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Comparative study of the growth performance of a domesticated strain of *Clarias gariepinus* (Burchell, 1822) and a wild strain of *Clarias senegalensis* (Valenciennes, 1840) using artificial reproduction

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Abstract
This study was carried out to assess the zootechnical performance of a domesticated strain of *Clarias gariepinus* compared with a wild strain of *Clarias senegalensis*. This work was performed on 4g juveniles reared in tanks and obtained by artificial reproduction using 3 males and 2 females for each species. The experiments were carried out in the hatchery of the Agence Nationale de l'Aquaculture (ANA) fish farm in Richard-Toll. Fish were divided into two ponds, with 38 juveniles of *C. gariepinus* in pond P1 and 37 of *C. senegalensis* in pond P2. During the 21-day rearing period, temperature values (ranged from 25°C to 29.5°C) and pH (from 7.48 to 8.13) were those recommended for the breeding of species of the *Clarias* genus. Growth data were obtained by evaluating various growth parameters. Data on average weight gains showed that *C. gariepinus* had the best results with an average weight gains (AWG) of 8.13g, compared with 4.47g for *C. senegalensis*. Concerning the feed conversion ratio (FCR), *C. gariepinus* had the lowest value (1.80 compared with 2.21 for *C. senegalensis*), which also means that this fish assimilates the food more efficiently. Similarly, *C. gariepinus* also showed the best Specific Growth Rate (SGR) (9.97%/day) compared with *C. senegalensis* (7.13%/day). These results revealed that *C. gariepinus* performed better than *C. seneglensis* for all the variables studied, but suggest that this latter species of Senegalese strain could indeed be reared in captivity.

Keywords: *Clarias gariepinus*, *Clarias senegalensis*, growth performance, aquaculture

Introduction
Population growth in developing countries and changing dietary habits are driving a sharp rise in demand for animal proteins, in both urban and rural areas. While most of the supply of living aquatic resources is still provided by fishing, the proportion of aquaculture has grown considerably in recent years.
Aquaculture is one of the pillars of the accelerated growth strategy in many African countries. In Senegal, it aims to strengthen economic activity and the emergence dynamic based on continuous, sustainable growth. The Agence Nationale de l'Aquaculture (ANA) has invested in the implementation of several special programs whose objectives include increasing sustainable livestock production and improving food quality and safety at all stages of the food chain (ANSD, 2022) [1]. This public-private partnership initiative has enabled the establishment of modern hatcheries for the production and distribution of clarias larvae, as well as centers for the pre-frying of these larvae.
However, despite these sustained efforts, this sub-sector faces obstacles linked to difficulties in fish growth, particularly during fry rearing. One response to this issue is fish farming of species with high growth potential, such as those of the *Clarias* genus. In Senegal, breeding of this species is fairly recent, due to the difficulties of producing juveniles in captivity. However, the artificial reproduction techniques described by Viveen et al. (1985) [2] have facilitated the supply of fry and consequently boosted production of this species. Availability of fry must, however, be accompanied by efficient growth. Fish growth results from the concomitant action of specific endogenous factors (genetic baggage)

(Grobler et al., 1992) [3] and exogenous factors such as abiotic characteristics (temperature, dissolved oxygen concentration, luminosity) and biotic characteristics (availability of food resources (Ezenwaji and Ikussenmiju, 1981) [4]. This study, which aims to evaluate and compare the growth performance of *Clarias gariepinus* (Burchell, 1822) [14] and *Clarias senegalensis* (Valenciennes, 1840) fry, will help provide data to meet promoters' demand for quality fry through artificial reproduction.

2. Materiel and Methods

2.1 Study area

The experiments were carried out in the hatchery of the Agence Nationale de l'Aquaculture (ANA) fish farm in Richard-Toll. The ANA is an autonomous administrative structure under the Senegalese government's Ministry of Fisheries and Maritime Economy.

