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International Journal of Current Research
Vol. 10, Issue, 08, pp.72738-72742, August, 2018

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

EFFECTS OF FEEDINGS PRACTICES ON GROWTH PERFORMANCE AND FEED UTILIZATION OF *HETEROTIS NILOTICUS FINGERLINGS*

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ARTICLE INFO

Article History:
Received 08th May, 2018
Received in revised form 14th June, 2018
Accepted 10th July, 2018
Published online 30th August, 2018

Key Words:
Heterotisniloticus,
Feed intake, Feeding frequency, Growth performance

ABSTRACT

Two series of experiments have been successively conducted to determine the modalities of food distribution to *Heterotisniloticus* fingerlings in fish-farming pond. In the first experiments, three daily rations have been separately tested on fingerlings of 165.81 ± 4.59 g. These are: (T1) = 4% of fingerlings total weight the whole duration of breeding, (T2) = 5%, 4% and 3.5% of fingerlings total weight, respectively the first month, the second month and the last one for the continuation of the breeding, and (T3) = 3.5% of fingerlings total weight the whole duration of breeding. At the end of this experiment, T2 gave the best growth results in the fish which reached for this ration a final average weight of 933.79 ± 7.52 g. The second experiment concerned the frequency of feeding. Fingerlings of 281.26 ± 19.05 g, have been subjected to three frequencies of nourishment namely: (2md) = 2 meals per day, (3md) = 3 meals per day and (6md) = 6 meals per day. The highest final average weight of fish (1009.45 ± 17.51 g) and the best food efficiency were observed in fish receiving 6 meals per day. The frequency of 3 meals can also be recommended insofar as the obtained growth results of the fish are not significantly different from those obtained with 6 meals per day.

Citation: ***Tra Florent Goure-Bi, Celestin Melecony Ble, Nahoua Issa Ouattara Yao Laurent Alla and Assoi Olivier Etchian*, 2018.** "Effects of feedings practices on growth performance and feed utilization of heterotis niloticus fingerlings.", *International Journal of Current Research*, 10, (08), 72738-72742.

INTRODUCTION

Aquaculture is an expanding and important growth sector for the production of high protein foods. This activity sector now provides half of the fish for human consumption (FAO, 2016). The growing interest in aquaculture today is mainly due to the decline in natural fish stocks caused by excessive and uncontrolled fishing (Naylor *et al*., 2000 and Pauly *et al*., 2002). However, despite the significant growth in world aquaculture production, this sector has not yet reached a viable economic dimension in Africa, either in terms of volume or in terms of the place of this activity in other production systems (Lazard et al., 1991). In sub-Saharan Africa, the major problem related to the development of aquaculture sector is the high cost of food. In aquaculture, food accounts for more than 50% of the total cost of production.

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DOI: https://doi.org/10.24941/ijcr.31853.08.2018

One of the priorities in fish farming, therefore, is the reduction of the expenses related to food, and therefore the control of the cost of production of fish for food (Jauncey *et al*., 1982). Food input is an essential link in the aquaculture activity, a good distribution strategy would optimize the growth of fish and minimize the release of pollution sources in the fish-farming ponds. It is in this context that we did this study. It aims to obtain information on the optimal modalities of food intake to *Heterotis niliticus* fingerlings in fishponds. This is specifically to determine the best daily amount and the best fractionation of daily food intake.

MATERIALS AND METHODS

Fish and experimental conditions: All the experiments were conducted in the farm of the NGO called APDRACI (Association of Pisciculture and Rural Development in Tropical and Humid Africa of Côte d'Ivoire) in Daloa a town in the west area of Côte d'Ivoire (West Africa). These experiments have been carried out in rectangular ponds of 100 square meters, supplied with water by a dam, itself fed by a natural and inexhaustible spring. A diversion system with PVC water supply pipes of a diameter of 100 mm allowed to put in water into the ponds and another system allowed to empty totally the ponds by gravity. The breeding pipe system is an open one with a slight drainage system of water permanently. The ponds have an average depth of 1.5 m and the water level varied between 70.39 ± 3.42 and 75.57 ± 1.02 cm deep. The fish used were fingerlings of *Heterotisniloticus* speces whose initial masses ranged from 165.23 ± 4.55 g to 168.45 ± 3.17 g.

Experimental procedure: The food was formulated to 30% of protein and 19 kilojoules/g of energy with agricultural products and was granulated at Oceanology Research Center (CRO) in Abidjan. The same food has been used for all experiments. All trials have been done in triplicate and the fish were fed daily from Monday to Sunday. We put in fish into the pond two days after supplying water at a density of 0.3 individuals per square meters. In total, two fishing of control separate by twenty-seven days were conducted for each trial. During fishing, fish were always individually measured, weighed and counted before being returned to a pond. The physicochemical parameters of the water were taken down every day for the temperature and every Monday for the oxygen and pH. The average values of these parameters throughout the experiments were relatively stable and did not significantly vary from one pond to another. The pH ranged from 6.53 ± 1.37 to 6.96 ± 0.28; the temperature ranged from 26.28 ± 0.49 to 30.23 ± 1.28 ºC and the average content in dissolved oxygen ranged from 5.11 ± 1.04 to 7.05 ± 0.52 mg / l. Each trial lasted 81 days.

