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(RESEARCH ARTICLE)

GROWTH PERFORMANCE OF THE BOUAKÉ AND BRAZIL STRAINS OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*, LINNAEUS 1758) REARED IN FLOATING CAGES IN CÔTE D'IVOIRE

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ABSTRACT

The Nile tilapia (*Oreochromis niloticus*) is the main farmed fish in Côte d'Ivoire. How its two approved strains, Bouaké and Brazil, compare in floating cages was unknown. This study assessed their growth performance during grow-out on the Sassandra River, at Buyo (Côte d'Ivoire). Six floating cages of 87.5 m^3 (three per strain) were stocked with 4,800 monosex male fingerlings each. Mean initial body weight was 18.15 ± 1.90 g for Bouaké and 18.63 ± 0.69 g for Brazil. Fish received a 32% protein industrial feed twice daily for 125 days. The feeding rate was adjusted monthly after each control seining. Water quality stayed within the tolerance range of the species (temperature: 28.98–29.21 °C; dissolved oxygen: 5.78–6.06 mg/L; pH: 7.01–7.09). At harvest, the Brazil strain reached a higher final body weight (370.10 ± 32.33 g vs 296.08 ± 25.87 g; $p < 0.05$). Daily weight gain (2.61 ± 0.03 vs 2.05 ± 0.19 g/day), specific growth rate (2.25 ± 0.04 vs 2.05 ± 0.08 %/day), total production (1,393.25 ± 25.34 vs 1,143.05 ± 64.10 kg) and yield (50.22 ± 1.88 vs 41.20 ± 2.18 kg/m^3/year) followed the same pattern. Survival rates (78.43 and 80.43%) did not differ. The Brazil strain is therefore better suited to cage grow-out in Côte d'Ivoire.

Keywords: Nile Tilapia; Bouaké Strain; Brazil Strain; Floating Cages; Growth Performance; Côte d'Ivoire

1 INTRODUCTION

Fish is a major food item in Côte d'Ivoire. National production, however, falls far short of demand. The Ministry of Animal and Fisheries Resources estimates the national need at about 650,000 t of fish per year, while domestic production is close to 110,000 t [1]. Aquaculture is therefore a strategic lever. It can strengthen food security, create jobs, and cut the import bill for fishery products.

Among farmed species, the Nile tilapia *Oreochromis niloticus* (*O. niloticus*), holds the leading position. It grows fast, tolerates tropical conditions well, is hardy, and is well accepted by consumers [2]. It is the main species farmed in Côte d'Ivoire, with an annual production of about 7,700 t [1].

The genetic make-up of the stock sets the ceiling on farm performance. Tilapia strains differ in growth, survival, feed conversion, and yield. These differences reflect origin and selection history [3, 4]. Under farming conditions, an improved strain usually outperforms unselected commercial strains [5]. The environment also matters. The same genotype does not perform the same in a pond, in a cage, or in an intensive system [6]. Comparing a local strain, Bouaké, with an introduced, improved one, Brazil, therefore has a double value. Scientifically, it measures the combined effect of selection and local adaptation [2]. Practically, it shows whether the announced gains hold up during grow-out in cages, under real feeding regimes. Early data on the Ivorian aquaculture landscape already point in this direction at the fingerling stage [7].

Recent Ivorian studies have evaluated *O. niloticus* in extensive or semi-intensive ponds, including the Bouaké and Brazil strains. They found the improved Brazil strain promising under these conditions [8, 9]. Pond results, however, cannot be transposed to floating cages. In cages, fish face different conditions: permanent water renewal, strong hydrodynamics, high stocking density, and hand feeding [10, 11]. Few strain-comparison studies exist for floating cages, and they concern other settings [10, 11]. To our knowledge, none covered the Bouaké and Brazil strains in Côte d'Ivoire at the time this trial was designed. This gap justified the present work. Its objective was to assess the zootechnical performance of the two strains during grow-out in floating cages.

2 MATERIALS AND METHODS

2.1 Study site

The trial ran on the Sassandra River, at Buyo, Côte d'Ivoire. The cages were set in calm water, close to the bank, at a site accessible year-round.

2.2 Experimental design and rearing management

Six floating cages were installed, three per strain. Each cage measured 5 m × 5 m × 3.5 m, i.e. 87.5 m^3. A total of 14,400 monosex male *Oreochromis niloticus* fingerlings of each strain, "Brazil" and "Bouaké", were used. Mean initial body weight was 18.15 ± 1.90 g (Bouaké) and 18.63 ± 0.69 g (Brazil). Fish were split evenly across cages, 4,800 per cage, i.e. about 55 fish/m^3. Both strains received the same industrial feed with 32% protein. The feeding rate was set from mean live body weight and adjusted monthly after each control seining. Feed was distributed by hand twice a day, at 09:00 and 15:00. Zootechnical monitoring relied on monthly control seining. At each seining, 100 fish per cage were sampled, weighed, and returned to the cage. The cycle lasted 125 days.

