Original Research Article

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

ABSTRACT

This is a comparative study for understanding the low fish production in the Goh region (Central-Western of Côte d'Ivoire) through the management of the fivemain fish farms. Study was cary out during 35 days, from August to September 2017. The farmers are all over 45 years old menand sexing fish late. 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 200individualsof *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. Yopohoué farm,follow,where DWG = 1.18 ± 0.31g/day, with SGR = 1.81 ± 0.3%/day, and K = 1 ± 0.01 were obtained. Bahompa 3 farm is third withDWG= 0.89 ± 0.72 g/day, with SGR = 1.15 ± 0.46%/day and K = 0.99 ± 0.04 . Bahompa 1 farm, follow with DWG = 0.68 ± 0.19 g/day, SGR = 2.02 ± 0.41%/day and K = 1 ± 0.1 . ThenSanepa farm is the last withDWG = 1.11 ± 0.18g/d SGR = 1.21 ± 0.11%/day and K = 1 ± 0.98 . 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: growth performances, *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'Ivoireand the fish growth parameters, for improving the productivity of tilapia *Oreochromis niloticus*.

2- MATERIAL AND METHODS

2.1 Study area

Data were collected from five farms in the departement of Ouragahio witch is located at 6 ° 25'00 '' N and 5 ° 55'00''W, in the Goh region (figure 1) where farms visited

are located in the Bahompa, Sanepa and Yopohoué villages. This department is located in the forest zone and has small rivers system.

The work was carried out during 35 days, 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.

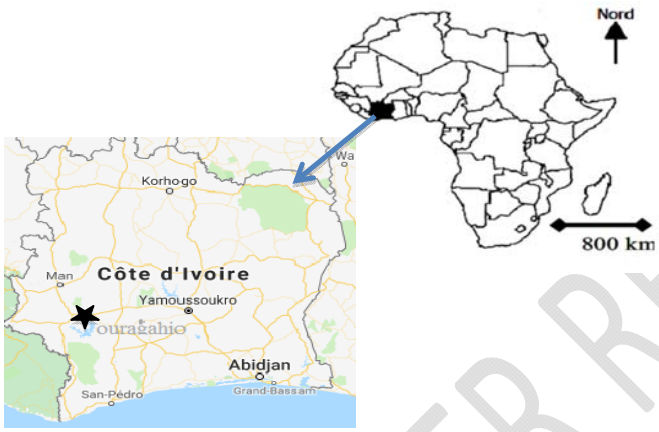

Figure 1: study area of Ouragahio

2.2.Study designand data collection

-Measurements of fish

A 6 mm mesh seine was used to catch 200 fish at each farmfor a total of 1000 fish.Fish were weighed to the nearest gram and measured to the nearest mm.All the 1000 fish have beenused 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 scaleand measured with a 0.01 mm precision graduated icthyometer to study the length-weight relationship.

-. Farms characteristics

The farmer fact sheets were used to collect data on the farmer's socio-economic profile, fish feeds, aquaculture practices and aquaculture facilities at each farm.

2-3. Studied parameters

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

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).

Average Weight Gain (AWG)

The average weight gainexpressed 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.

Specific Growth Rate (SGR)

The specific growth rateexpressed 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, ln: logarithm, d=day

Length-weight relationship

The length-weight relationshipthat 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.

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 speciesis used.

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

2.4. Statistical analysis

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

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

Theparameters of each farm and farmer's socio-economic profile aresummarized in the table 1. The five farms are owned by over 40 years old men and are aged of 8 to26 years.

The fish are fed at will, with rice bran, and the fry are kept in the breeding ponds until sexing, after 3 months.

Table 1: Technical characteristics of farms

Farms	Owners	Owner's age (years)	Age of the farm (years)	Area	Number of damps	Number of ponds	Average fry weight (g) at 3 month	Breeding time (month)	Weight mean (g)
Bahompa 1	Farmer	50	8	2.5	2	4	32.5	12	425
Bahompa 2	38 persons	Mean of 40	11	3	1	8	25.55	9	400
Bahompa 3	Farmer	57	26	3	4	10	29, 2	12	425
Yopohoué	Retired civil	63	17	2.5	2	4	35.1	12	425
Sanepa	Retired civil	63	23	2.5	4	10	30.55	10	350

3-2. Fish growth parameters

The table2 presents the different parameters of fish growth according to their age, in each farm. The daily weight gain is higher for the Bahompa 2 farm, followed by Yopohoué farm, Sanepa farm, Bahompa 3 farm and lower for the Bahompa 1 farm.The average weight gain show higher value in the Sanepa farm,followed by Bahompa 2 farm , Bahompa 3 farm, then Yopohoué farm and lower in Bahompa 3 farm.The mean of the recorded Specific Growth Rates indicate higher values for the Bahompa 2 farm and Bahompa 1 farm, lower in the Yopohoué farm, Sanepa farms and Bahompa 3 farm.

Table 2: Parameters of fish growth

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

Li= initial avarage length ; **Lf=** final average 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.

