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Comparative Study of the Effects of Imported Industrial Feed and Local Feed on the Growth of Nile Tilapia (*Oreochromis niloticus*) Fry

Jean Fall (Corresponding Author)

University Institute of Fisheries and Aquaculture (IUPA), Cheikh Anta Diop University (UCAD), 45784, Dakar, Senegal. E-mail: kagoshima77@yahoo.com

Yoba Oumou Balde

Centre National de Formation des Techniciens des Pêches et de l' Aquaculture, 10, km, 5 Rte de Rufisque, Pikine, Dakar Sénégal.

Paul Mamadou Ndour

Université du Sine Saloum El-Hâdj Ibrahima NIASS, Kasnack, Face Ex Cinéma ABC, Kaolack, Dakar Sénégal.

Ndeye Codou Mbaye

Universitaire de Pêche et d'Aquaculture, UCAD II, Batiment Pédagogique, Rez de Chaussée BP 5005. Dakar Sénégal

Alla Ndione

Institut Universitaire de Pêche et d'Aquaculture, UCAD II, Batiment Pédagogique, Rez de Chaussée BP 5005. Dakar Sénégal

Aliou Ndao

Centre National de Formation des Techniciens des Pêches et de l' Aquaculture, 10, km, 5 Rte de Rufisque, Pikine, Dakar Sénégal.

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Abstract

A major challenge in tilapia farming is optimizing feed efficiency, as feed costs constitute a significant portion of production expenses. Fish farmers often choose between imported industrial feeds (formulated with standardized nutrient compositions) and locally produced feeds, which may vary in quality and nutritional content but offer a more affordable alternative.

This study investigates the comparative effects of imported industrial feed (R0) and locally sourced feed (R1) on the growth performance of Nile tilapia (*Oreochromis niloticus*) fry. Ninety Nile tilapia fry, with an initial average weight of 0.30 g, were divided into two groups and fed either imported industrial feed or locally sourced feed for 60 days to assess the effects of these two types of feed. The tilapia fry were distributed across six tanks, with fifteen fish per 40 L tank. The fish were fed twice daily, in the morning at 8:00 am and in the afternoon at 5:00 pm. Growth parameters such as weight gain, feed conversion ratio, and survival rate were monitored throughout the experiment. The results indicate that while both feed types supported the growth of Nile tilapia fry, significant differences in growth rates were observed between the two groups. No significant difference was found in the feed conversion ratio, with the R0 control diet showing a FCR of 1.33, while the R1 test diet had a FCR of 1.68. A similar trend was noted for the specific growth rate (SGR). Regarding the survival rate (SR), the control diet showed no mortality (SR = 100%), while the test diet recorded a low mortality rate (SR = 93.33%). This study provides valuable insights into the potential of using locally sourced feeds as a cost-effective alternative to industrial feeds without compromising fish growth. The findings contribute to the development of more sustainable and economically viable feeding strategies for Nile tilapia farming, particularly in resource-limited regions.

Keywords: growth, imported diet, local diet, cost

1. Introduction

Senegal is a country with significant potential in terms of water resources, including rivers, lakes, marshes, and the sea. The country's economy is supported by various sectors, such as agriculture, livestock farming, and notably, fishing. However, the fishing industry is currently facing several challenges, including overfishing, as resources are becoming increasingly scarce. The growing demand for fish products, driven by population growth, further exacerbates this issue. As a result, production from capture fisheries can no longer meet the national demand for fish products. In this context, aquaculture — the farming of aquatic organisms, including fish, crustaceans, mollusks, and aquatic plants (FAO, 2007) — is emerging as a necessary solution to bridge this gap. Aquaculture is a key component of the Emerging Senegal Plan (PSE), which aims to increase aquaculture production to 50,000 tons by 2030.

