Scholars Academic Journal of Biosciences
Abbreviated Key Title: Sch Acad J Biosci
ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online)
Journal homepage: https://saspublishers.com
NLM ID:101629416

OPEN ACCESS
Biosciences

On-Farm Growth Performance of the Brazilian Strain of *Oreochromis niloticus* Fed Industrial Versus Local Feeds in Côte d'Ivoire

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DOI: https://doi.org/10.36347/sajb.2025.v13i12.009 | **Received:** 17.10.2025 | **Accepted:** 26.12.2025 | **Published:** 29.12.2025

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Abstract | **Original Research Article**

The present study was conducted to evaluate the growth performance of the Brazilian strain of *Oreochromis niloticus* fed floating pellets and a locally formulated powdered feed in major aquaculture areas of Côte d'Ivoire. A total of 28,800 male fingerlings (mean initial weight: 6.75 ± 2.21 g) of the Brazilian strain of *O. niloticus* were stocked in six 400 m² earthen ponds located in six fish-farming localities across the country. Fish were fed two types of diets: floating industrial pellets and a locally formulated powdered feed. Survival rates ranged from 85 to 94%, with an average of 89.54 ± 2.87%. Final mean weights varied from 294 ± 41 to 475 ± 41 g. The highest values were recorded in fish fed floating pellets in Gagnoa, while the lowest were observed in fish receiving powdered feed in Bouaké. Specific growth rates ranged from 2.85 ± 0.23 to 3.24 ± 0.21% day^{-1} and followed trends similar to those of final mean weight. Floating pellets resulted in lower apparent feed conversion ratios (1.83–2.07) compared to powdered feeds (1.94–3.14). These findings highlight the influence of feed type and local environmental conditions on the zootechnical performance of *O. niloticus* and confirm the advantage of floating pellets in improving fish productivity.

Keywords: Tilapia, Brazilian strain, zootechnical performance, Côte d'ivoire.

1. INTRODUCTION

In Côte d'Ivoire, animal protein intake relies largely on fish, which is more affordable than meat and therefore constitutes a staple food for economically vulnerable households. However, a substantial proportion of the fish consumed in the country is imported. National fish demand, estimated at approximately 740,000 tons per year, is currently met at only about 10%. National production, estimated at around 110,000 tons by the Ministry of Animal and Fishery Resources (MIRAH, 2023), is largely supplied by capture fisheries, with aquaculture contributing only marginally (8,467 tons in 2023).

Several constraints continue to limit the development of aquaculture in Côte d'Ivoire, including the high cost of industrial feed, land tenure issues, insufficient technical support, low technical capacity of stakeholders, limited species diversification, and the lack of fast-growing fish strains (Anvo *et al.,* 2025). To address the latter constraint, the Ivorian government introduced an improved Brazilian strain of *Oreochromis niloticus* in 2014 to stimulate national fish production.

*Oreochromis niloticus is the fourth most farmed aquaculture species worldwide (***FAO, 2018; Sissao *et al.*, 2019***) and the leading aquaculture species in Côte d'Ivoire. (***Yao *et al.*, 2017***)*. Its biological characteristics including rapid growth, high robustness, ease of reproduction, dietary flexibility, and high consumer acceptance have made it the focus of numerous research and dissemination programs. Previous studies conducted under experimental conditions and in farmers' environments have demonstrated that the Brazilian strain is well adapted to Ivorian environmental conditions (**Tre Bi *et al.*, 2023; Anvo *et al.*, 2023**).

Despite its proven zootechnical performance, the large-scale adoption of the Brazilian strain in Côte d'Ivoire remains constrained by the high cost of

industrial feeds. In practice, farmers frequently rely on locally available powdered feeds, whose zootechnical efficiency remains poorly documented. Therefore, it is essential to assess, under real farming conditions, the growth potential of the Brazilian strain of *O. niloticus* when fed locally formulated feeds compared with industrial floating pellets across different aquaculture zones of Côte d'Ivoire.