The length-weight relationshipparameters of specimens of *Oreochromis niloticus* in the fivefarms aresummarized in the table 3. The b valuesof fish of all the farms are less than 3 (p = 0.05). According to the statistical (t)test of student, fishes have a minor allometry, indicating a growth in weight slower than in length.The values of relative condition factor (K)provide informations on the reproductive capacity of these fish, which induces their low growth parameters.

Table 3: Length-weight relationshipand relative condition factor parameters

Farms	Average size (cm)	Average weight (g)	Fish age (d)	P equation	Allometry b	Correlation R	(t) test	K
Bahompa 1	12.5±0.82	87.09±17.56	62	$P = 0.92LS^{1.69}$	1.69	0.88	p = 0.05	1±0.98
Bahompa 2	15.43±1.33	164.26±41.67	92	$P = 1.02LS^{1.58}$	1.58	0.93	p = 0.05	1±0.01
Bahompa 3	14.06±3.33	146.49±98.69	135	$P = 1.28LS^{1.36}$	1.36	0.84	p = 0.05	0.99±0.04
Yopohoué	15±1.26	132.15±28.02	92	$P = 1.16LS^{1.43}$	1.43	0.94	p = 0.05	1±0.01
Sanepa	17.2±0.82	225.75±33.25	183	$P = 1.29LS^{1.36}$	1.36	0.74	p = 0.05	1±0.98

cm: centimeter; g : gram; d: day; P : allometry equation; b: allometry value; R: correlation value; p: statisticaly comparison value ; K: condition factor value

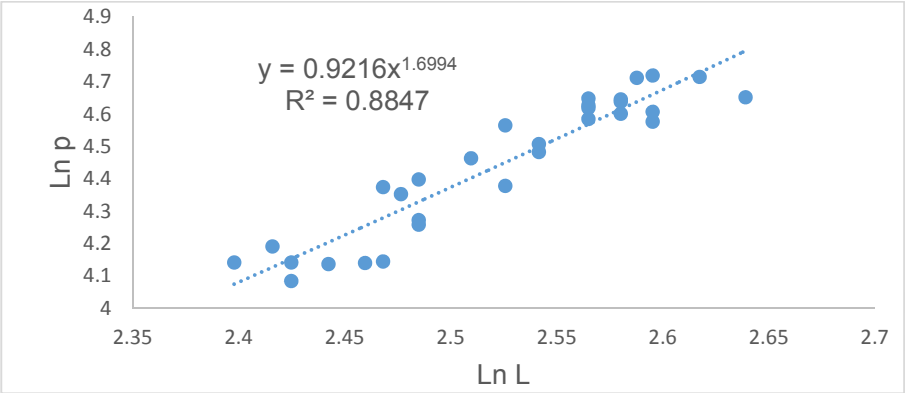

Figure 2:Length-weight relationship of *Oreochromis niloticus* in Bahompa 1 farm.

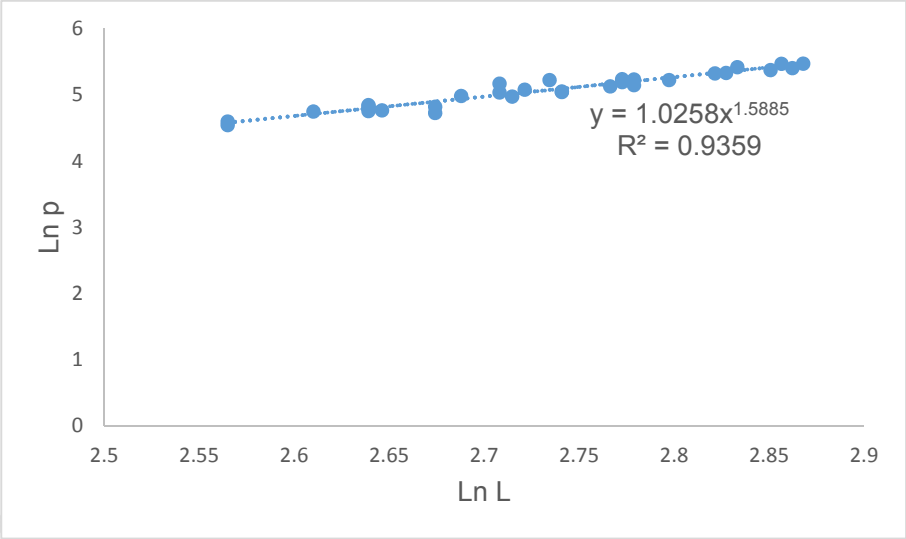

Figure 3: Length-weight relationship of *Oreochromis niloticus* in Bahompa 2 farm.