The commune of Richard Toll is located on the shores of the Senegal River (16°27'N, 15°42W), on either side of the Taouey marigot, which links the Senegal River to Lac de Guiers. Richard-Toll is 106 km from Saint Louis and 28 km from Dagana in northern Senegal. It is characterized by a sub-arid climate with low average rainfall (300 to 500 mm) (Ndiaye, 2021) [5].

2.1 Water quality measurements

Water quality was observed on each culture system during the study. Data were collected from each culture system. Environmental parameters such as temperature and pH where daily measured using a pH/temperature sensor HI12963.

2.2 Larval source and experimental set up

For artificial reproduction, five brood fish of *Clarias gariepinus* (Benin strain) from the Richard-Toll fish farm and five of *Clarias senegalensis* (Senegal River strain) were used. For each species, three males and two females were selected. These individuals were weighed and transported to the hatchery, then stored and acclimatized separately in four Happas (HMb, HFb, HMs and HFs) for 48 hours.

To induce egg maturation, a hormonal solution of Ovaprim was used (Gilles et al., 2001) [6]. Prior to dorsal intramuscular injection of the hormone, each fish was weighed to deliver the appropriate dose. The first injection took place in the morning, with milt time scheduled for 8 hours later in the evening. *C. gariepinus* male genitors GMb1, GMb2 and GMb3 were 1kg, 1,500kg and 1,800kg respectively, and received doses of 0.2ml, 0.3ml and 0.36ml respectively. Females GFb1 of 1.500kg and GFb2 of 1.200Kg received Ovaprim doses of 0.75ml and 0.6ml respectively.

The same procedure was repeated for *C. senegalensis*. Male genitors GMs1 weighing 500g, GMs2 900g and GMs3 600g received 0.1ml, 0.18ml and 0.12ml respectively, while female specimens GFs1 weighing 1,400kg and GFs2 weighing 1,200Kg received 0.7ml and 0.6ml Ovaprim respectively.

2.3 Experimental diets

Three types of food were used for feeding clarias larvae and juveniles to compare the growth of *C. gariepinus* and *C. senegalensis*. For the first few days, the larvae were fed dry artemia nauplii. Then, at 9 days of rearing, mosquito larvae were added to the diet. Finally, on the 15th day of rearing, the feed was changed to an industrial diet. Artemia was cultured in a 15-liter bottle. To do this, 30mg of dry artemia were introduced into a beaker, moistened for an hour and then introduced into the bottle. The bottle was shaken continuously. After 24 hours of culture, the artemia nauplii larvae were collected in a beaker and rinsed to remove their shells and salt.

Mosquito culture was carried out in a pond with a dimension of 0.8 x 0.5 x 4 m. Skins of various fruits (mango, papaya, etc.) were introduced and fermented in the water-filled tank to attract mosquitoes. For best results, the environment was exposed to electric light at night. As the mixing temperature did not reach 28°C, a thermostat was used to raise it. After 48 hours of culture, the mosquito larvae were harvested and fed to the fish larvae.

The industrial feed was imported from Ghana. Table 1 shows the proportions of the various ingredients present in it for 20 kg of feed.

Table 1: Feed formula for the industrial feed

Components	For 20 kg	%
Fish meal	6	30
Peanut meal	4.6	23
Corn flour	4.4	22
Rice bran	4	20
Mineral premix	0.2	1
Vitamin premix	0.2	1
Aqua binder	0.2	1
Fish oil	0.4	2
Cowpea	0	0
Total	20	100

The chemical composition of the imported feed used is shown in Table 2.

Table 2: Chemical composition of the industrial feed

Analyses	(%)
Crude protein	29.00
Crude fat	8.00
Crude cellulose	4.20
Crude ash	7.70
Calcium	0.94
Humidity	0
Total phosphorus	0.95
Sodium	0.15

2.4 Feeding trial

Fish were divided into two ponds, with 38 individuals of *C. gariepinus* in pond P1 and 37 of *C. senegalensis* in pond P2. After 24 hours, the time required to destress the fish, the individuals were fed with the same food and the same ration.