The present study aimed to compare the zootechnical performance of the Brazilian strain of *O. niloticus* fed industrial floating pellets versus locally formulated powdered feed in major fish-farming areas of Côte d'Ivoire.

2. MATERIALS AND METHODS

2.1. Biological material

The biological material consisted of all-male monosex fingerlings of the improved Brazilian strain of *O. niloticus*, produced through hormonal sex reversal. Fingerlings were obtained from broodstock supplied to five hatcheries by the Research Station on Inland Fisheries and Aquaculture of the National Agronomic Research Center (CNRA). The mean initial weight of fingerlings was 6.75 ± 2.21 g.

2.2. Experimental procedure

A total of 28,800 male monosex fingerlings were stocked at a density of 3 fish m^{-2} in 24 ponds. Each dietary treatment was applied to two ponds per locality. Fish were fed twice daily (09:00 and 16:00). Monthly sampling was carried out to monitor growth and adjust feeding rates. The trial lasted five months. Trials were conducted in six farms located in major aquaculture areas of Côte d'Ivoire: Abengourou, Agboville, Bouaké, Daloa, Gagnoa, and Soubré. A total of 24 earthen ponds (400 m^2 each) were used, with four ponds per farm allocated to the two dietary treatments in duplicate. Two types of diets were used: an industrial floating pellet feed and a locally formulated powdered feed. Feeding rates were adjusted according to fish weight following Kreman et al. (2020). The daily ration was divided into two meals, distributed at 08:00 and 15:00. Both diets had comparable crude protein contents ranging from 36 to 41 % (Table 1). Feeding was carried out by the host farmers at each experimental site. Water temperature, pH, electrical conductivity, and dissolved oxygen were measured monthly in situ using a Hanna multiparameter probe (model 98194), prior to sampling operations.

Table 1: Ingredients (g/kg) of ration and theoretical biochemical composition (%) of local and industrial feeds

Diet ingredient contents		
Ingredients (g)	**Local formulated diets**	**Industrial diet**
Rice meal (g)	220 -120	Information not available
soybean meal (g)	500 -550	
Local fish meal (g)	200-250	
Vitamin Mineral Complex (g)	10	
Methionine (g)	10	
Lysine (g)	10	
Red palm oil (g)	50	
Total	**1000**	
Diet Biochemical compositions		
Protein (%)	36.24 – 41.5	36 - 40
Fat (%)	8.5 - 9.75-	9 -10
Ash (%)	6.2 - 7.0	6.5 - 6.7

2.3. Growth performance parameters

The following parameters were calculated:

Mean weight gain (MWG, g) = final weight − initial weight

Survival rate (SR, %) = 100 × final number of fish / initial number of fish

Feed conversion ratio (FCR) = feed intake (g) / weight gain (g)

Specific growth rate (SGR, % day^{-1}) = 100 × [ln(final mean weight) − ln(initial mean weight)] / rearing duration

2.4. Statistical analysis

Zootechnical and physicochemical data were tested for normality using the Shapiro–Wilk test (α = 0.05). One-way analysis of variance (ANOVA) was performed, and significant differences were identified using Tukey's HSD test. All analyses were conducted using STATISTICA 7.1 software.

3. Results and discussion

3.1. Physicochemical parameters of the pond water

Table 2 presents the variations in water physico-chemical parameters (temperature, dissolved oxygen, and pH) in the rearing ponds according to feed type (floating pellets or powdered feeds) and locality.

Water temperature across all ponds varied significantly among localities ($p < 0.05$), with values ranging from 27.28 ± 0.27 to 29.25 ± 0.31 °C. The highest temperatures were recorded in Bouaké under both floating pellets (29.10 ± 0.30 °C) and powdered feed treatments (29.25 ± 0.31 °C), whereas the lowest values were observed in Abengourou (27.64 ± 0.26 °C

with floating pellets and 27.28 ± 0.27 °C with powdered feeds).

