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Research Article

Comparative Effect of Monoculture and Polyculture in Two Species of Clariidae: *Heterobranchus longifilis* and *Clarias gariepinus* in Post Fingerlings Growth

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Abstract

In order to improve the production of Clariidae, a study on the type of cultivation of *Heterobranchus longifilis* and *Clarias gariepinus* in post fingerlings growth phase was carried out in tanks. It took place from March to May 2018 at the IRAD fish station in Koupa-Matapi (LN: 5º 21 'to 5º 58' and LE: 10º 17 'to 11º 02') west region Cameroon. For this fact 180 fry therefore 90 *Heterobranchus longifilis* and 90 *Clarias gariepinus* with an average weight 3.55 ± 0.68 g; 8.46 ± 0.41cm of total length and 7.37 ± 0.30 cm of standard length were used. The 180 fry were divided into three treatments of 60 individuals (T1 treatment: *Clarias gariepinus*, T2 treatment *Heterobranchus longifilis* and T3 treatment: *Clarias gariepinus* + *Heterobranchus longifilis*). Each treatment was repeated twice. The fish were fed twice per day at a rate of 10% of the ichthyobiomass readjusted each month after control fishing with a feed at 42% crude protein. From the results of this trial, it appears that unlike the higher mortality rates (11.66 ± 2.36%) recorded in monoculture *Clarias gariepinus*, the highest cannibalism rates were obtained in monoculture of *Heterobranchus longifilis* (13.33 ± 4.71%). The survival rate was not influenced by the type of culture. Nevertheless, the highest rate (94.44 ± 0.00%) was observed in *Heterobranchus longifilis* in polyculture. The highest growth values were recorded for *C. gariepinus* in polyculture and the weakest for H. longifilis in polyculture. For linear growth, the highest values were recorded in *C. gariepinus* in monoculture. In order to reduce the rate of cannibalism and mortalities in *Clarias gariepinus* and *Heterobranchus longifilis* in post fingerlings growth phase, it is preferable to combine these two species.

Introduction

Low cost and easy accessibility make fish the most consumed animal protein source in the world in general and in developing countries in particular. Its demand increased from 10 to 20 kg / inhabitant / year between 1960 and 2016 [1]. In sub-Saharan Africa and particularly in Cameroon, fish contributes about 50% of animal protein to human nutrition [2]. However, the ever-increasing strong demand is not accompanied by a significant national production (fishing and fish farming). In 2013, it was estimated at 180000 tones, i.e. only 1000 t (1%) from fish farming for a demand estimated at 300000 tones [3]. However, Cameroon has many aquaculture assets, including 400 km of inland water [4] for an estimated potential of 20,000 t per year [5]. Exploiting this potential would not only help to reduce imports, which cost each year nearly 100 billion CFA francs in Cameroon [6], but also to create new jobs. Unfortunately, many constraints still hinder the growth of this sector, including the high cost of food, lack and access to capital, and the unavailability of quality fry [7]. In spite of these constraints, Cameroonian fish farming is full of a variety of species among which African catfish *Clarias gariepinus* are and *Heterobranchus longifilis*.

According to Legendre [8] these two species are of remarkable piscicultural importance because of their hardiness, their rapid growth; of a diversified diet [9]). Consumed fresh or smoked, African catfish pulpit is much more appreciated in Cameroon compared to other fish species [10]. However, their expansions are still limited by the unavailability and inaccessibility of quality fry. In current practices in local hatcheries, fry are delivered to very young fish farmers (less than 5g) without respecting the pre-enlargement phase, which induces yields of less than 50% at emptying [11]. This is due to cannibalization and increased mortality in these species before the size of 12g [12]. Knowledge of the best types of precooking crops could reduce these problems and contribute to the improvement of *C.gariepinus* and *Heterobranchus longifilis* production. The present work aims to contribute to the improvement of the production of juveniles of *Clarias gariepinus* and *Heterobranchus longifilis*. More specifically, the aim is to evaluate the effect of crop type on the survival rate, cannibalism, mortality and growth performance of *Clarias gariepinus* and *Heterobranchus longifilis*.

