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Optimal Feeding Frequency for African Sneakhead Fish (*Parachanna obscura*, Gunther, 1861) Fingerlings Reared in Captivity

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Abstract *Parachanna obscura* is a fish that has a good economic value and is an important performance for aquaculture. By identifying the optimum stocking density and frequency of feeding, farmers can successfully decrease the feed charge and increase growth performance. The aim of our study is to define optimum frequency of feeding of *P. obscura* fingerlings reared controlled condition. Therefore the experiment was conducted during three months. The fingerlings of *P. obscura* were fed one of four schedules at 3% of body weight. The initial weight body was 13.27±0.07 g. At the end of this study, the results prove that survival rates were 100% and were not significantly affected by the frequency of feeding (p>0.05). Growth performances varied significantly with treatments (p<0.05). The augmentation of frequency of feeding above 3 times/day did not produce any significant (p>0.05) improvement of growth. Therefore, optimal feeding frequency for *Parachanna obscura* fingerlings reared in controlled conditions is three times daily.

Keywords Feeding frequency; *P. obscura*; Fingerlings; Diet

Background

The snakehead belonging to the family Channidae is one of the important native fish of freshwater of tropical Africa and Asia (Ng and Lim, 1990). The local and international markets greatly demand on Channidae due to its tasty flesh and medicinal value in enhancing wound healing and reducing potsoperative pain (Mollah et al., 2009). *Parachanna obscura* is the most common African Channidae (Bonou and Teugels, 1985). It is a hardy species that supports stressful conditions (Kpoguè et al., 2013a). It has good economic value and is an important performance for aquaculture (Micha, 1974; Boladji et al., 2011). It is not a fatty fish but an intermediate one (Mujina et al., 2009). It is consumed for its nutritional value (Ama-Abasi and Ogar, 2013) and its flesh is white, firm, practically boneless and has an good flavor. To maintain this fish population as well as its rehabilitation and conservation, development of a suitable technology for rearing of *P. obscura* fingerlings is necessary. Efforts on culturing *P. obscura* merely start and end at collecting them from the wild. It is reared in small reservoirs in hydro-agricultural purpose in Ivory Cost (Lazard and Legendre, 1994). It is also extensively cultured in Cameroon, Nigeria and Democratic Republic of Congo (De Graaf, 2004; FAO, 2007; Bassey and Ajah, 2010). In intensive fingerlings culture, several factors influence survival rate, welfare, growth, feed efficiency, production including feeding level (El-Sayed, 2002; Imtiaz, 2007), dietary nutrient level (NRC, 1993), stocking density (Ma et al., 2006; Chambel et al., 2015; Gao et al., 2017) and feeding frequency (Jamabo et al., 2015). The overfeeding of fish pollutes the water of the aquaculture and meant expenses supplement on the production cost. However, the optimization of the feed ration and the frequency of distribution constitute fields of research in the aquaculture. In aquaculture, stocking density is the concentration which fish are stocked into a system (De Oliveira et al., 2012). By identifying the optimum stocking density and feeding frequency, farmers can successfully decrease the feed cost and increase growth and also able to manage other parameters such as variation of individual size and qualities of water which are deemed important in rearing of fish in culture conditions. Feeding level requirements, dietary (protein, lipid and carbohydrate) level requirements of *P. obscura* fingerlings have been determined by

(Kpoguè and Fiogbé, 2012; Kpoguè et al., 2013b; Kpoguè et al., 2018a; Kpoguè et al., 2018b). No work has yet been undertaken on feeding frequency of *P. obscura* fingerlings. The aim of study is therefore to determine optimum frequency of feeding of *P. obscura* fingerlings reared controlled condition.

1 Results

During the experimental, physico-chemical parameters are 27.85 ±0.29 ℃ for the temperature, 6.57 ±0.16 mg/L for the dissolved oxygen and 6.15 ±0.82 for pH. Survival rate, growth performances (condition factor, specific growth rate and final body weight) and feed efficiency during the study are presented in Table 1. There was no mortality recorded during the experiment period. Survival rate didn't vary among treatments and was 100% ($p>0.05$). Growth performances varied significantly with treatments ($p<0.05$). Thus the greatest final body weight was achieved by the fish fed treatments T2 (3 times/day), T3 (4 times/day) and T4 (5 times/day). The least final body weight (26.75±0.86 g) was recorded with fish fed treatment T1 (2 times/day). The specific growth rate and the condition factor improved significantly ($p<0.05$) as feeding frequency increased from twice (T1) for 3 times/day (T2). The augmentation of feeding frequency above 3 times/day did not produce any significant ($p>0.05$) improvement of specific growth rate (Figure 1). Feed efficiency did not varied significantly with treatment ($p>0.05$). Nevertheless, it varied from 0.51 ±0.05 (T1) to 0.63 ±0.12 (T3).

