively 17 and 23 years old, are managed by their owners who are retired civils, with each 63 years old. The Yopohoué farm is composed of 2 dams and 4 ponds, and the Sanepa farm has 4 dams and 10 ponds, each extending over 2.5 hectares. Ponds are all bypassed dams.

The fish are fed at will, with rice bran, and the fry are kept in the breeding ponds until sexing, after 3 months, with respective average weights at 25.55 g (Bahompa 2 farm), 29, 2 g (Bahompa 3 farm), 30.55 g (Sanepa farm), 32.5 g (Bahompa 1 farm) and 35.1 g (Yopohoué farm). The average weight of the fish after one year of breeding, vary from 350 g to 500 g and are sold at the price of 1200 CFA (1.82 €) per kilogram concerning Yopohoué farm, Bahompa 3 farm and Bahompa 1 farm. Those of the fish of Bahompa 2 farm are of 400 g after 9 months of breeding and sold at 1500 CFA (2.28 €) per kilogram, while at the Sanepa farm, the average weight at 10 months of breeding is 350 g and are sold at a price of 1500 CFA (2.28 €) per kilogram.

3-2. Fish growth parameters

The table below presents the different parameters of fish growth according to their age, in each farm.

a- Daily Weight Gain

The daily weight gain is higher on the Bahompa 2 farm (DWG = 1.54 ± 0.47 g/d, followed by the Yopohoué farm (DWG = 1.18 ± 0.31 g/d), then Sanepa Farm (DWG = 1.11 ± 0.18 g/d), Bahompa 3 Farm (DWG = 0.89 ± 0.72 g/d) and Bahompa 1 Farm (DWG = 0.68 ± 0.19 g/d).

b- Average Weight Gain

The average weight gain show higher value on the Sanepa Farm (AWG = 195,2± 33,38 g), followed by Bahompa 2 Farm (AWG = 138,71± 42,57 g), Bahompa 3 Farm (AWG = 117,29± 97,95 g), then Yopohoué farm AWG = 97,05± 28,33 g), and lower (AWG = 54,59± 17,62 g) for Bahompa 3 Farm.

c- Specific Growth Rate (SGR)

The mean of the recorded Specific Growth Rates indicate higher values for the Bahompa 2 farm (SGR = 2.04 ± 0.36%/d) and Bahompa 1 farm (SGR = 2.02 ± 0.41%/d) , lower on the Yopohoué farm (SGR = 1.81 ± 0.3%/d) then lower on the Sanepa farms (SGR = 1.21 ± 0.11%/d) and Bahompa 3 farm (SGR = 1, 15 ± 0.46%/d).

d- Length-weight relationship

- Length-weight relationship in Bahompa 3 Farm

The length-weight relationship of specimens of *Oreochromis niloticus* at the Bahompa 3 Farm have a size distribution ranging from 10 cm to 20.2 cm with an average of 14.06 ± 3.33 cm after 135 days of aging. Their weight varies from 50.6 g to 351.7 g. The average weight is estimated to 146.49 ± 98.69 g.

The weight-length relationship is expressed by the following equation: $P = 1.2832LS^{1,3638}$, ($R^2 = 0.84$) (figure 1). According to the statistical test of student (t), the value of (b = 1.36) is less than 3 (p = 0.05). These fish have a minor allometry, showing a growth in length higher than in weight.

- Length-weight relationship in Bahompa 1 farm

Specimens of *Oreochromis niloticus* from Bahompa 1 farm have a size distribution ranging from 11 cm to 13.7 cm with an average of 12.5 ± 0, 82 cm after 62 days of rearing. Their weight varies from 59.4 g to 112.1 g. The average weight is estimated to 87.09 ± 17.56 g.

The length-weight relationship is expressed by the following straight line equation: $P = 0.9216LS^{1.6994}$, ($R^2 = 0.88$) (figure 2). According to the student's statistical test (t), the value of (b = 1.69) is less than 3 (p = 0.05). The fish have a minor allometry indicating a growth in weight slower than in length.