Dissolved oxygen concentrations showed marked variation according to feed type. Ponds supplied with floating pellets exhibited significantly higher dissolved oxygen levels (4.94 ± 0.38 to 6.38 ± 0.41 mg L^{-1}) than those receiving powdered feeds (3.98 ± 0.61 to 4.52 ± 0.18 mg L^{-1}). Maximum values were observed in Bouaké and Agboville under the floating pellet treatment, whereas the minimum value was recorded in Abengourou with powdered feeds.

Water pH remained relatively stable throughout the study, ranging from 6.89 ± 0.15 to 7.49 ± 0.35, indicating neutral to slightly alkaline conditions across all sites. Differences among localities and feed types were minor, reflecting good chemical stability of the aquatic environment.

Table 2: Physico-chemical parameters of water in rearing ponds according to dietary treatments and localities

Dietary treatments	Localities	Water physico-chemical parameters		
		Temperature	Dissolved oxygen	pH
Floating pellet feed	Daloa	27.91±0.17^{c}	5.48±0.19^{b}	7.37±0.23
	Soubré	28.39±0.15^{b}	5.59±0.31^{b}	7.11±0.10
	Gagnoa	28.78±0.16^{ab}	5.38±0.33^{b}	7.49±0.35
	Agboville	27.76±0.27^{c}	6.05±0.15^{a}	7.35±0.23
	Abengourou	27.64±0.26^{c}	4.94±0.38^{b}	7.33±0.19
	Bouaké	29.10±0.30^{a}	6.38±0.41^{a}	7.19±0.24
Powdered feed	Daloa	27.89±0.09^{c}	4.48±0.21	7.22±0.31
	Soubré	28.41±0.13^{b}	4.12±0.37	6.91±0.21
	Gagnoa	28.69±0.18^{b}	4.31±0.29	7.03±0.39
	Agboville	27.71±0.31^{c}	4.52±0.18	7.14±0.51
	Abengourou	27.28±0.27^{c}	3.98±0.61	6.96±0.09
	Bouaké	29.25±0.31^{a}	4.38±0.56	6.89±0.15
Values represent means and standard deviations of two replicates. Values not marked with the same letter are significantly different (Anova, $p<0.05$) for each column of the table.				

3.2. Performances zootechniques

Table 3 presents the zootechnical performance recorded after 131 days of rearing. The results indicate that the zootechnical performance of the Brazilian strain of *Oreochromis niloticus* varied significantly according to locality and feed type (floating pellets or powdered feeds), despite the diets having similar protein contents.

Survival rates of the Brazilian strain of *O. niloticus* remained generally high (>85%) across all treatments. However, significant differences were observed ($p < 0.05$), with higher survival recorded in Soubré (93.51%) for fish fed floating pellets and in Bouaké (94.44%) for those receiving powdered feed. Conversely, the lowest survival rates were recorded in Bouaké (86.58%) for fish fed the industrial diet and in Agboville (85.75%) for those fed powdered feed.

Under the floating pellet treatment, fish reared in Gagnoa exhibited the highest final mean weights (FMW; 475 ± 41 g), which were significantly higher than those observed in Abengourou (299 ± 23 g), while Daloa, Bouaké, and Agboville showed intermediate values that were statistically comparable. A similar trend was observed for mean weight gain (MWG), confirming the significant effect of locality on growth performance. Under the powdered feed treatment, ANOVA revealed a significant reduction in growth performance compared with floating pellets ($p < 0.05$). The highest FMW values were recorded in Daloa (395 ± 29 g) and Soubré (377 ± 19 g), whereas Agboville (294 ± 41 g), Bouaké (296 ± 21 g), and Abengourou exhibited significantly lower values, indicating a notable interaction between feed type and locality.

Specific growth rate (SGR) differed significantly among treatments ($p < 0.05$). The highest values were observed in fish fed floating pellets in Gagnoa (3.24 ± 0.21% day^{-1}) and Daloa (3.15 ± 0.23% day^{-1}), whereas the lowest values were recorded in Abengourou (2.87 ± 0.07% day^{-1}). In fish fed powdered feed, no significant differences in SGR were observed among localities; however, the highest SGR was recorded in Daloa (3.19 ± 0.21% day^{-1}) and the lowest in Gagnoa (2.85 ± 0.23% day^{-1}).