In recent years, Senegal's aquaculture sector has experienced notable, yet uneven, growth. Between 2000 and 2010, production stagnated at approximately 100 tons per year. However, from 2012 to 2022, the sector's cumulative production reached an estimated 12,659 tons, including fish (tilapia and catfish), shellfish, macro-algae, and crocodiles. Despite this progress, aquaculture production remains low, which can be attributed, in part, to the lack of a sufficient supply of high-quality, locally available feed. Industrial feed is essential for meeting the nutritional needs of farmed aquatic organisms, ensuring optimal growth and performance. However, reliance on imports and the high cost of imported feed have become significant barriers to the development of fish farming.

Given this, research is needed to develop locally produced, high-quality, cost-effective feed that can support the growth of *Oreochromis niloticus* (Nile tilapia). The aim of this study is to compare a local feed with an imported feed in terms of their impact on the growth and survival of Nile tilapia fry. Specifically, the study will:

- Evaluate the growth performance of *Oreochromis niloticus* fry,
- Assess the feed efficiency of *Oreochromis niloticus* fry,
- Examine the survival rate of *Oreochromis niloticus* fry fed with different diets,
- Analyze the economic profitability of the feed and fish production.

2. Material and Methods

2.1 Diet Formulation

The formulation of fish feed is a process developed using a mixture of ingredients (by-products of plant and/or animal origin). It was carried out using the 'PEARSON square method'. Table 1 shows the proportion of the various ingredients used after formulation of the diet (R1).

Table 1. Composition of the diets R0 and R1

INGREDIENTS	R0 (Imported feed)	Local feed (R1%)
Fish meal	Fish meal, Soya cake meal, Wheat meal, Soya oil, Maize meal, Rice bran, Distiller's Dried Grains with Soluble (DDGS) and Maize gluten	25
Tuna by-product meal		20
Soyabean meal		14
Peanut cake meal		12
Wheat bran meal		7
Corn meal		7
Blood meal		5
Cassava meal		4
Fish Oil		2
Vitamins[a]		1
Minerals[b]		1
Yeast		2
TOTAL (g)	100	100
Crude Protein (%)	37	36.9
Crude Lipid (%)	8	8.4

a=vit A 250000 UI; vit D3 250000UI; vit E 5000 mg; vit B1 100 mg; vit B2 400 mg; vit B3 (pp) 1000 mg; vit B5 pantode Ca 2000mg; vit B6 300 mg; vit K3 1000 g; vit C 5000 mg; H biotin 15 mg; choline 100 g; anti-oxydant (BHT), crushed and calcined attapulgite qs 1000 mg;

b=phosphorus 7%; calcium 17%; sodium 1,5%; potassium 4,6%; magnesium 7,5%; manganese 738mg; zinc 3000 mg; iron 4000 mg; copper 750 mg; iodine 5 mg; cobalt 208 mg; calcined and ground attapulgite qs 1000 g; fluorine 1.5% (approximately), *2.2 Diet Production*

The diet (R1) was formulated based on Table 1. After processing, the quantities of the various ingredients were weighed and mixed together. Approximately 30% water was added to this mixture to create a malleable paste. A chopper was then used to convert the paste into spaghetti-like filaments, which were sun-dried for 3 days. After drying, the filaments were broken up into a powder and stored in a dry, well-ventilated area.

2.3 Rearing Conditions

Nile tilapia (*Oreochromis niloticus*) fry were obtained from the CNFTPA aquaculture hatchery. A total of ninety (90) Nile tilapia fry were fed with two different diets: a control diet (R0, imported feed) and a tested diet containing tuna co-products (R1, local feed). The fry were distributed across six tanks, with 15 fry per tank. The tanks were filled to two-thirds of their volume (20 L) and each tank was equipped with an air diffuser to oxygenate the water. The fry was fed twice a day, once in the morning at 08:00 and again in the evening at 17:00. The tanks were cleaned daily in the morning and evening by siphoning off waste and uneaten food that had accumulated at the bottom. After siphoning, the waste water was replaced with fresh water. Growth parameters were measured through control fishing every 15 days. The experiment lasted for 60 days.