- Length-weight relationship in Bahompa 2 farm

Oreochromis niloticus specimens from Bahompa 2 farm have a size distribution ranging from 12 cm to 17.6 cm with an average of 15.43 ± 1.33 cm at 92 days of age. Their weight varies from 93.8 g to 236.6 g. The average weight is estimated to 164.26 ± 41.67 g.

The weight-length relationship is expressed by the following equation: $P = 1.0258LS^{1.5885}$, ($R^2 = 0.93$) (figure 3). According to the student's statistical test (t), the value of (b = 1.58) is less than 3 (p = 0.05). These fish have a minor allometry indicating that their growth in length is faster than in weight.

- Length-weight relationship in Sanepa farm

Specimens of *Oreochromis niloticus* from Sanepa farm have a size distribution ranging from 15.2 cm to 18.6 cm with an average of 17.2 ± 0.82 cm after 183 days of culture. Their weight varies from 156 g to 312.5 g. The average weight is estimated to 225.75 ± 33.25 g.

The length-weight relationship is expressed by the following equation: P = 1.2975LS1.3658, (R2 = 0.74) (figure 4). According to the statistical test of student (t), the value of (b = 1.36) is less than 3 (p = 0.05). The fish have a minor allometry indicating a growth in weight slower than in length.

- Length-weight relationship in Yopohoué farm

Oreochromis niloticus specimens from Yopohoué farm have a size distribution ranging from 12.2 cm to 17 cm with an average of 15 ± 1.26 cm after 92 days of age. Their weight varies from 78 g to 189.3 g. The average weight is estimated to 132.15 ± 28.02 g.

The weight-length relationship is expressed by the following equation: $P = 1.1665LS^{1.433}$, (R2 = 0.94) (figure 5). According to the student's statistical test (t), the value of (b = 1.43) is less than 3 (p = 0.05). The fish have a minor allometry showing a growth in weight slower than in length.

e- Relative condition factor (K)

The mean values of observed relative condition factors are K = 0.99 ± 0.04 on Bahompa 3 farm, K = 1 ± 0.98 (Sanepa farm), K = 1 ± 0.98 (Bahompa 1 farm) and K = 1 ± 0 , 01 (Bahompa 2 farm), then K = 1 ± 0.01 (Yopohoué Farm). These values provide

information on the reproductive capacity of these fish, which induces their low growth parameters.

The analysis of fish farming in the Goh region (Ouragahio) shows that this activity is exclusively made by men. [6] reports that women represent 5% of fish farm promoters in Ghana, and 6% to 10% in Cameroon and a substantially high proportion (8-11%) in Jamaica. This low presence of women in fish farming activities is due to societal constraints common to women, including access to land, water, management (literacy), capital (credit), entrepreneurship rights and, disposing of income and investing [17]; [18].

This study shows that fingerlings are sexed at 3 months of age, contrary [16] who states that fry must be sexed at 2 months of age. Farmers justify this delay of sexing by the recurrent lack of food for the fish and thus allow 95% of fry to reach a sexing weight of 25 g to 40 g. Rice bran is the food used by fish farmers, but Bahompa 2 farm uses industrial feed as a supplement. [19] report that by-products are used more by farmers (76.5%) than by employees (11.3%) or economic operators (5.2%). Similarly, [20] indicate that fish farmers use by-products exclusively in all regions of Côte d'Ivoire.

The farms studied show different weight gain with *Oreochromis niloticus* relatively to their farm practices. The daily weight gain observed after 3 months of breeding is better in fish raised on the Bahompa 2 farm with DWG = 1.54 ± 0.15 g/d, followed by the Yopohoué farm (DWG = 1.18 ± 0.31 g/d). This parameter is low (DWG = 0.68 ± 0.19 g/d) after 2 months of rearing at the Bahompa 1 farm and after 4 months of rearing for the Bahompa 3 farm (DWG = 0.89 ± 0.72 g/day). It remains low after 6 months of rearing on the Sanepa farm (DWG = 1.11 ± 0.18 g/d).