The feed conversion ratio (FCR) was significantly influenced by feed type ($p < 0.05$). Floating pellets resulted in significantly lower FCR values (1.83–2.07) compared with powdered feeds (1.94–3.14), indicating better feed efficiency of the Brazilian strain of *O. niloticus* when fed the industrial diet. Under the floating pellet treatment, the highest FCR was observed in Bouaké (2.07 ± 0.07) and the lowest in Soubré (1.83 ± 0.11). For the powdered feed treatment, the lowest FCR values were recorded in Daloa (1.94 ± 0.09), whereas the highest were observed in Abengourou (3.14 ± 0.10).

Table 3: Zootechnical performance of the Brazilian strain of *Oreochromis niloticus* according to dietary treatments and localities

Dietary treatments	Localities	Parameters					
		IW (g)	FW (g)	MWG (g)	SGR. % day^{-1})	SR (%)	FCR
Floating pellet feed	Daloa	6.87±0.5	428±34^{ab}	421.13±73^{ab}	3.15±0.23^{ab}	90.25±1.2^{a}	1.94±0.09
	Soubré	7.09±1.1	352±15^{b}	344.91±63^{b}	2.98±0.13^{ab}	93.51±0.9^{a}	1.83±0.11
	Gagnoa	6.79±1.05	475±41^{a}	468.21±81^{a}	3.24±0.21^{a}	89.12±2.5ab	1.89±0.20
	Agboville	6.55±0.7	380±39^{b}	373.45±39^{b}	3.09±0.8^{a}	87.63±2.3ab	1.87±0.09
	Abengourou	6.88±1.5	299±23^{c}	292.12±23^{c}	2.87±0.7^{b}	89.43±0.6^{a}	1.99±0.14
	Bouaké	6.61±1.05	398±35^{b}	391.39±35^{b}	3.12±0.20^{ab}	86.58±0.6^{b}	2.07±0.07
Powdered feed	Daloa	5.98±0.75	395±29^{a}	389.02±28^{a}	3.19±0.21	87.54±1.9^{bc}	1.94±0.09^{d}
	Soubré	6.79±1.23	377±19^{a}	370.21±45^{a}	3.06±0.31	92.34±3.1^{ab}	2.23±0.22^{cd}
	Gagnoa	7.15±0.4	301±38^{b}	293.85±38^{b}	2.85±0.23	87.25±0.4^{b}	2.55±0.17^{bc}
	Agboville	6.79±1.15	294±41^{b}	287.21±41^{b}	2.87±0.13	85.75±0.9^{c}	2.88±0.06^{b}
	Abengourou	6.95±1.02	312±25^{b}	305.05±65^{b}	2.90±0.09	91.25±2.2^{a}	3.14±0.10^{a}
	Bouaké	6,71±1,58	296±21^{b}	289,29±21^{b}	2,89±0,32	94,44±2,7^{a}	2,06±0,08^{d}

Values represent means and standard deviations of two replicates. Values not marked with the same letter are significantly different (Anova, $p<0.05$) for each column of the table. IW : initial weight ; FW : final weight ; MWG : mean weight gain ; SGR : Specific growth rat ; SR : survival rate ; FCR: feed conversion ratio

3.3. DISCUSSION

The variations in water physico-chemical parameters observed in the rearing ponds reflect the combined influence of local environmental conditions and feeding practices. Temperatures recorded across all sites (27.28–29.25 °C) fell within the optimal range recommended for the growth and metabolism of *Oreochromis niloticus*, generally between 27 and 31 °C (Nehemia *et al.,* 2012). The significant differences observed among localities can be attributed primarily to regional climatic conditions particularly solar radiation and ambient temperature rather than to feed type. The higher values recorded in Bouaké indicate a favorable thermal environment likely to stimulate metabolic activity and fish growth. Dissolved oxygen concentrations showed a marked effect of feed type, with significantly higher levels in ponds supplied with floating pellets compared with those receiving powdered feeds. This difference may be explained by the greater stability and buoyancy of pellets, which reduce feed losses and the accumulation and decomposition of organic matter at the pond bottom processes known to increase oxygen consumption through microbial activity (Boyd & Tucker, 2012). Nevertheless, although lower under powdered feed treatments, dissolved oxygen concentrations generally remained above the critical threshold of 3 mg L^{-1} recommended for tilapia, a species recognized for its relative tolerance to moderate hypoxia (Abd El-Hack *et al.,* 2022).