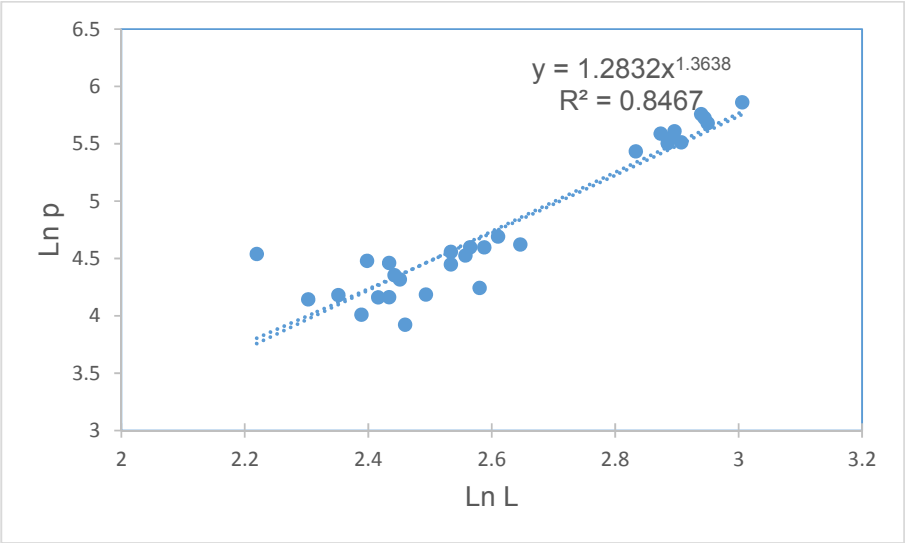

Figure 4:Length-weight relationship of *Oreochromis niloticus* in Bahompa 3 farm.

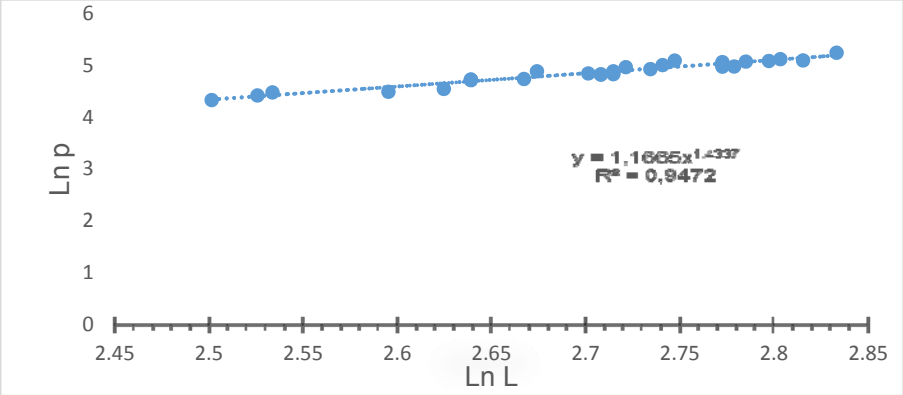

Figure 4: Length-weight relationship of *Oreochromis niloticus* in Yopohoué farm.

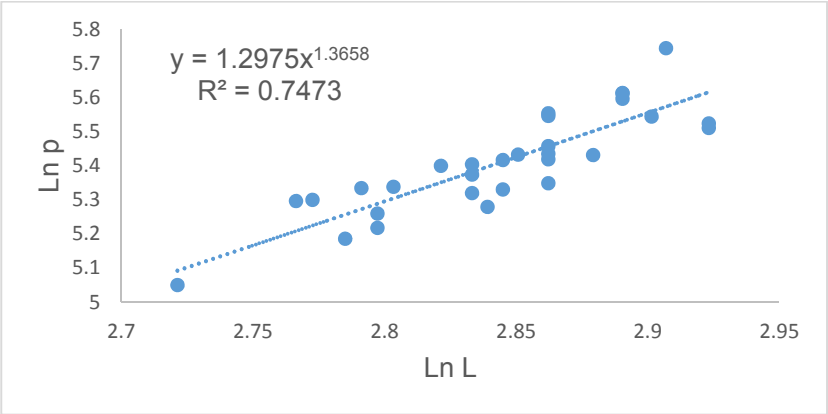

Figure 5:Length-weight relationship of *Oreochromis niloticus* in Sanepa farm.

3.3. Discussion

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 granulated 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 weightgain 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 followed by the Yopohoué farm. This parameter is low

after 2 months of rearing at the Bahompa 1 farm and after 4 months of rearing for the Bahompa 3 farm. It remains low after 6 months of rearing on the Sanepa farm.

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 periodof 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.

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. All of them are over 40 years old men. The by-products (rice bran) are only used for feeding in four farms (Bahompa 1, Bahompa 3, Sanepa and Yopohoué) and industrial granulated feed is aded in Bahompa 2 farm, that let to get the best growth performance in this 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.

5- ACKNOWLEDGEMENTS,

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6- COMPETING INTERESTS,

The authors declare that there is no conflict of interest.

7- AUTHORS' CONTRIBUTIONS

This work was done with a frank collaboration between all the authors. Kouassi Sylvain KONAN and Zana Ibrahim COULIBALY collected samples and designed the study.N'golo OUATTARAand Moustapha DIABY performed the data processing and the all, drafted the first version of the manuscript.Kouakou YAOwrote the protocol and corrected the first versions of the manuscript. All authors read and approved the final manuscript.

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