The best specific growth rate obtained in the Bahompa 2 farm has a value of 2.04 ± 0.36%/d. It is lower than the Bahompa 3 farm that's value is 1.15 ± 0.46%/d. These low daily weight gains and specific growth rates are justified by the poor nutritional quality of the by-products used by fish farmers. Indeed, fish growth is influenced by many factors including diet and environmental variables. The poor nutritional quality of the rice bran would justify the long production times, the low market weight (200 g to 350 g) after more

than a year of breeding on the Bahompa 3 farm, Bahompa 1 farm, Sanepa farm and Yopohoué farm and the average daily gains of tilapia less than 1.5 g/d obteined in all farms. [21] justify these slow growths by the low protein content and low digestibility of rice bran fibers by fish, because the performance of a compound feed is highly dependent on the variability of the digestibility, adsorption and the availability of the nutrients that constitute it.

The length-weight relationship of the *Oreochromis niloticus* fish allows to determine the coefficients of allometry. For all farms, the values of this coefficient varied from 1.36 to 1.69. These values remain much lower than those reported in the literature, which range between 2.8 and 3 [22]. [23] reported that various factors including seasons, environmental parameters, food availability, feeding ratio, habitat, sex, and physiological conditions of fish may be responsible for differences observed with the coefficient of allometry reported by the different studies. The coefficient of determination (R^2) value of all fish indicate strong relationships between length and weight. Our results are consistent with works of [24] and [25] with different fish species from various water bodies.

The realative condition factor is a morphometric index used to evaluate the physiological state of the fish in relation to its well-being. The values obtained from the condition factor K vary from 0.99 ± 0.10 to 1 ± 0.30 for fish of all farms. According to [26], the highest values of K appear in a period of reproductive activities preparation. The poor condition factors obtained in this study indicate that the condition of the fish is poor, reflecting a state of fish stress. [27] noted that this factor was not constant for species or populations over a long period and could be influenced by biotic and abiotic factors such as diet and gonad development.

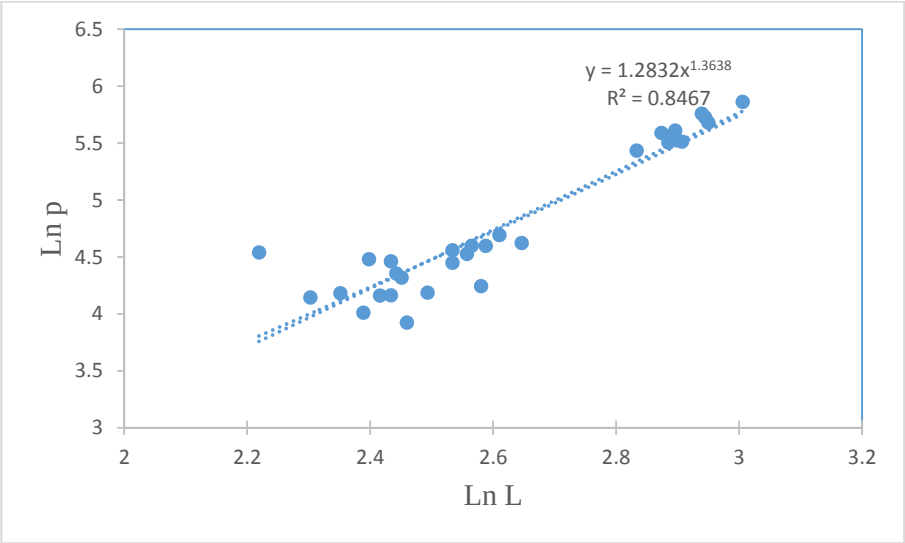

Figure 1: Length-weight relationship of *Oreochromis niloticus* in Bahompa 3 farm.