Experiment 1: determination of the feeding allowance

For this experiment, three rations were tested:

Ration (T1) = 4% of fingerlings total weight, regardless of the size of the fish during the fish farming cycle. This is usual rate practiced in the ponds of the region,

Ration (T2) = 5%, 4% and 3.5% of fingerlings total weight respectively the first month, the second months and the rest of the breeding cycle. This is according to the theory of Winberg (1956) which shows that the fundamental relationship correlating the basic rate of metabolism of an animal to its size stipulates the reduction of relative rations with the growth size of the animal,

Ration (T3) = 5% of the fingerlings total weight, regardless of the size of the fish during the duration of the fish farming cycle.
For each trial, the daily ration was divided into four equal meals distributed between 9 am and 4 pm with one's hand.

Experiment 2: Determination of feeding frequency: For this experiment, three feeding frequencies have tested with the best ration found in the previous test. Those are :(2md) = two meals a day, (3md) = three meals a day, (6md) = six meals a day. The daily ration was distributed at regular times according to the frequency between 9 am and 4 pm.

Biochemical analyzes: Biochemical analyzes have been carried out in nutrition laboratory of Center for Research of Oceanology (CRO). These analyzes focus on the levels of proteins, lipids, moisture, cellulose and ashes of the ingredients, experimental feeds, homogenized carcasses of 5 whole fish taken at random at the beginning of the experiment and homogenized carcasses of 3 whole fish taken randomly at the end of the experiment in each enclosure. They have been duplicated using the AOAC (1995) standard methods. The crude proteins were measured by the Kjeldahl method (self-analyzer Kjel-foss), lipids by the hot method (Soxhlet type). The crude cellulose has been analyzed by the Weende method (acid and alkaline hydrolysis). The dry weight was determined by measuring the weight lost after drying for 24 h in an oven at 105 ° C. The ashes have been determined after samples incineration of the muffle oven at 550 ° C for 24 hours. The carbohydrate content, assimilated to the non-nitrogenous extract (ENA), has been determined by difference from the values found for the other constituents of the diets.

Growth parameters: To estimate fish growth and characterize tested food use efficiency, zootechnical parameters such as: Daily weight Gain (DWG), specific growth rate (SGR), condition coefficient (K), voluntary ingesting (VI), feed conversion ratio (FCR), protein efficiency ratio (PER), Survival Rate (SR) and Yield were calculated:

$$\text{DWG} = \frac{\text{Final body weight (g)} - \text{Initial body Weight (g)}}{\text{Number of experimentalday}}$$

$$\text{SGR (\%/day)} = 100 \times \frac{\ln[\text{Final body weight (g)}] - \ln[\text{Initial body Weight (g)}]}{\text{Number of experimentalday}}$$

$$\text{FCR} = \frac{\text{Feedintake(g)}}{\text{Fish weight gain (g)}}$$

$$\text{PER} = \frac{\text{Fish weight gain(g)}}{\text{Proteinintake (g)}}$$

$$\text{SR (\%)} = 100 \times \frac{\text{Final number}}{\text{Initial number}}$$

$$\text{Yeild} = \frac{\text{Final total weight (g)} \times 365}{\text{Area (m}^2\text{)} \times \text{number of experimentalday}}$$

$$K = 100 \times \frac{\text{Final body weight (g)}}{\text{Fish total length}^3\text{ (cm)}}$$

VI (%/day) = 100 × Feed intake (g) / [(Initial body weight + Final body weight) g/ 2)] / number of experimental day.

Statistical Analysis: Data were expressed as mean ± SD (n = 3). The effects of dietweretested with one way analysis of variance (ANOVA), followed by Tukey's test. Differences were considered significant when P\0.05. Statistical analyses were performed using STATISTICA 7.1 software.

RÉSULTS

Feeding allowance

Survival and growth: The survival rate are high overall. The analysis of variance ANOVA 1 showed no significant difference ($p > 0.05$) between the survivals registered by the treatments. The values of the growth parameters (Table 1) are significantly higher ($p < 0.05$) for T2. We all the same, notice that the average weight of the fish with T2 treatment became higher than that of the T1 one just only.

Table 1.Growth performances and survival of *Heterotisniloticus* fingerlings subject to different dietary rations.