Material and Methods

Period and area of study

The study took place from March to May 2018 at the IRAD fishing station in Foumban, more precisely at the Koupa-matapit fish farm (5° 21 'to 5° 58' North LE: 10° 17 'to 11° 02 '10 ° 48,826' Longitude East and an altitude of 1147m in the Western Region of Cameroon. The climate is of the Sudano-Guinean type and includes a rainy season (March-October) and a season Dry (November-February) The average values of the temperature and the rainfall recorded annually are respectively 22 °C and 1800 mm [13].

Animal material

A total of 180 fry including 90 *Clarias gariepinus* and 90 *Heterobranchus longifilis* were used. The fry came from a nursery pond at the IRAD fish station with a mean weight of 3.55 ± 0, 68 g; 8.46 ± 0.41cm and 7.37 ± 0.30cm respectively as total length and standard length.

Breeding structure

Six concreted tanks (length 2m, width 0.7m, height 1m) were used. A water supply system consisting of a PCV pipe and valves arranged in parallel allowed the entry and control of the flow of water in each of these tanks. A mosquito net was installed at the entrance for water filtration and to prevent predators from entering the bins. The average flow rate per tank was 0.015 ± 0.002 l / s for a water renewal of 200% per day. A basin was placed under a floating plastic frame allowed to collect food refusals from each tray. Each tray was covered with a net screen over which straws were placed to prevent the entry of predators into the bins and also create a shading to facilitate food consumption [14].

Conduct of the test

The 180 fry were divided into three treatments of 60 individuals each (T1 treatment: *Clarias gariepinus*, T2 treatment: *Heterobranchus longifilis* and T3 treatment: *Clarias gariepinus* + *Heterobranchus longifilis*). Each treatment was distributed in duplicate.

All treatments received 42% protein feed twice per day, consisting of fishmeal, soybean meal, yellow cornmeal, blood meal, palm oil and vitamin premix. The physicochemical characteristics of the water (pH, temperature, dissolved oxygen and conductivity) were measured weekly. The live weight, the total and standard length as well as the refusals collected made it possible to evaluate the following growth characteristics:

Food consumption (CA) = Food served - refusal

Weight gain (GP) = final weight - initial weight

Average daily gain (ADG) = (final weight-initial weight) / (time (day))

Specific growth rate (TCS) = lnfinal weight-lninitial weight / ((time day))

Consumption index (CI) = (Quantity of food consumed) / (Weight gain)

Mortality, cannibalism and survival rates were assessed as follows:

Mortality = (Number of initial fish-mortality)* 100 / (Number of initial fish)

Cannibalism rate = (Number of initial fish - number of missing fish)* 100 / (Number of initial fish) with

Number of fish missing = number of initial fish - number of deaths

Survival rate = (Number of initial fish - number of finfish)* 100 / (Number of initial fish)

Statistical analyses

The one-way analysis of variance (ANOVA) was used to test the effect of crop type on cannibalism, mortality, survival and growth performance of *Clarias gariepinus* and *Heterobranchus longifilis*. Where there were significant differences between the means, the Duncan test was used for the 5% cut-offs. Regressions were used. The statistical software SPSS 14.0 made it possible to carry out all analyses.

Results

Effect of crop type on the evolution of total length and live weight of *Clarias gariepinus* and *Heterobranchus longifilis*

The evolution of live weight and total length according to the type of culture thus illustrated in Figure 1, shows that the trend,

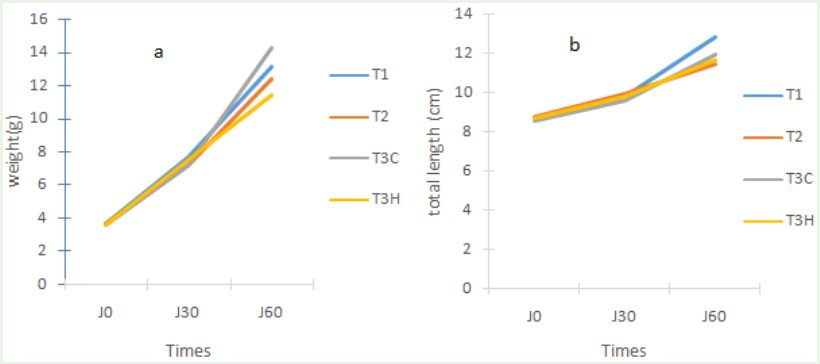

Figure 1: Evolution of weight (a) and linear (b) growth as a function of time.

