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Feeding rate requirements for *Schilbe intermedius* (Rüppel, 1832) fingerlings reared in captivity

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Abstract

The control of the breeding of *Schilbe intermedius* in captivity, passes by the determination of its nutritional requirements. The present study aims therefore to determine the optimal feed ration of the fingerlings of *S. intermedius*. The experiment was carried out in circular basins during 28 days. After their capture in natural environment, their transfer in controlled area and their acclimatization to the artificial food used (coppens: protein 45%.), the fingerlings used (average weight: 3.12±0.83g) were subjected to four feed rations (2, 5, 8 and 11% of the biomass) tested in triplicate each one. Thus, the lowest rate of survival (64.00±1.15%) was recorded for the fingerlings'lot subjected to the ration of 8% where the pH is more acid (5.29).The final average weight (4.63±0.00g), the specific growth rate (1.19±0.08%/day) and the food effectiveness (0.53±0.00) obtained with the ration of 11% were the highest. These values are significantly different (P< 0.05) than those obtained with the ration of 2%.The best consumption index was registered with the ration of 2%. According to the model of Brett, the maximum and optimal daily rations of *S. intermedius fingerlings* were estimated to 4.6 % and 8.5 % respectively.

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Introduction

Fish is a precious and essential source of protein for the nutritional balance and human health. In the developing countries, it represents 24% of the animal protein contributions (FAO, 2014). In 2012, only 60% of the world halieutic production, came from the natural production. This is the consequence of the decrease of the natural halieutic productivity owing to the anthropic pressures and the evolution of the environmental conditions (FAO, 2014). Thus, some fish species including *Schilbe intermedius* (Rüppel, 1832) are overexploited (Lalèyè *et al.,* 1997; Tossavi, 2013). In order to reduce the pressures exerted on them in the natural environment, the breeding of *S. intermedius* in captivity proves to be requisite.

S. intermedius is a fish widespread in Africa except Northen and the Southen areas which height can reach 500 mm (Paugy *et al.,* 2004). It is appreciated by the majority of the consumers and identified as an aquacole species (Fermon, 2010), but its domestication was never tried.

Several studies such as parasitology (Smit *et al.,* 2000), food ecology (Teferra *et al.,* 2003; Mosepele *et al.,* 2006), structure, biology and reproduction (Ahouansou Montcho *et al.,* 2011) were carried out on *S. intermedius*. However, its nutritional requirements were never been evaluated. The evaluation of these needs will not happen without the determination of feeding rate. This justifies our study because the control of the reproduction in captivity and the determination of the quantitative and qualitative needs are inherent in a good domestication (Lazard *et al.,* 2004; Monentcham, 2009). Moreover, the food effectiveness and the survival of breeding fish are strongly influenced by the feed ration (Brett and Grove, 1979; Pickering, 1993; Kpogue, 2013).This parameter makes as well as possible to express the potential performances of the fish (Kerdchuen, 1992; Kpogue, 2013). Thus, malnutrition can lead to a reduction in the performances of the fish's growth while an overfeeding leads to a wasting food and causes water pollution. Consequently, the knowledge of the quantitative food needs for a species will make it possible to reduce the production costs for a better profitability of the aquacoles companies, but also, to minimize the risks of pollution of the breeding medium (Woods, 2005).

The present study aims therefore to determinate the feed ration able to induce the optimal zootechnical performances of *S.intermedius* fingerlings fed in captivity.

Materiel and methods

Provenance of fish

S. intermedius fingerlings used in this study were captured in the "Acadjas" installed on the delta of the Ouémé river in Agonlin-Lowé (N 0639' 378 ", E 00228' 571"), a village of the commune of Adjohoun (Southern of Benin). The average values of temperature, pH and dissolved oxygen of this medium were 27.2 ± 0.1°C; 6.9 ± 0.2 and 5.8 ± 0.1mg/L respectively.

Experimental conditions

The fingerlings collected at Agonli-Lowé, were transferred in circular basins on the research station on diversification of pisciculture from the Research Laboratory on the Wetlands of located in the Faculty of Science and Technics of the University of Abomey-Calavi. These fingerlings were subjected to a progressive acclimatization phase in the physicochemical conditions of the station and the artificial feeding. They were therefore fed during the first two days with living frog tadpoles which were gradually substituted by commercial food Coppens (protein 56%) with a diameter of 0.8 mm, in the proportion of 25% from the third to the fourth day, 50% the fifth day, 75% the sixth day and 100% the seventh day.