2.4 Parameters of Fish Growth, Survival and Feed Efficiency

These parameters highlight a number of growths, feed efficiency and survival factors:

Specific Growth Rate (SGR, %/d) = ((ln IMW-ln FMW)/rearing time x100

Absolute Mean Weight Gain (AMWG, g) = FMW- IMW, With IMW = initial mean weight and FMW= final mean weight of the fish

Relative Mean Weight Gain (RMWG, %) = (FMW-IMW) *100/IMW. With IMW = initial mean weight and FMW=final mean weight of the fish

Survival rate (SR, %) = (FN/IN) *100, With FN: Final numbers; IN: initial Numbers

Feed Conversion rate (FCR)= Quantity of feed distributed/ absolute weight gain

2.5 Economic Profitability Parameters

The economic profitability parameters will highlight the cost price of the feed formulated on the basis of the various ingredients used. They will be calculated using the following formulas:

Cost of feed (CA) = ∑ (cost of ingredients/kg) x amount of incorporation

Price of a kg weight gain (PGP/kg) = (feed cost/kg) x FCR

2.6 Statistical Analysis

The data were analyzed using Statistical Analysis System (SAS-PC) software (Joyner, 1985) and subjected to an analysis of variance (ANOVA). The Duncan test was used to compare significant differences between treatments, a significance level of 5% was used.

3. Results

3.1 Water Quality Parameters

The pH values and temperature are presented in the table 2. The temperature ranged from 21.25°C to 25.2°C for the control diet (R0), with pH values ranging from 6.75 to 8.43. For the local diet (R1), the temperature varied from 20.8°C to 25.65°C, with pH values ranging from 7.0 to 8.61. The average temperatures for the two diets were similar, 22.62°C for R1 and 22.97°C for R0. The average pH values were also close, 7.47 for R0 and 7.72 for R1.

Table 2. Water quality parameters

Paramètres / **Diets**	**T (°C)**			**pH**		
	Min	**Mean**	**Max**	**Min**	**Mean**	**Max**
R0 (Control)	21.25	22.97	25.20	6.75	7.47	8.43
R1 (tested diet)	20.80	22.62	25.65	7.00	7.20	8.10

3.2 Growth, Feed Efficiency and Survival Parameters

The growth, feed efficiency and survival parameters are indicated in the table 3. The experiment began with an initial mean weight (IMW) of 0.30 g. After 60 days, the final mean weight (FMW) varied from 2.52 g (R1) to 3.53 g (R0). The average mean weight gain (AMWG) ranged from 2.22 g (R1) to 3.22 g (R0), while the relative mean weight gain (RMWG) was 739.82% for diet R1 and 1063.14% for diet R0. The best growth parameters, such as weight gain (AMWG and RMWG), were obtained with the R0 control diet, which showed a significant difference compared to the R1 test diet. No significant difference in specific growth rate (SGR) was recorded between the diets. Fish fed the R1 diet had an SGR of 3.78%/day, while those fed the R0 diet had an SGR of 4.37%/day. Fish fed the R1 diet had a feed conversion ratio (FCR) of 1.68, while those fed the R0 diet had an FCR of 1.33. Survival rates ranged from 93.33% (R1) to 100% (R0). No significant difference in feed conversion rate (FCR) or survival rate (SR) was observed between the two diets.

Table 3. Results of growth, feed efficiency and survival parameters

Growth Parameters	R0 (industrial feed)	R1 (local feed)
IMW (g)	0.30 ± 0.01[a]	0.31± 0[a]
FMW (g)	3.53 ± 0.46[a]	2.52± 0.37[b]
AMWG (g)	3.2 ± 0.47[a]	2.22± 0.38[b]
RMWG (%)	1063.14± 129.75[a]	739.82 ± 144.76[b]
SGR (%/d)	4.37± 0.20[a]	3.78 ± 0.33[a]
FCR	1.33± 0.1[a]	1.68 ± 0.2[a]
SR (%)	100 ± 0[a]	93.33 6.66[a]

The superscript letters a and b show that there is a significant difference between the diets ($P < 0.05$).