T1 = *Clarias gariepinus* in mono culture, T2 = *Heterobranchuslongifilis* in monoculture, T_3c = *Clarias gariepinus* in polyculture T_3H = *Heterobranchuslongifilis* in polyculture.

Table 1: Variation in growth characteristics by crop type.

growth characteristics	Treatments			
	T_1	T_2	T_{3C}	T_{3H}
Live weight (g)	13,10 ± 2,55[a]	12,40 ± 4,60[a]	14,30 ± 4,49[a]	11,40 ± 2,11[a]
Weight gain (g)	9,40 ± 2,83[a]	8,750 ± 4,76[a]	10,70 ± 4,08[a]	7,80 ± 1,93[a]
Length (cm)	12,28 ± 0,77[a]	11,41 ± 1,36[a]	11,95 ±1,51[a]	11,65 ± 1,17[a]
Length gain (cm)	3,56 ± 1,01[a]	2 ,68 ± 1,54[a]	3,27 ± 1,18[a]	2,93 ± 1,15[a]
Average daily gain (g)	0,15 ± 0,04[a]	0,14 ± 0,07[a]	0 ,17 ± 0,06[a]	0,13 ± 0,03[a]
Specific growth rate (%)	2,12 ± 0,51[a]	1,96 ± 0,73[a]	2,25 ± 0,42[a]	1,92 ± 0,37[a]
K	0,70 ± 0,09[c]	0,80 ± 0,11[ab]	0,82 ± 0,11[a]	0,73 ± 0,14[bc]
CA (g)	959,50 ± 3,53[a]	896,00 ± 9,14[b]	907,00 ± 10,87[ab]	907,00 ± 10,87[ab]
IC	3,38 ± 0,19[a]	3,37 ± 0,08[a]	3,47 ± 0,31[a]	3,47 ± 0,31[a]

a,b: averages with the same letters on the same line are not significantly different (p> 0.05), TCS = specific growth rate, IC = consumption index, CA = food consumption, K = condition factor. T1: *C.gariepinus* in monoculture, T2: *H.longifilis* in monoculture, T3C: *C.gariepinus* in polyculture, T3H: *H.longifilis* in polyculture.

profile and overall appearance are comparable between crop types regardless of the period. At the end of the trial, the highest weight growth values were recorded in *C.gariepinus* fry in polyculture and lowest in juvenile fry of *H. longifilis* in polyculture. In terms of linear growth, the highest values were obtained in juvenile *Clarias gariepinus* fry, while the lowest values were in monoculture batches of *Heterobranchus longifilis*.

Influence of crop type on growth characteristics of *Clarias gariepinus* and *Heterobranchus longifilis*

The effect of crop type on growth characteristics as shown in Table 1 shows that the highest food consumption was obtained in monoculture of *C. gariepinus*, which was comparable to the polyculture of *C. gariepinus* and *H. longifilis*. The highest values of condition factor K were recorded with *C. gariepinus* in polyculture (T3C) and lowest in monoculture *C. gariepinus* (T1). Although not significant difference, the highest live weight and specific growth rate were obtained in polyculture with *C. gariepinus* and lowest with *H. longifilis* in polyculture (T3H).

Weight-length relationship of species according to crop type

The weight-length relationship as a function of crop type is illustrated in Figure 2 (T1, T2, T3C and T3H). It appears that in both monoculture and polyculture of the two species of Clariidae the coefficient of determination R^2 is very close to 1 showing that the weight is 98% related to the size of the fish.