2.5 Growth parameters

Results are obtained by evaluating the following growth parameters:

Average initial weight (IW):

IW (g) = initial biomass / initial number of fishes

Average final weight (FW):

FW (g) = final biomass/Final number of fishes

Average weight gain: this parameter was used to evaluate fish weight growth over a given period of time. In the present study, absolute weight gain (AWG) were used.

$$AWG\ (g) = FW - IW$$

Average daily gain (ADG)
This is a coefficient used to assess the effectiveness of the feed used on fish growth.

ADG (g/d) = Weight gain/duration of experiment

The food conversion ratio (FCR)
This coefficient is used to characterize feed utilization efficiency.

$$FCR = \frac{Amount\ of\ feed\ distributed\ per\ fish}{Weight\ gain}$$

The specific growth rate (SGR): this coefficient measures the weight gained by each fish each day, as a percentage of its live weight.

$$SGR\ \left(\%\frac{g}{day}\right) = 100 * \frac{(\ln(FW) - \ln(IW))}{duration\ of\ experiment\ per\ day}$$

3. Results

3.1 Physicochemical parameters

To monitor water quality, temperature and pH values were taken twice a day. However, only the mean values are shown in Table 3. During the 21-day rearing period, average temperatures ranged from 25°C to 29.5°C in the *Clarias gariepinus* rearing environments (P1), and from 25.9 to 27.05 in the *Clarias senegalensis* ponds (P2). pH ranged from 7.56 to 7.91 in P1 and from 7.48 to 8.13 in P2.

Table 3: Mean and standard error (SE) of water environmental parameters in the two ponds during the experiment

Species	Parameters	Experimental weeks		
		Week 1	Week 2	Week 3
Clarias gariepinus	Temperature	25,97±0.85	26,7±0.12	26,23±0.33
	pH	7,88±0.57	7,91±0.42	7,56±0.66
Clarias senegalensis	Temperature	26,22±0.85	27,05±0.20	25,9±0.15
	pH	7,48±0.57	7,57±0.14	8,13±0.33

3.2 Growth parameters

Average weight gain: The results of this study showed a clear difference between the two clarias species in terms of average individual weight. From roughly equal average weights on the first day of rearing between the two species (on average 4g), these values had risen by the end of the experiment to 20.16 g for *C. gariepinus* and 16.45 g for *C. senegalensis*, meaning a difference of 3.71 g in favor of the domesticated strain.

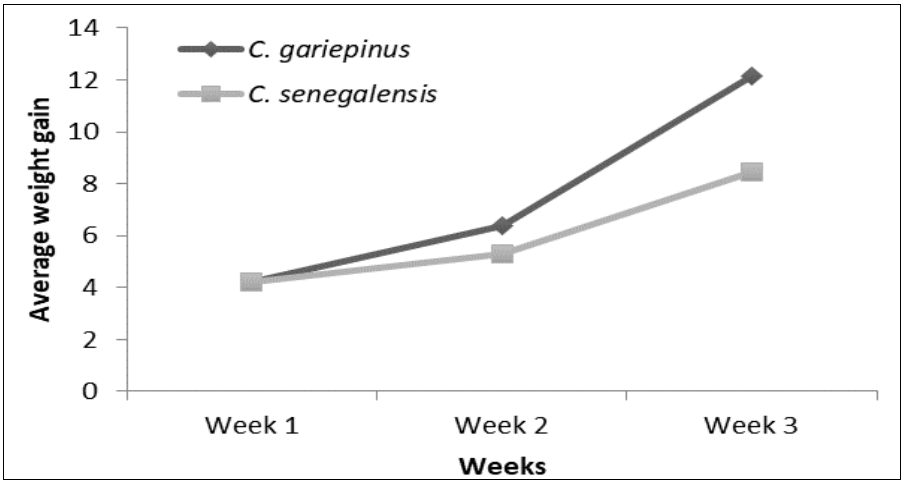

Fig 1: Variation in mean weight of *C. gariepinus* and *C. senegalensis* juveniles over three weeks of rearing. Each point represents the mean estimates of ich specimens.