2.3 Water quality monitoring

Water quality was followed through physico-chemical measurements in the cages. Readings were taken monthly, twice on the same day (09:00 and 17:00), in all six cages. Water temperature, pH, conductivity, dissolved oxygen, transparency, and depth were recorded. Temperature, pH, conductivity, and oxygen were measured in situ with a HANNA HI 9828 multiparameter probe. Transparency was read with a Secchi disk. Depth was measured with a handheld echo sounder (Plastimo Echotest II).

2.4 Zootechnical parameters

Data from the start, the end, and each monthly control seining were used to compute the following parameters:

- Survival rate (SR): SR (%) = 100 × (final fish number / initial fish number) [12]
- Weight gain (WG): WG (g) = final weight (g) − initial weight (g)
- Daily weight gain (DWG): DWG (g/day) = (final weight (g) − initial weight (g)) / rearing period (days)
- Specific growth rate (SGR): SGR (%/day) = 100 × [ln (final weight) − ln (initial weight)] / rearing period (days) [13]

- Feed conversion ratio (FCR): FCR = dry feed distributed (kg) / weight gain (kg) [13]

2.5 Statistical analysis

Production parameters and physico-chemical data were first tested for normality with the Kolmogorov-Smirnov test (α = 0.05). Strains were then compared by one-way analysis of variance (ANOVA). Significant differences were identified with Tukey's HSD test. The significance threshold was set at 5%. All analyses were run in STATISTICA 7.1.

3 RESULTS

3.1 Water quality

Table 1 lists the mean physico-chemical values recorded in the cages of both strains. Water temperature (28.98 to 29.21 °C on average), pH (7.01 to 7.09), dissolved oxygen (5.78 to 6.06 mg/L), and transparency (48.10 to 49.62 cm) stayed within the range suitable for optimal growth of Nile tilapia [14] throughout the cycle. Only conductivity (26.49 ± 1.50 vs 27.31 ± 7.38 µS/cm) and depth (15.54 ± 1.59 vs 15.01 ± 0.36 m) differed significantly between the two sets of cages ($p < 0.05$). These gaps are small. Strain has no influence on water variables, so they most likely reflect spatial heterogeneity of the site (cage position, local bathymetry) rather than any growth-limiting factor. The environment therefore did not confound the strain comparison.

Table 1: Physico-chemical parameters of the water in the rearing cages of the Bouaké and Brazil strains of *Oreochromis niloticus*

Parameters	Strains	
	Brazil strain	Bouaké strain
Temperature (°C)	29.21 ± 1.41	28.98 ± 1.77
pH	7.01 ± 0.34	7.09 ± 0.29
Dissolved oxygen (mg/L)	6.06 ± 1.05	5.78 ± 0.97
Conductivity (µS/cm)	26.49 ± 1.50^{b}	27.31 ± 7.38^{a}
Transparency (cm)	48.10 ± 7.21	49.62 ± 4.19
Depth (m)	15.54 ± 1.59^{a}	15.01 ± 0.36^{c}

Values are means ± standard deviations of two readings per cage. Within a row, values not sharing the same letter differ significantly (one-way ANOVA, $p < 0.05$).

3.2 Zootechnical performance

Table 2: Zootechnical parameters of the Brazil and Bouaké strains of *Oreochromis niloticus* reared in floating cages for 125 days

Index	Brazil strain	Bouaké strain
Survival rate (%)	78.43 ± 0.42^{a}	80.43 ± 0.40^{a}
Initial mean weight (g)	17.60 ± 1.09^{a}	18.48 ± 1.09^{a}
Final mean weight (g)	370.10 ± 32.33^{a}	296.08 ± 25.87^{b}
Weight gain (g)	352.50 ± 24.60^{a}	277.60 ± 25.90^{b}
Daily weight gain (g/day)	2.61 ± 0.03^{a}	2.05 ± 0.19^{b}
Specific growth rate (%/day)	2.25 ± 0.04^{a}	2.05 ± 0.08^{b}
Total production (kg)	1,393.25 ± 25.34^{a}	1,143.05 ± 64.10^{b}
Yield (kg/m^3/year)	50.22 ± 1.88^{a}	41.20 ± 2.18^{b}

Values are means ± standard deviations of three replicates (cages). Within a row, values not sharing the same letter differ significantly (one-way ANOVA, $p < 0.05$).