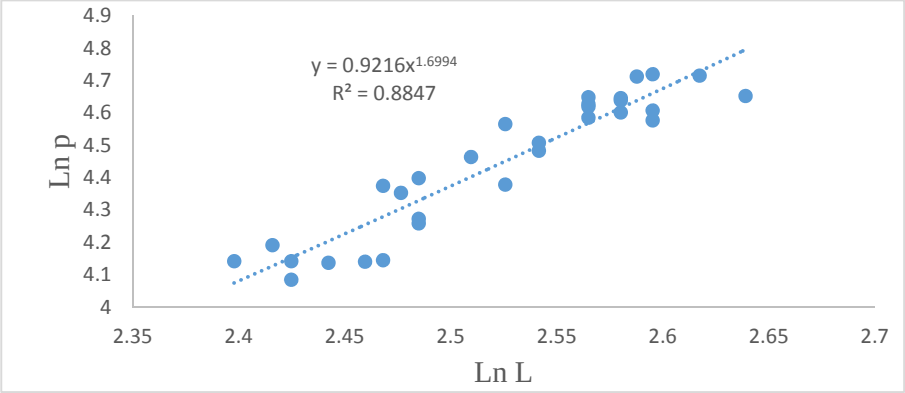

Figure 2: Length-weight relationship of *Oreochromis niloticus* in Bahompa 1 farm.

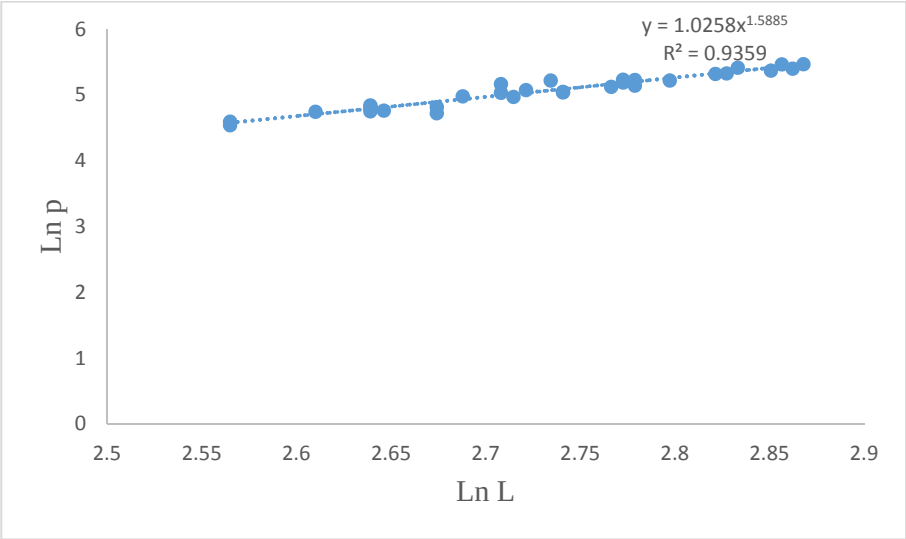

Figure 1: Length-weight relationship of *Oreochromis niloticus* in Bahompa 2 farm.

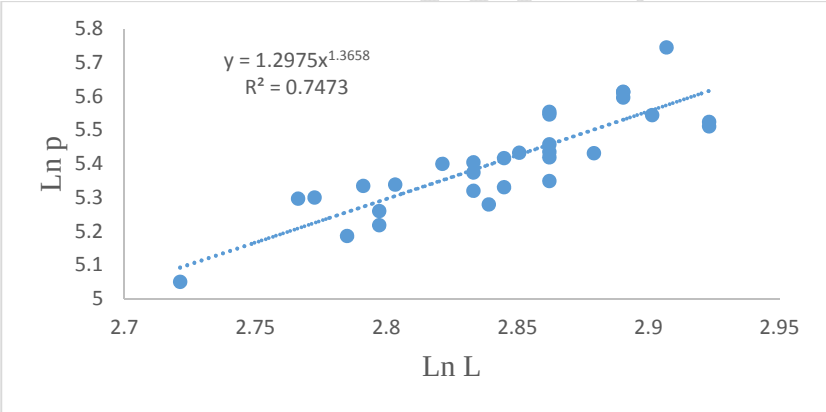

Figure 4: Length-weight relationship of *Oreochromis niloticus* in Sanepa farm.