Table 4: Growth parameters for *C. gariepinus* and *C. senegalensis* juveniles

Parameters	*C. gariepinus*	*C. senegalensis*
IW (g)	4.03	3.98
FW (g)	12.16	08.45
AWG (g)	8.13	4.47
ADG (g)	0.38±0.71	0.21±0.28
FCR	1.80± 0.38	2.21±0.41
SGR (%g/day)	9.97±0.88	7.13±0.04

Feed conversion ratio (FCR): The feed conversion ratio was 1.80 for *C. gariepinus* and 2.21 for *C. senegalensis* (Table 4). These results showed that *Clarias gariepinus* fry had relatively the best ratio between dry weight of feed distributed and weight gain obtained.

Specific Growth Rate (SGR): The highest value of specific growth rate was found in the *C. gariepinus* individuals (Table 4). In fact, *C. gariepinus* has a specific growth rate of 9.97%, while *C. senegalensis* has a specific growth rate of 7.13%, giving a difference of 2.84%.

4. Discussion

Optimum water quality is essential to ensure good artificial

reproduction and influence the growth of clarias fry. During the 21-day experiment, the average temperature was 27.1 °C. This value is close to the optimal temperature for the growth of *C. gariepinus* fry, which varies between 25 °C and 30 °C according to Bara and Jobling (2002) [7]. As for pH, it was almost neutral throughout the rearing period, varying between 6.5 and 7.8. As a result, this value is between 6.7 and 7.5, which is the recommended pH range for rearing these species (Marimuthu et al., 2019) [8].

A comparison of growth performance between *C. gariepinus* and *C. senegalensis* fry reared in ponds had shown high growth performance in favor of fry from the Benin strain.

The average final weight obtained at the end of the experiment shows a higher performance for *C. gariepinus*, with an average weight of 6.0 g versus 3.2 g for *C. senegalensis*. These individual weight gain values recorded in the present study are similar to those obtained by Micha (1973) [9], but remain higher than those obtained by Gandaho (2007) [10], ranging between 0.20 and 0.25. The individual weight gain values recorded in this study were 0.38 for *C. gariepinus* and 0.21 for *C. seneglensis*. They are considerably lower than those obtained by Ducarme and Micha (2013) [11], which were 3 g/day. In contrast, individual weight gains obtained in the present study were higher than those obtained by Gandaho (2007) [10] with Moringa leaves (0.19 g/day) in *Clarias gariepinus*. The feed conversion ratio (FCR), a criterion used in zootechnics to measure the efficiency with which feed is converted into a given output from an animal, had shown that *C. gariepinus* (domesticated strain) values feed more highly than *C. senegalensis* (wild strain). The value obtained for *C. gariepinus* in this study (1.8) is in line with that of Ali et al. (2017) [12], who found conversion rates of 1.73 in Lates calcarifer (barramundi) fry fed on vegetable by-product feed. On the other hand, they are lower than those recorded by Rukera Tabaro et al. (2005) [13], who obtained rates ranging from 0.45 to 0.69 for *Clarias gariepinus* juveniles reared in ponds.

The specific growth rate (SGR) has shown the same trends as the previous growth parameters. Indeed, the best daily growth rate was obtained in *C. gariepinus* fry with a value of 9.97%/day, compared with 7.13%/day for *C. senegalensis*.

This fundamental difference between the two species could be due to the fact that *C. gariepinus* individuals had different social behaviors to those of *C. senegalensis*. Indeed, individuals of the wild strain were more demanding of stable conditions in order to feed, and were very agitated. According to Compaore et al. (2016) [14], wild strains need more time to make morpho-anatomical or morpho-physiological changes in order to adapt to new rearing conditions.

5. Conclusion

The present study on the zootechnical performance of a Beninese strain (*C. gariepinus*) and a Senegalese strain (C. seneglensis) was carried out under the same environmental conditions. Temperature and pH averages were within the limits recommended for clarias rearing. The results of this experiment revealed that *C. gariepinus* performed better than *C. seneglensis* for all the variables studied. However, these preliminary results suggest that *C. senegalensis* can be used in aquaculture in the same way as *C. gariepinus*. Its full domestication would definitely further improve its zootechnical performance.

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