Table 2 sets out the zootechnical results. Final body weight was significantly higher in the Brazil strain (370.10 ± 32.33 g) than in the Bouaké strain (296.08 ± 25.87 g), a difference of about 25% ($p < 0.05$). Weight gain (352.50 ± 24.60 vs 277.60 ± 25.90 g) and daily weight gain (2.61 ± 0.03 vs 2.05 ± 0.19 g/day) followed the same trend. So did the specific

growth rate (2.25 ± 0.04 vs 2.05 ± 0.08 %/day; $p < 0.05$). Survival, by contrast, was statistically similar between strains (78.43 ± 0.42 vs 80.43 ± 0.40%; $p > 0.05$). Total production per cage (1,393.25 ± 25.34 vs 1,143.05 ± 64.10 kg) and annual yield (50.22 ± 1.88 vs 41.20 ± 2.18 kg/m^3/year) were significantly higher for the Brazil strain, with a production advantage of about 22% per cycle.

4 DISCUSSION

The two strains were compared under similar rearing conditions. Mean temperature, pH, and dissolved oxygen stayed within the optimal range for Nile tilapia culture [14]. The significant differences in conductivity and depth were small. They cannot explain the growth gap between strains. These water values are consistent with those reported for cage farms on large African water bodies [10, 11].

The central result of this study is the clear superiority of the Brazil strain in floating cages. Its final body weight was about 25% higher, and its daily gain 27% higher, than that of the Bouaké strain. This agrees with fingerling-stage data from happas, where the Brazil strain already outperformed the other strains of the Ivorian aquaculture landscape [7]. It also agrees with pond grow-out trials in Côte d'Ivoire [8], including on farmers' ponds [9]. More directly, it matches a recent cage trial on Lake Taabo (Côte d'Ivoire), where the Brazil strain reached 385.76 g against 354.74 g for Bouaké after 120 days [15].

The advantage of the Brazil strain largely reflects its genetic history. Its founders came from the Bouaké station stock introduced into Brazil in 1971. There, the material was selected for growth, then reintroduced into Côte d'Ivoire in 2014 under the Ivorian-Brazilian cooperation program [8, 15]. Selection response is a well-established lever for growth improvement in Nile tilapia [3]. Improved strains also tend to beat unselected commercial strains under real farming conditions [5]. The behaviour of the two strains in Ivorian cages thus illustrates the joint effect of genetic selection and genotype × environment interaction: the same genotype does not express the same potential in every rearing system [6].

Survival was statistically similar between strains (78.43 vs 80.43%). Both genetic materials thus showed similar hardiness in this system. These rates remain below the 95.91–97.80% reported in cages on Lake Taabo from juveniles of about 60 g [15]. The difference is most likely linked to stocking size, which was far smaller here (about 18 g). Small juveniles are more sensitive to handling stress and to the hazards of early grow-out. Similar survival combined with faster growth strengthens the case for the Brazil strain: the production gap between strains comes from growth speed, not from differential losses of fish.

With annual yields of 50.22 and 41.20 kg/m^3/year, both lots reached the high productivity typical of intensive floating-cage systems on large African rivers and lakes [10, 11]. In practice, the results point to the Brazil strain as the best zootechnical choice for Nile tilapia grow-out in floating cages in Côte d'Ivoire, with about 22% extra production per cycle at identical management cost. Both strains remain in use among Ivorian fish farmers, though. Keeping genetic diversity across farms is also a matter of sustainable broodstock management.

This study has limits. It covered a single site, a single cycle, and one commercial feed. Strain × site × season and strain × feed interactions deserve further testing. The economic side (feed cost, gross margin, price by size class), which drives the farmer's choice, was also outside the scope of this work. It should be addressed next, as done in other strain comparisons [15].

5 CONCLUSION

This study adds new comparative data on the grow-out of the Bouaké and Brazil strains of Nile tilapia in floating cages in Côte d'Ivoire. After 125 days on the Sassandra River at Buyo, the Brazil strain clearly outgrew the Bouaké strain (final body weight 370.10 vs 296.08 g; daily gain 2.61 vs 2.05 g/day; yield 50.22 vs 41.20 kg/m^3/year) at a statistically similar survival rate. Under the conditions of this trial, the Brazil strain is therefore better suited to cage grow-out and should be the first choice of Ivorian fish farmers. Further trials over several sites and cycles, with an economic analysis, will consolidate this recommendation.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflict of interest with respect to this article.

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