After acclimatization, 600 fingerlings of *S. intermedius* with average weight of 3.12±0.83g were divided into batches of 50 fingerlings each in 12 circular basins (0.5 m of radius) filled with water until a height of 30 cm corresponding approximately to a volume of 235.5 liters. The water of the basins was continually renewed during all the test at rate of 1litre

per minute.

Four (4) feeding rates namely R_1, R_2, R_3, R_4, distributed respectively to 2, 5, 8 and 11 % of the biomass were tested in triplicate during 28 days. The food used was Coppens with a diameter of 1.5 mm, containing approximately 45% of protein, 10% of lipids and 18.5 Kj/g of crude energy.

The food was distributed manually every 2 hours from 8 AM to 6 PM. The remaining food per basin was weighed each evening after feeding.

Sampling

The total number and the biomass of fingerlings were determined per basin at the beginning and the end of the experiment. The individual weights and lengths of all fish were also measured by basin. Every 7 days, fishing of control were carried out. During these fishing of control, the fishes of each batch were counted and their total biomass was determined in order to readjusted the feeding rate. The basins were also completely cleaned. Moreover, all the duration of the experiment, the temperature, the pH and the dissolved oxygen concentration of water were measured daily.

Estimates of growth parameters

The data collected during the experiment, enable the calculation, for each treatment, of the following zootechnical parameters: Individual Weight Gain (IWG, g) = final body weight – initial body weight; Specific Growth Rate (SGR, %/day) = 100 x [ln(final body weight) – ln(initial body weight)]/d; Feed efficiency (FE) = (FB + DB – IB)/FD, Survival rate (Sr, %) = 100 x FN/IN, the Feed Conversion Ratio (FCR) = 1/FE and the Cost of Pre enlargement (CP, F.CFA/g) = CPC/IWG. With: ln = Napierian logarithm, d = duration of the experiment (number of days), IB = Initial Biomass, FB = Final Biomass, DB = Biomass of Dead fish, FD = total Food Distributed, IN = Initial Number of fish, FN = Final Number of fish, CP = Cost of Pre-enlargement, CPC = Cost Price of Coppens per fingerling.

Statistical analysis

The statistical comparison of the obtained results was performed with Statview software by the method one-way analysis of variance (ANOVA 1). Significant differences between the averages were determined using the test of LSD (Least Significant Difference) at $p < 0.05$ (Saville, 1990).

Results

The table 1 presents the average values of the physico-chemical parameters in the basins during the experiment. No significant difference was noticed for temperature ($p>0.05$). On the other hand, the pH and the dissolved oxygen concentration of water of the batch fed with R_3 were significantly lower than those of the batch fed with R_1 ($p < 0.05$).

Table 1. Variation of the physicochemical parameters according to the various treatments

Parameters	R_1 (2%)	R_2 (5%)	R_3 (8%)	R_4 (11%)
Temperature (°C)	27.38±0.412a	27.77±0.43a	28.04±0.45a	28.14±0.44a
pH	5.85±0.41a	5.73±0.43a	5.29 ±0.73b	5.57±0.23a
DO (mg/L)	6.23±0.73a	6.09±0.71a	5.83±0.73b	5.85±0.57b

On the same line, the values dividing the same letter are not significantly different ($p > 0.05$).

The feed efficiency registered was 0.45±0.01; 0.53±0.00; 0.50±0.01; 0.53±0.00 for the rations R_1, R_2, R_3 and R_4 respectively. Although no significant difference was noticed for these values ($P>0.05$), those recorded with R_2 and R_4 were slightly higher than the others (Fig. 2).

The specific growth rate increased significantly with the rationing rate ($p < 0.05$) (Table 2). The lowest SGR was obtained with the ration R1. No significant difference was observed between the SGR obtained with the rations 5%, 8% and 11% ($p > 0.05$).

Moreover, the table 2 shows that the feed conversion

ratio of the batches fed with the rations R2, R3 and R4 were significantly lower than that noticed with the batch R_1 ($p < 0.05$).

The final average weight varied significantly ($p < 0.05$) from 3.82 ± 0.00 to 4.63 ± 0.00g (Table 2). The figure 1 revealed that the highest average weights were obtained with the R2 rations, R3 and R4 ($p < 0.05$). However, the final weights obtained with the rations 5%, 8% and 11% are not significantly different ($p > 0.05$).

Table 2. Effect of the various feed rations on the principal zootechnical parameters of *Schilbe intermedius* fingerlings.