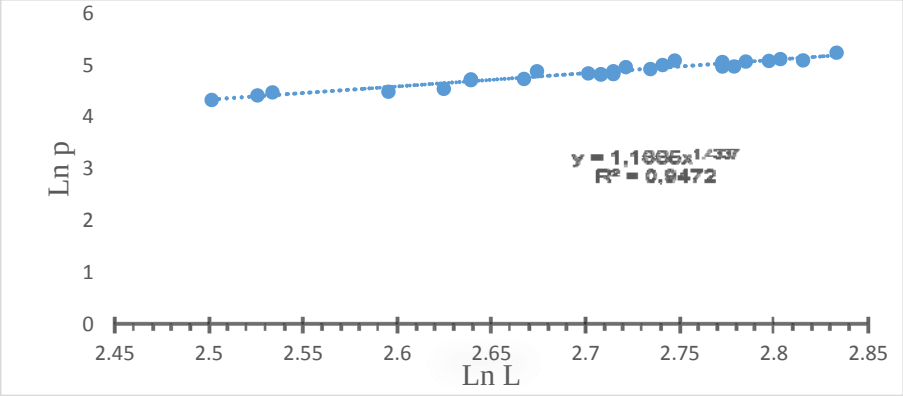

Figure 5: Length-weight relationship of *Oreochromis niloticus* in Yopohoué farm.

Table: **Growth parameters fishes**

Parameters	**FB3/age : (135 days)**	**FB1/age : (62 days)**	**FB2/age : (92 days)**	**FS/age : (183 days)**	**FY/age : (92 days)**
Li (cm)	10,33± 0,63	09,06± 0,50	11,03± 0,43	10,23± 0,48	09,10± 0,33
Lf (cm)	14,06± 3,33	12,5± 0,82	15,43± 1,33	17,2± 0,82	15± 1,26
Wi (g)	29,20 ± 3,99	32 ,5± 2,87	25,55± 3,97	30,55± 3,07	35,1± 3,7
Wf (g)	146,49± 98,69	87,09± 17,56	164,26± 41,67	225,75± 33,25	132,15± 28,02
DWG (g/d)	0,89 ± 0,72 ^{d}	0,68± 0,19 ^{e}	1,54± 0,47 ^{a}	1,11± 0,18^{c}	1,18± 0,31^{b}
AWG (g)	117,29± 97,95	54,59± 17,62	138,71± 42,57	195,2± 33,38	97,05± 28,33
SGR (%/d)	1,15± 0,46 ^{e}	2,02± 0,41^{b}	2,04± 0,36 ^{a}	1,21± 0,11 ^{d}	1,81± 0,3^{c}

Li= initial avagrage length ; **Lf=** final averag length ; **Wi=** initial average weigth ; **Wf=** final average weigth; **DWG** : Daily Weight Gain ; **AWG** : Average Weight Gain ; **SGR** : Specific Growth Rate ; **FB1** : Bahompa 1 farm ; **FB2** : Bahompa 2 farm ; **FB3** : Bahompa 3 Farm ; **FS** : Sanepa farm ; **FY=** Yopohoué farm.

The letters (a, b, c, d, e) mentioned in the table show that there is a significant difference (P = 0.05) between the averages tested on the different farms.

4- Conclusion

The comparative study of the five fish farms in Ouragahio (Goh region) shows that all fish farmers practice fish sexing. However, only Bahompa 2 farm make controls. Three of the fish farmers are native and two are non-native. All of them are over 45 years old men. The by-products (rice bran) are used for feeding in four farms (Bahompa 1, Bahompa 3, Sanepa and Yopohoué) and industrial feed is aded in Bahompa 2 farm. The best performance of the fish has been registered at Bahompa 2 farm followed by the Yopohoué farm, and Bahompa 3 farm, then Sanepa farm and finally in the Bahompa 1 farm. Fishes of all farms grow more in lenght than weight. The observed relative condition factors present values indicating that fish on these farms are stressed in their living environment.

6- COMPETING INTERESTS,

The authors declare that there is no conflict of interest.

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