Table 1 Growth performances, feed efficiency and survival rate of experimental fishes

Parameters	T1	T2	T3	T4
Initial body weight (g)	13.23±0.03 ^{a}	13.29±0.04 ^{a}	13.27±0.06 ^{a}	13.29±0.06 ^{a}
Final body weight (g)	26.75±0.86 ^{a}	30.13±0.55^{bc}	32.57±1.45 ^{c}	33.03±0.42 ^{cd}
Feed efficiency	0.51±0.05 ^{a}	0.58±0.07 ^{a}	0.63±0.12 ^{a}	0.62±0.06 ^{a}
K (condition factor %)	0.72±0.05 ^{a}	0.77±0.01^{b}	0.78±0.03^{b}	0.79±0.04^{b}
Survival rate (%)	100±0.00 ^{a}	100±0.00 ^{a}	100±0.00 ^{a}	100±0.00 ^{a}

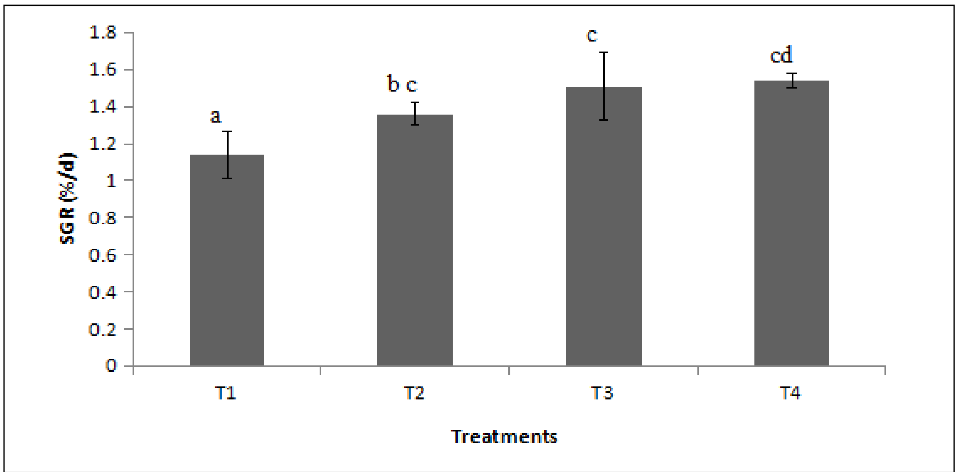

Figure 1 Relationship between specific growth rate and feeding frequency

2 Discussion

The mean quality of water parameters values (dissolved oxygen, pH temperature) observed in this study were within the recommended range for *P. obscura* according to Bonou and Teugels (1985) and Riehl and Baensch (1991). Feeding and feeding frequencies are key factors that determine the growth and survival chances of fishes (Ndome et al., 2011). Multiple feedings has previously been found to be stimulatory for growth, survival and feed utilization in fingerlings of Indian major carps (Choudhury et al., 2002; Kiaalvandi et al., 2011; Ashfauq et al., 2017). The results of our study showed that, in any treatments, a survival rate (100%) was affected by the feeding frequency. These results confirmed that *P. obscura* is a hardy and rustic species (Kpoguè et al., 2013a). Growth performances (final body weight, specific growth rate and condition factor) varied significantly with treatment. But the augmentation of feeding frequency above 3 times/day did not produce any significant ($p>0.05$) improvement of growth. The least growth performances were recorded in fingerlings fed with twice/day groups.