IMW: initial mean weight, FMW: final mean weight, AMWG, absolute mean weight gain, RMWG, relative mean weight gain, SGR: specific growth rate, FCR: feed conversion ratio, SR: survival rate.

3.3 Biochemical Composition of Fish Flesh

Table 4 shows the composition of the experimental fish fed the different diets. The crude protein content of the fish flesh from those fed the local feed is higher than that of the fish fed the imported feed. However, there were no significant differences in crude lipid and ash content between the fish fed the local and imported diets.

Table 4. Analysis of fish flesh composition

	Crude Protein (%)	Crude lipid (%)	Ash (%)
R0 (Industrial feed)	15.69 ±1.02[b]	7.03±0.01[a]	4.23±1.04[a]
R1 (Local Feed)	17.80±0.04[a]	7.94±1.00[a]	3.73±0.02[a]

Mean with the same letter are not significantly different ($P>0.05$).

3.4 Economic Analysis

The cost of the local feed (R1) is shown in Table 5. The price of the local feed (R1) is 0.91 USD, while the price of the imported feed (R0) is 1.98 USD. The results indicate that the imported feed (R0) is nearly twice as expensive as the local feed (R1).

Table 5. Price of different ingredients and local feed (R1)

Ingredients	Price (USD/kg)	Quantity (g)	Total price (FCFA/kg)
Fish meal	0.83	250	0.21
Soybean Meal	0.68	140	0.10
Tuna by-product meal	0.83	200	0.17
Peanut cake meal	0.41	120	0.05
Wheat bran meal	0.66	70	0.05
Corn meal	0.83	70	0.06
Blood meal	0.41	50	0.02
Cassava meal	0.74	40	0.03
Fish oil	0.68	20	0.01
Vitamins	4.54	10	0.05
Minerals	1.24	10	0.01
Yeast	3.93	20	0.08
Other expenses			0.08
TOTAL		1000	0.91

Tables 6 shows the values obtained from the economic analysis for the production of one kilogram of feed and fish. The results indicate that the cost of producing one kilogram of fish is lower under the R1 system, at 1.53USD. In contrast, the production cost for fish under the R0 system reaches 2.63USD per kilogram. In summary, the results of the economic analysis demonstrate that the R1 system offers economic advantages.

Table 6. Cost of producing one kilogram of fish

Experimental diets	FCR	COST/kg (USD)
Imported feed (R0)	1.33	2.63
Local feed (R1)	1.68	1.53

4. Discussion

Water quality is of fundamental importance for the well-being of farmed fish. Poor control of water parameters can lead to the onset of disease or increased mortality over the long term. It can also slow growth and cause other adverse effects due to stress. Temperature and pH variations during the experiment ranged from 22.97°C to 25.20°C for temperature, and from 7.47 to 7.72 for pH. These temperature values fall within the range proposed by Mjoun et al. (2010), which is 22°C to 29°C, the optimal for the growth of *Oreochromis niloticus*. Accordingly, pH range was optimal for Nile tilapia growth. Bahnasawy et al. (2009) suggested that *Oreochromis niloticus* grows best at a pH between 7 and 9, while Malcolm et al. (2000) suggested an ideal pH range of 6.5 to 8.5.