Water pH remained relatively stable, ranging from 6.89 to 7.49, indicating neutral to slightly alkaline conditions favorable for the culture of *O. niloticus*. This pH stability suggests good buffering capacity of the ponds, likely related to soil characteristics and the management of feed inputs. pH values between 6.5 and 8.5 are generally considered optimal for tilapia physiology, reproduction, and growth (El-Sherif & El-Feky, 2009).

The zootechnical performance observed in the Brazilian strain of *Oreochromis niloticus* after 131 days of rearing highlights the combined influence of locality and feed type on survival, growth, and feed efficiency.

The high mean survival rates recorded across all treatments (89.54 ± 2.87%) indicate good adaptation of this strain to local farming conditions. Comparable survival levels have been reported for tilapia reared in semi-intensive systems, underscoring the robustness of the species under variable environmental conditions (El-Sayed, 2006). However, the survival rates observed in the present study were higher than those reported by Anvo *et al.,* (2023) for the same strain across nine localities in Côte d'Ivoire. The significant differences among localities and between studies may be related to site-specific environmental factors, such as water quality and pond management practices.

Growth performance was significantly higher in fish fed floating pellets, particularly in Gagnoa, where the highest final mean weights and weight gains were recorded. These results confirm the key role of feed quality in tilapia growth, as floating pellets are generally better balanced nutritionally and exhibit higher digestibility (El-Sayed, 2006; Tacon & Metian, 2008). In addition, the extruded nature of the pellets may have contributed to the observed performance, as extrusion is known to enhance nutrient digestibility in fish (Anvo *et al.,* 2017). In contrast, the lower performance observed with powdered feeds, especially in Agboville and Bouaké, may be attributed to reduced feed stability in water, leading to nutrient losses and decreased effective feed intake. Indeed, a substantial proportion of powdered feed broadcast over ponds may be lost through wind

dispersion along pond dikes or through leaching and sedimentation at the pond bottom (Kreman *et al.,* 2020), thereby reducing feed utilization efficiency and fish growth.

Specific growth rate (SGR) followed a similar pattern, with significantly higher values under floating pellet feeding, particularly in Gagnoa and Daloa. These SGR levels are comparable to those reported in previous studies on tilapia fed industrial diets under controlled conditions (Makori *et al.,* 2017 ; Nehemia *et al.,* 2012). Conversely, the absence of significant differences in SGR among localities under powdered feed treatments suggests a common nutritional limitation across these treatments, which may have masked the effects of local environmental conditions on growth.

Feed conversion ratio (FCR) was significantly improved with floating pellets, indicating superior feed efficiency. FCR values below 2.0 are generally considered satisfactory for tilapia reared under semi-intensive conditions (Boyd & Tucker, 2012). The higher FCR values observed with powdered feeds, particularly in Abengourou, reflect less efficient feed utilization, likely due to poor particle cohesion, nutrient leaching, and increased organic loading of ponds. These findings are consistent with reports emphasizing the negative effects of non-pelleted feeds on feed efficiency and water quality (Tacon & Metian, 2008).

4. CONCLUSION

The results of this study confirm that the use of floating pellets, in combination with favorable local conditions, optimizes growth performance and feed efficiency of the Brazilian strain of *Oreochromis niloticus*. These findings highlight the critical role of feed selection as a key driver for improving fish productivity, while taking into account local environmental specificities. From a future perspective, it would be relevant to evaluate improved locally produced pelleted feed formulations capable of reducing feed losses while remaining economically accessible to fish farmers.

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