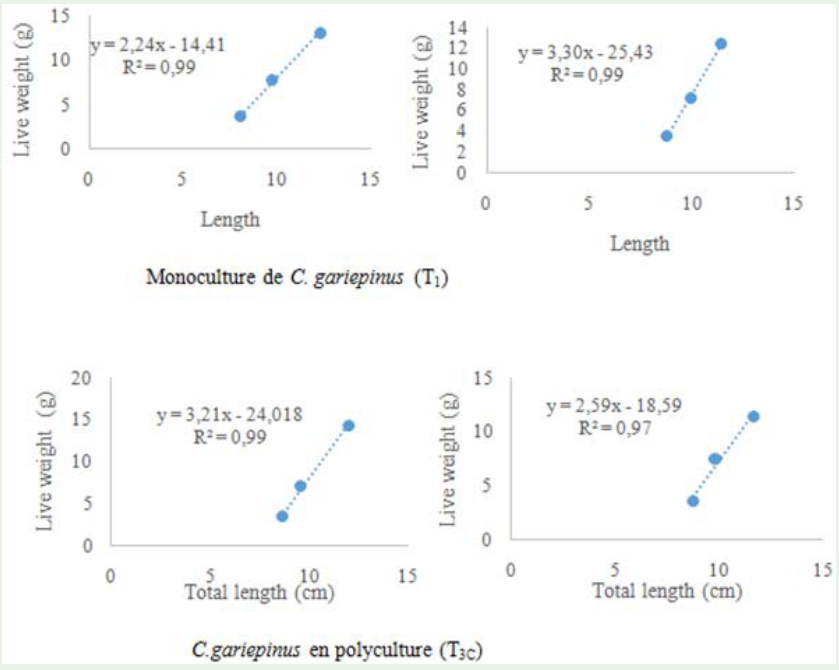

Figure 2: Weight-length relationship of juveniles of *Clarias gariepinus* and *Heterobranchus longifilis* depending on the type of crop.

Table 2: Survival rates, cannibalism rates and mortality rates by Crop Type.

Parameters	Monoculture		polyculture	
	T_1	T_2	T_{3C}	T_{3H}
Mortality rates (%)	10,00 ± 2,36[a]	3,33 ± 2,70[b]	6,66 ± 0,00[b]	3,33 ± 2,714[b]
Cannibalism rates (%)	3,33 ± 0,00[b]	13,33 ± 4,71[a]	3,33 ± 2,71[b]	3,33 ± 2,71[b]
Survival rates (%)	86,67 ± 0,00[a]	83,56 ± 9,42[a]	90,56 ± 4,49[a]	94,44 ± 0,00[a]

a, and b: averages with the same letters for the same line are not significantly different (p> 0.05), T1 = *Clarias gariepinus* in monoculture, T2 = *Heterobranchus longifilis* in monoculture, T3C = *Clarias gariepinus* in Polyculture, T3H = *Heterobranchus longifilis* in fry polyculture.

Effect of crop type on Cannibalism, mortality and survival rates in *Clarias gariepinus* and *Heterobranchus longifilis*

Analysis of the variance showed that the culture type had a significant effect ($p<0.05$) on the mortality and cannibalism rate in juvenile *Clarias gariepinus* and *Heterobranchuslongifilis* as presented in Table 2. At the high mortality rates (11.66 ± 2.36%) observed in monoculture *Clarias gariepinus*, the highest cannibalism levels were obtained in monoculture of *Heterobranchus longifilis* (13.33±4.71%). The survival rate was not influenced by the type of culture. Nevertheless, the highest rate (94.44±0.00%) was obtained in polyculture in *Heterobranchus longifilis* in Table 2.

Discussion

The growth characteristics results show that apart from food consumption and the k factor, the other growth characteristics of *Clarias gariepinus* and *Heterobranchuslongifilis* were comparable regardless of crop type. These results are similar to those obtained by Teugels et al. [15] in *Heterobranchuslongifilis* and *Clarias gariepinus* larvae for 17 days after hatching. Whatever the type of crop, the growth characteristics obtained during the experiment was low. They are due to the nitrite content, ammonia and high conductivities (45-60 µS) indicated as harmful by the recommended values (15-45µS) for farmed animals in ponds. In addition, regardless of crop type, the temperatures obtained were low (22.5-26.5) and below the recommended limits (27.5-32.5°C) by Anderson and Fasta [16] for optimal growth. Dissolved oxygen values (1.70-1.95) were well below that recommended (5 mg / l) by Saloom and Duncan [17]; the pH obtained in the tanks was lower (4.5-5.5) than the recommended values 6.5 and 9 for the breeding of catfish. These could explain the low food consumption and therefore the low growth rates recorded in this study.