The results of this study show better growth performance in fish fed with industrial (NATURALLEVA) feed (R0) compared to those fed with local feed (R1), although the latter may represent a promising alternative. This difference could be attributed to a nutritional imbalance or lower digestibility of the proteins used in the local feed. These results highlight the importance of further optimizing local feed formulations to ensure proper nutritional balance, improving feed efficiency while reducing production costs in aquaculture. The findings suggest that the local feed can be a viable alternative to industrial feed, although adjustments are needed to optimize its performance in terms of feed conversion and growth. Several studies have shown that commercial diets perform better than local feeds. Awotoye et (2020) reported that fish fed with Skretting (imported feed) had better growth performance, with higher mean weight and length gains compared to those fed with Blue Crown (local feed). Furthermore, Mustapha et al. (2014) showed that growth performance was influenced by the proximate composition of the feeds. In contrast, Abdulkadiri et al. (2011) reported no significant difference between commercial catfish feeds and on-farm-made aquafeed. The survival rate (SR) varied from 93.33% (R1) to 100% (R0), and the components of the imported and local feeds had no significant effect on fish survival ($P > 0.05$). This suggests that the mortalities recorded may be more attributable to handling during biometric surveys than to the diets tested. This finding aligns with Akiyama (1991), who stated that the growth rate of experimental animals should meet at least 85% of an acceptable standard.

The higher crude protein content observed in the flesh of fish fed the local diet (17.80%) compared to those fed the industrial diet (15.69%) suggests that the protein sources used in the local formulation were effectively utilized for muscle development. However, despite the higher protein content, previous research indicates that protein digestibility and amino acid balance play crucial roles in determining overall growth performance (NRC, 2011). Inadequate digestibility of certain protein sources, such as plant-based proteins, can limit amino acid availability, potentially affecting fish growth (Gatlin et al., 2007). Regarding crude lipid content, no significant differences were found between the two diets (7.03% for R0 vs. 7.94% for R1), suggesting that lipid metabolism in Nile tilapia is more influenced by dietary energy levels than by protein sources alone (Ng & Romano, 2013). For ash content, no significant differences were observed between the diets (4.23% for R0 vs. 3.73% for R1), indicating that mineral deposition was not significantly altered by the feed formulation. Similar results were reported by Yousaf et al. (2022), who found that dietary modifications primarily affected growth performance and protein retention, with limited impact on ash content.

The results of the economic analysis show that the cost per kilogram of feed varied between 0.91 USD for diet R1 and 1.98 USD for diet R0. These results indicate that diet R1 (local feed) is less expensive compared to diet R0 (industrial feed). Moreover, the R1 diet, being cheaper, also reduces the production costs per kilogram of fish (1.53 USD), despite a slightly higher feed conversion ratio (FCR). These results are consistent with those of Sall (2022), who demonstrated a reduction in production costs per kilogram of fish for the local diet compared to Biomar industrial feed (EFICO CROMIS), which cost 1.37USD. However, our results contrast with those of several other studies. Awotoye et Adesina (2020) reported that the average cost of feeding 1 kg of fish with Blue Crown feed was N361.08k, while imported commercial feed cost

N339.26k. The cost of feeding with local feed to achieve a weight gain of 31.67g was ₦80, while feeding with Coppens to achieve a weight gain of 148.58g cost ₦16 (Mustapha et al., 2014). The cost of production for extruded feed (EF) was about 26% lower than for pelleted feed (PF), primarily due to better feed utilization. The load of phosphorus (P) and nitrogen (N) for the PF diet was 59% and 29% higher, respectively, compared to EF. Therefore, extruded feed (EF) delivered better economic gains with lower environmental impact than pelleted feed (PF) (Musa et al., 2023).

5. Conclusion

This study has demonstrated that both imported industrial feed and locally sourced feed can support the growth of Nile tilapia (*Oreochromis niloticus*) fry, but with notable differences in their performance. The results of this study show that the best growth performances were recorded in Nile tilapia fry fed the imported R0 diet. After 60 days of feeding, the results related to specific growth rate, feed conversion rate, and survival rate showed no significant difference between the two diets (industrial feed and local feed). Although the best performances were achieved with the imported feed, locally sourced feed, though more affordable, was still capable of sustaining healthy growth, albeit at a slightly slower rate. This suggests that local feed options, when formulated correctly with available resources, can serve as a viable and cost-effective alternative to imported feeds, especially in regions where economic constraints make industrial feed less accessible. The findings highlight the need for further research into optimizing local feed formulations to improve their nutritional balance and efficiency.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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