Parameters		R_1 (2%)	R_2 (5%)	R_3 (8%)	R_4 (11%)
Number	Initial	150	150	150	150
	Final	102	99	96	102
Average body weight (g)	Initial	3.13±0.86	3.12±0.83	3.13±0.83	3.13±0.80
	Final	3.82±0.00a	4.63±0.00b	4.62±0.01b	4.63±0.00b
Specific Growth Rate (SGR) (%/day)		0.54±0.02a	1.173±0.01b	1.12±0.01b	1.19±0.08b
Feed efficiency (FE)		0.45±0.01a	0.53±0.00b	0.50±0.01b	0.53±0.00b
Survival rate (%)		68,00±3.05a	66,00±2.30a	64,00±1.15a	68,00±4.16a
Feed Conversion Ratio(FCR)		2.23±0.05a	1.87±0.03b	1.99±0.05b	1.88±0.02b

On the same line, the values dividing the same letter are not significantly different ($p > 0.05$).3.

The table 3 shows that the pre-enlargement cost of fingerlings fed with R_2 and R_4 were significantly lower and more economically profitable than that of the two other treatments ($p<0.05$).

According to the model of Brett (Fig. 3), the optimal and maximum ration of *S. intermedius* fingerlings were respectively estimated at 4.6% and 8.5% of their biomass.

Table 3. Estimate of the cost of pre enlargement per *Schilbe intermedius* fingerling fed with various rations at the end of 28 days.

Parameters \ Diets		R_1 (2%)	R_2 (5%)	R_3 (8%)	R_4 (11%)
Average body weight (g)	Initial	3.13±0.86	3.12±0.83	3.13±0.83	3.13±0.80
	Final	3.82±0.00a	4.63±0.00b	4.62±0.01b	4.63±0.00b
Individual weight gain (g)		0.69a	1.51b	1.49b	1.5b
Quantity of feed/fingerling*		2.09	3.71	3.90	3.67
Price of "Coppens" (F.CFA/g)		3.5	3.5	3.5	3.5
Cost price of "Coppens" / fingerling (F.CFA)**		7.32	12.99	13.65	12.85
Cost of pre enlargement / g of fingerling (F.CFA/g)		10.60a	8.60b	9.16c	8.56b

* Quantity of food distributed by fingerling = Quantity of distributed feed/ alive fingerlings at the end of the experiment number .

** Cost price of Coppens by fingerling (F.CFA) = Quantity of distributed feed/fingerling X Price of Coppens (F.CFA/g).

Discussion

The results of this study show a significant effect of the feeding rate on the growth of fingerlings of *S. intermedius*. During this experiment, the survival rates (68±3.05%; 66±2.30%; 64±1.15%; 68±4.16%) are different from the 100% obtained by Kpoguè *et al.* (2011) during the estimation of the optimal ration for the fingerlings of *Parachanna obscura*. However, they are in agreement with the conclusions of Hecht and Appelbaum (1988) and Durville *et al.* (2003)

which indicate that with predatory fish fingerlings, the adaptation to artificial food affects their survival rate. The survival rates recorded in this study could be also explained by the acid pH of the water in the basins which was out of the tolerance range of pH (6 à 8) of *S. intermedius* (Lalèyè *et al.,* 2003, 2005; Chikou, 2006). Thus, the lowest survival rate was recorded with R_3 in the basin which water was more acid. Moreover, contrary to most of catfishes, *S. intermedius* is devoid of accessory respiratory organ and consequently very exacting for the water dissolved oxygen.