The maximum values of average daily gain recorded in *Heterobranchus longifilis* (0.15 g / d) are greater than 0.12 g / day obtained by Coulibaly [14] in *Heterobranchus longifilis* with a loading weight of 0, 8g high in bins covered for 90 days but very low compared to 3 g / d obtained by Legendre [18] in breeding of *Heterobranchus longifilis* in pond in phase of enlargement and still much lower than 5g / day obtained in *Heterobranchus longifilis* raised at low density in pens and in association with Tilapia; the highest average daily gain obtained in *Clarias gariepinus* in combination (0.18g) shows that the latter has more valorized the food than in other System; it is slightly higher than 0.14g obtained in *Clarias gariepinus* with a feed based on Néré seeds and containing 42% of proteins and very much less than 3 g / day obtained by Micha [19] in the same species. These poor performances could be justified by the physicochemical conditions of the water. Whatever the type of crop, the specific growth rates (2.10 ± 0.51% - 1.92 ± 0.37%) are lower than 3.77%; 3.61%; 3.59%; 3.57% obtained by Coulibaly [20] from *Heterobranchus longifilis* reared respectively without a refuge system, with white, blue and black refuge systems; also less than 4, 26% and 3.85% obtained by Toko [21] at *Clarias gariepinus* respectively with a food at 45% 42% protein. Factor K values that provide information on fish overweight were significantly influenced ($p<0.05$) between treatments and ranged from 0.71 to 0.83. Although higher than 0.71 to 0.76 found by Ekoue [22] in *Clarias gariepinus*, the maximum value (0.83) was lower than 1.86 reported by Melwa et al. [23]. These values remain below to 1, which indicates that the fish is not well condition. This difference in values would probably be related to the age of the fish and the physicochemical conditions of the water. Significantly high cannibalization rates ($p<0.05$) in bins containing only *Heterobranchus longifilis* (13.33±4.7%) would be caused or increased by a range of biotic factors (such as aggressiveness) and abiotic (water transparency, brightness). This reflects the great voracity of the fry of *Heterobranchus longifilis* by contribution to the fry of *Clarias gariepinus*. These results are lower than 21.8% obtained in fry *Heterobranchus longifilis* in breeding without a refuge system [14]. The low rate of cannibalism obtained in polyculture with *Heterobranchus longifilis* could be the results of a concealment of fry this species among those of *Clarias gariepinus* which decreased aggression towards each other.

Mortality rates were significantly different between treatments. The highest rate obtained in *Clarias gariepinus* (10.00 ± 2.35%) shows that the latter is less hardy than *Heterobranchus longifilis*. These mortalities were due to the stresses caused by the handling of the species during control fisheries combined with the physicochemical parameters of the water. Nevertheless, regardless of the species, the results are lower than the 15.0±1.7% and 14.0 ± 2.0% obtained by Coulibaly [14] in *Heterobranchus longifilis* grown in uncovered vats and feeding respectively the day and the year. Night Survival rates are virtually high regardless of crop type and range from 83.56±9.42% to 94.44±0.00% and are well above 64.0%; 71.1%; 74.0%; 70.9% obtained by Coulibaly [22] in *Heterobranchus longifilis* reared with respectively without refuge system, with a white, blue and black refuge system, but very weak compared to the 100%. This difference squeezed out of cannibalism due to stress caused by handling (catching and weighing) fish during control fisheries

Conclusion

At the end of this study, it appears that, except for the condition factor K and the consumption index; all the growth characteristics were not influenced by the type of crop whatever the species. Rates of cannibalism and mortality were influenced by the type of crop.

Thus, the highest cannibalism rate was recorded in *H. longifilis* and the mortality rate in *C. gariepinus* in monoculture.

To reduce the rate of cannibalism and the mortality rate in *Clarias gariepinus* and *Heterobranchus longifilis* in post fingerlings growth phase, it is recommended to combine these two species.

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