Growth generally increased with feeding frequency up to a given limit (Wang et al., 1998; Bascinar et al., 2007; Asuwaju et al., 2014; Jamabo et al., 2015). Indeed, according to several studies, the schedules of feed strongly affect the ingestion and the assimilation of feed. The fish which are less frequently fed can adapt to such conditions by consuming greater quantities of feed during each feeding. If schedules are applied for a long period, this can lead to the hyperphagia. The fish which are well fed more frequently consume a greater quantity of; while feed, when the intervals between the meals are short, feed crosses the digestive area more quickly, having for result an ineffective digestion. Feed efficiency did not varied significantly with treatment (p>0.05). Nevertheless, it varied from 0.51±0.05 (T1) to 0.63±0.12 (T3). This result was an indication of better food utilization efficiency when feeding frequency is thrice time daily. According to Jamabo et al. (2015), feeding frequency is optimal for the condition of the trial suggesting that both growth parameters and feed utilization are most efficiency. Therefore, optimal feeding frequency for *Parachanna obscura* fingerlings reared in controlled conditions is three times daily. This observation agrees with the findings of several authors. According to Abid and Ahmed (2009) and Aderolu et al. (2010), optimum feeding frequency of *Labeo rohita* and *Clarias gariepinus* fingerlings is three times daily respectively. Moreover, three feeding a day have been found to be sufficient for maximum growth of *Oncorhynchus mykiss* (Ruohonen et al., 1998).

3 Materials and Methods

3.1 Fish and experimental design

The experiment was conducted in the experimental Station in the Wetlands Research Unit of Faculty of Abomey Calavi University (6°25’1.53’’N, 2°20’42.2’’E). 300 fingerlings of *Parachanna obscura* (mean weight: 13.27 ± 0.07 g) were collected in a pond on the experimental station. They were stocked per a 225 liter tank for 12 weeks. Water was continuously renewed (1 L/min). Tanks were protected at half with a perforated wooden plank to avoid fish from jumping out. Based on nutrient of various ingredients composition (Table 2), experimental diet was formulated (Table 3) and used during the trial. Sulfate of ferrous was used to decrease a possible toxicity of free gossypol in the diet. The ingredients diet were ground, weighted and mixed. Feed preparation was made by mixing the ingredients with boiling water and oil in paste. The paste was transformed into pellets of 2 mm diameter by food blender. After freeze drying at a temperature of 28 to 35℃ in lyophilisator, the pellets were manually broken in small pieces. The fishes were fed one of four schedules (Table 4) at 3% of body weight (Kpoguè and Fiogbé, 2012) from 08:00 AM to 08:00 PM up to apparent satiation. Each treatment was tested in triplicate. The density of 50 fishes/tank was used.

Table 2 Composition of the main ingredients (g/100 g dry matter)

Composition		Cotton seed meal	Soybean meal	Maize bran	Fish meal
Essential	Threonine	0.45	0.76	0.20	2.31
Amino-Acids	Valine	0.50	0.56	0.20	2.77
	Methionine	0.20	0.24	0.06	1.94
	Isoleucine	2.50	0.52	0.13	2.45
	Leucine	0.95	1.72	0.50	3.79
	Phenylalanine	1.10	1.36	0.50	3.74
	Histidine	0.70	0.64	0.44	1.75
	Thryptophan	0.40	0.32	0.25	0.57
	Lysine	0.50	1.20	0.44	4.22
	Arginine	2.15	2.04	1.80	3.43
Anti-nutrients	Phytic acid	0.36	0.57	0.04	No detectable
	Gossypol	0.11	Not significant	Not significant	Not significant

Physico-chemical parameters of water were measured during the experiment period. A portable chemical multimeter parameters served to measure temperature, pH and dissolved oxygen.

Test fishing was carried every seven days. Ponds were emptied and washed. Fishes were counted and weighted per pond. Test fishing enabled ration readjusting in relation to biomass. At the end of experiment, biomass, total fries number, weight and individual length were measure in each pond.

Table 3 Formulation and proximate composition of experimental diet

Ingredients	Percentage (%)
Cottonseed meal	20
Maize bran	12
Fish meal	45
Soybean meal	17
[a]Soya oil	2
[b]Carboxymethylcellulose	1
Iron sulphate	0.5
[c]Premix (Vit-Min)	2.5
Proximate analyses	
Moisture (%)	88.5
Ash (%)	9.22
Crude lipid (%)	7.69
Carbohydrate (%)	13.76
Crude protein (%)	42.86
[d]Brute Energy (MJ/100 g)	1.76
Protein/Energy (g/MJ)	24.35
Antinutrients	
[e]Phytic acid	17.4
[e]Gossypol	2.0