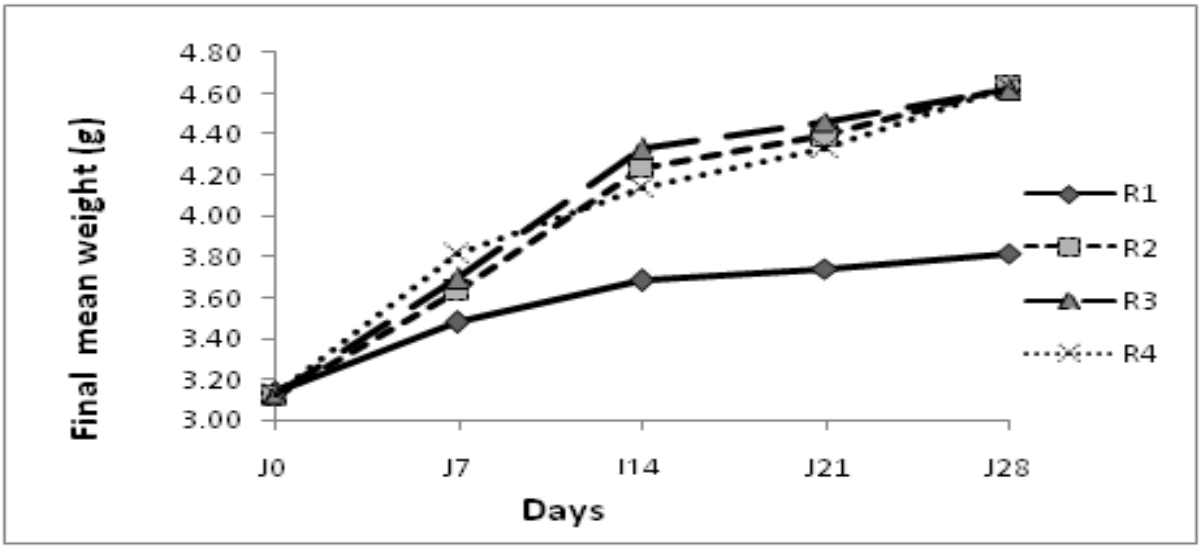

Fig. 1. Evolution of the average individual weights according to the rationing of the fingerlings of *Schilbe intermedius*.

The SGR, which enable to more appreciate the growth potential of fish, revealed in this study, a variation according to various treatments (R_1, R_2, R_3, and R_4).They are respectively of: 0.54±0.02 %/day; 1.173±0.01 %/day; 1.12±0.01 %/day; 1.19±0.08 %/day. These values are close to 1.11-1.52 %/day obtained by Aderolu *et al.* (2010) for fingerlings of *Clarias gariepinus* but lower than 3.18 %/day obtained by Kpoguè (2013) for *P. obscura* fingerlings of 2.45g and 2.63 and 3.10 %/day obtained respectively by Mélard *et al.* (1995) and Fiogbé (1996) of *Perca fluviatilis* fingerlings of 3g.

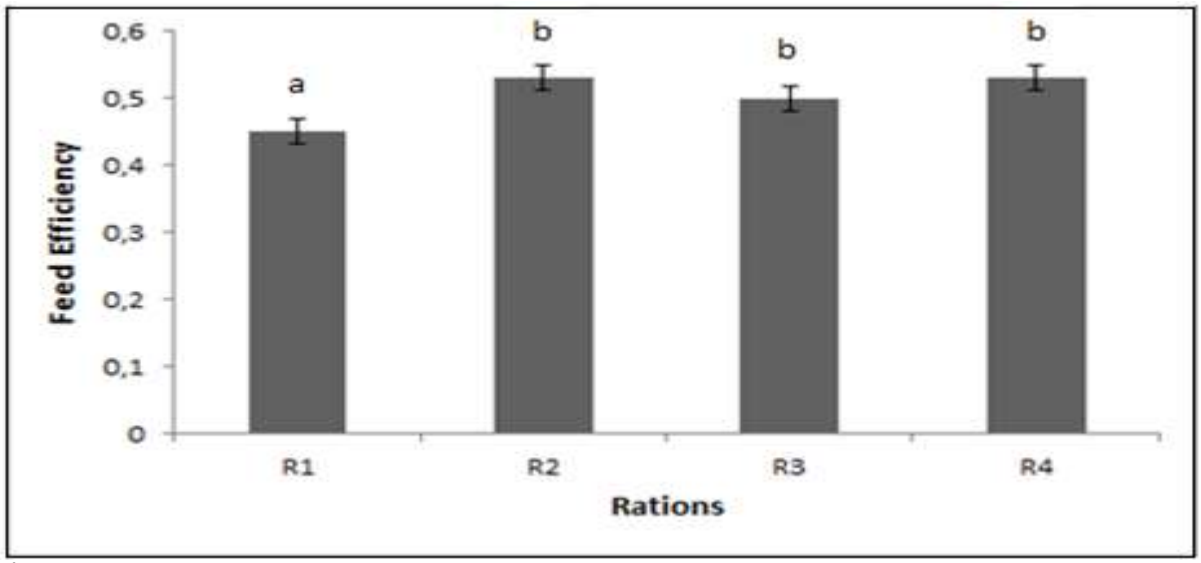

Fig. 2. Variation of feed efficiency at *Schilbe intermedius* fingerlings fed with various rations for 28 days.

These very low rates compared to the values from 4 to 5% obtained under particular experimental conditions by Harmon and Peterson (1994), are however in the range of 0.5 and 3 % usually recorded in aquaculture (Barnabe, 1991).The values of the FE obtained during this experiment varied between 0.45±0.01 (R_1) and 0.53±0.0 (R_2 and R_4) and were higher than those recorded by Kpoguè *et al.* (2011) on fingerlings of *Parachanna obscura* fed with the same food (Coppens 1.5mm).This suggests that *S. intermedius* converted better this food. Although the maximum growth is observed for the batch fed with R_2 ration, one notes no significant difference between the FCR of this batch and that of the batches R_3 and R_4.This can be explained by the fact that the food was distributed by minimizing. Indeed, a low growth and high FCR can indicate malnutrition or a bad assimilation of feed by fish (Durville *et al.,* 2003).

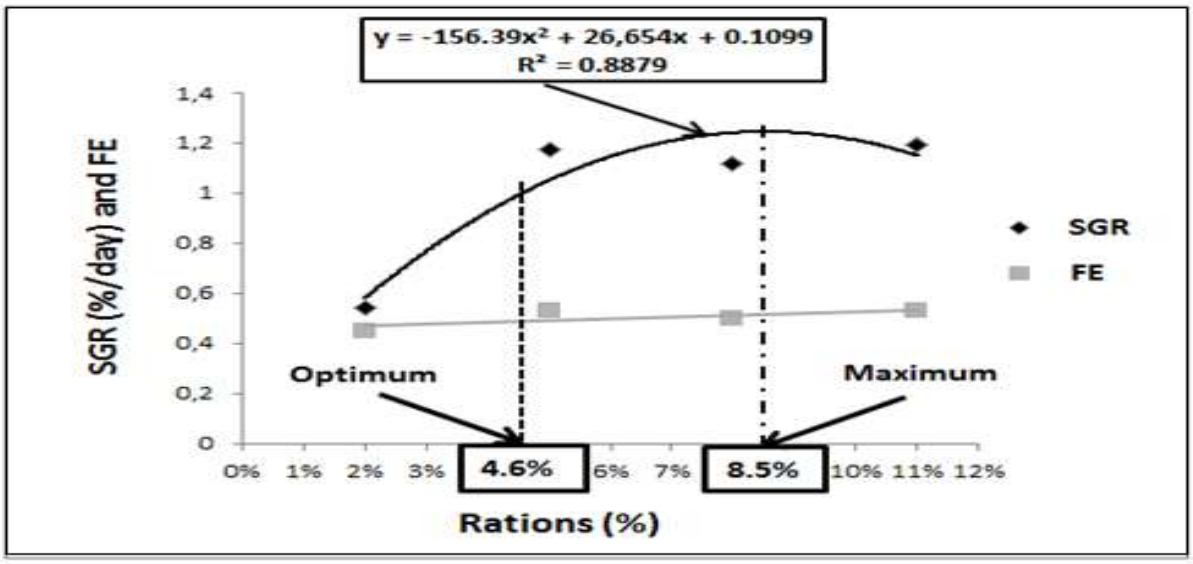

Fig. 3. Variation of Specific Growth rate (SGR) according to the model of Brett and the feed efficiency of *S.intermedius* fingerlings fed with various rations for 28 days.

According to an economic standpoint, the optimal feed ration is the one which associates minimal feed ration and the maximum feed efficiency (Kpoguè *et al.,* 2011). According to that economic approach, the optimal feed ration at *S. intermedius* fingerlings with individual average weight of 3.12 g is approximately 5% of the biomass of fish. With the model of Brett the daily optimal ration is approximately 4.6 % of the biomass of fish and the maximum ration, corresponding to the maximum growth rate is approximately 8.5 %. This optimal ration is well located in the ranges reported by Khan *et al.* (2004) which obtained for *Cirrhinus mrigala,* the best FE and SGR with rations from 4 to 6% of the biomass. These results corroborate those of Lequenne (1984), Kerdchuen (1992), Fiogbé (1996) and Kpoguè (2013) according to which the optimal feed ration varies from 1 to 5% for carnivorous fingerlings fish with an initial weight higher than 1g.

Conclusion

At the end of this experiment, it can be conclude that for *S. intermedius* with initial average weight of 3.12g, the optimal daily ration is approximately 4.6 % of the fish biomass whereas the maximum ration is approximately 8.5 %. For fishes of higher size, the feed rations still remain to be determined with precision. The survival rates observed for all the treatments, can allow a breeding in captivity of this species. Nevertheless, these survival rates must be improved by correcting the water pH. For a better assessment of the quantitative requirements of this specie, it will be necessary to determinate the density of loading and the frequencies of feeding.

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