Note: [a] Songha ïcenter (Republic of Benin); [b] SIGMA-Aldrich Chemie, Steinhem, Germany; [c] Drugstore, premix (vitamin-mineral) contains (‰): Vitamin A 4,000,000 U.I; Vitamin D 800,000 U.I; Vitamin E 40,000 U.I; Vitamin K_3 1,600 mg; Vitamin B_1 4,000 mg, Vitamin B_2 3,000 mg; Vitamin B_6 3,800 mg; Vitamin B_{12} 3 mg; Vitamin C 60,000 mg; Biotin 100 mg; Inositol 10,000 mg, Pantothenic acid 8,000 mg; Nicotinic acid 18,000 mg; Folic acid 800 mg; Cholin chloride 120,000 mg; Colbat carbonate 150 mg, Ferrous sulphate 8,000 mg; Potassium iodide 400 mg; Manganese oxide 6,000 mg; Cuivre 800 mg; Sodium selenite 40 mcg; Lysine 10,000 mg; Methionin 10,000 mg; Zinc sulphate 8,000 mg; [d]Calculated from nutrient content: 23.01 Kj/g protein; 38.07 Kj/g lipid and 17.15 Kj/g carbohydrates; [e] By calculation using value in Table 2

Table 4 Hours and frequency of feeding

Treatments	Feeding frequency	Feeding hours					
T1	2x/day	8 h					18 h
T2	3x/day	8 h		13 h			18 h
T3	4x/day	8 h	11 h 20		14 h 40		18 h
T4	6x/day	8 h	10 h	12 h	14 h	16 h	18 h

3.2 Chemicals and calculations

Standard methods for dry matter were used to analyze the ingredients and diet samples. The (oven drying) at 105 ℃ for 24 h, crude protein (CP) (N-Kjeldahl×6.25) and ash (oven incineration at 550 ℃ for 12 h) were used. Lipids were extracted according to Bligh and Dyer (1959). Analysis of the amino acids in the ingredients was carried out by high performance liquid chromatography (HPLC, Waters 474, Milford, MA, USA). These analyses were carried out according to the method described by Alegria et al. (1999). Whereas gossypol was determined according to the method described by Imorou Toko et al. (2008), phytic acid in the ingredients was acid-extracted using 3% H_2SO_4 for 60 min at room temperature, centri-fuged at 3,897 g for 15 min. Supernatant was mixed with $FeCl_3$ (0.1 N) and centrifuged again to obtain a precipitate at which we added de-ionized water and NaOH (1.5 N) to extract the phytate after incubation at 80 ℃ during 30 min. After the feeding trial, fish were collected, counted, weighed and the different parameters were calculated as follows:

$$\text{Survival rate (SR)} = \frac{\text{FN}}{\text{IN}} \times 100$$

$$\text{Final mean weight (FMW)} = \frac{\text{FB}}{\text{FN}}$$

$$\text{Specific growth rate (SGR)} = \frac{\ln(\text{FMW}) - \ln(\text{IMW})}{\text{T}} \times 100$$

$$\text{Feed efficiency (FE)} = \frac{\text{FB} + \text{DB} - \text{IB}}{\text{dR}}$$

$$\text{Consumption index (CI)} = \frac{1}{\text{FE}}$$

Where: FN = final fish number per pond, IN = initial fish number per pond, FB = final biomass per pond, Ln = logarithm, T = time (experiment duration), DB = dead fish biomass (g), IB = initial biomass per pond (g), DR = distributed ration (g).

3.3 Statistical analysis

Data collected during experiment were encoded in Excel software version 2010. Different zootechnical parameters, physico-chemical and morpho-metrical were calculated. Mean and range of each parameter were calculated and graphs were drawn. Statistical analyses were carried out by using STATVIEW software (version 5.01) at 5% probability threshold. A one way analysis of variance was carried out to compare zootechnical performances of different treatments. In case of significant differences, the Fisher LSD (Least Significant Difference) test served to means comparisons.

4 Conclusion

Fixing the optimum frequency of feeding, farmers can decrease the feed cost and increase growth parameters. This study showed that the augmentation of feeding frequency above 3 times/day did not produce any significant improvement of growth. Therefore, optimal feeding frequency for *Parachanna obscura* fingerlings reared in controlled conditions is three times daily.

Authors' contributions

All authors contributed equally in this study and writing of the manuscript. All authors read and approved the final manuscript.

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