Treatments	Indices						
	IBW (g)	FBW (g)	SR (%)	DWG (g/d)	SGR (%/d)	Yield (t/ha/y)	K
T1	165.67±6.49	901.12±7.67[a]	88.89±9.62	9.08±0.17[a]	2.09±0.06[a]	8.58±1.03[a]	0.90±0.08[b]
T2	165.23±4.55	933.79±7.52[a]	94.44±9.62	9.49±0.06[a]	2.14±0.03[a]	9.68±1.16[a]	1.04±0.02[a]
T3	166.56±4.48	649.34±27.91[b]	88.89±9.62	5.96±0.40[b]	1.68±0.09[b]	5.53±0.44[c]	0.71±0.03[c]
Probability	*ns*	*0.000087*	*ns*	*0.000137*	*0.00156*	*0.00338*	*0.000743*

Data are mean values ± SD (n = 3); means in the same row with the same superscript were not significantly different (P>0.05)

Table 2. nutrient efficiency of *Heterotisniloticus* fingerlings subject to different dietary rations

Treatments	Indices		
	FRC	PER	VI (%/d)
T1	2.47±0.27[b]	1.36±0.14[b]	4.00±0.32[b]
T2	1.61±0.08[a]	2.07±0.09[a]	2.72±0.06[a]
T3	1.66±0.13[a]	2.01±0.15[a]	2.26±0.16[a]
Probability	*0.00179*	*0.0010*	*0.000145*

Data are mean values ± SD (n = 3); means in the same row with the same superscript were not significantly different (P>0.05)

Table 3. Proximate whole-body composition (% dry weight) of *Heterotisniloticus*

	Initial	Treatments			
		T1	T2	T3	*probability*
Protein (%)	14.70±0.04	17.76±0.17[a]	17.02±0.35[a]	15.38±1.03[b]	*0.00125*
Lipid (%)	5.83±2.3	9.69±0.23[a]	9.17±0.20[a]	6.27±1.28[b]	*0.000345*
Moisture (%)	82.37±1.35	74.10±0.67[c]	75.20±0.82[b]	77.60±0.87[a]	*0.00154*
Ash (%)	5.12±0.61	3.19±0.59[b]	3.67±0.64[b]	4.06±1.52[a]	*0.00116*

fingerlingssubject to different dietary rations data are mean values ± SD (n = 3); means in the same row with the same superscript were not significantly different (P>0.05).

Table 4.Growth performances and survival of *Heterotisniloticus* fingerlings subject to different feeding frequency

Treatments	Indices						
	IBW(g)	FBW(g)	SR(%)	DWG(g/d)	SGR(%/d)	Yield(t/ha/y)	K
2md	167.90±2.51	678.23±43.90[b]	94.44±9.62	6.30±0.56[b]	1,72±0,10[b]	6,43±1,43[b]	0,74±0,10[b]
3md	168.45±3.17	943.35±6.57[a]	94.44±9.62	9.56±0.08[a]	2,13±0,02[a]	9,76±1,15[a]	1,01±0,12[a]
6md	166.52±8.10	1009.45±17.51[a]	100±0.00	10.41±0.17[a]	2,22±0,05[a]	11,39±0,18[a]	1,08±0,10[a]
Probabilité	*ns*	*0.000014*	*ns*	*0.000014*	*0.00156*	*0.00345*	*0,017*

data are meanvalues ± SD (n = 3); means in the same row with the same superscript were not significantly different (P>0.05)

Table 5.nutrientefficiency of *Heterotisniloticus* fingerlings subject to different feeding frequency

Treatments	Indices		
	FCR	PER	VI (%/d)
2md	2.26±0.46[b]	1.52±0.28[b]	3.19±0.29
3md	1.66±0.11[a]	2.02±0.13[a]	2.78±0.09
6md	1.58±0.04[a]	2.11±0.05[a]	2.80±0.04
Probability	*0.044*	*0.014*	*ns*

data are meanvalues ± SD (n = 3); means in the same row with the same superscript were not significantly different (P>0.05)

Table 6. Proximate whole-body composition (% dry weight) of *Heterotisniloticus* fingerlings subject to different feeding frequency

	Initial	Treatments			
		2md	3md	6md	*probability*
Protein(%)	13.35±0.04	15.76±0.17[a]	16.35±1.25[b]	17.88±1.22[c]	*0.00125*
Lipid(%)	5.17±1.9	7.58±0.8[a]	8.79±0.56[b]	9.87±2.17[c]	*0.000345*
Moisture(%)	85.37±0.35	77.26±1.38[a]	75.18±2.02[b]	74.30±1.78[b]	*0.00154*
Ash(%)	4.92±1.25	3.19±0.59	3.89±1.46	3.06±1.52	*ns*

data are meanvalues ± SD (n = 3); means in the same row with the same superscript were not significantly different (P>0.05)

before the end of the experiment. T2 treatment allow to obtain the highest yield (9.68 ± 1.16 t / ha / year) and the highest condition factor (1.04 ± 0.02). The lowest growth performance of fish was obtained with T3 treatment.

Nutrientefficiency : Table 2 describes how treatments have influenced the efficiency of use of food by fish. It was observed throughout the experiment that for the lowest ration rate (T3), the fish would rush to the food supplied fed and greedily ate it. The lowest FCR (1.61 ± 0.08) and the highest protein efficiency coefficient (2.07 ± 0.09) were observed in T2-treated fish.

Biochemical body composition : The fish body composition (Table 3) at the end of experiment shows an increase in protein and lipid levels, and a decrease in moisture and ashes rates for all treatments. Analysis of variance ANOVA 1 shows that the body composition of fish varies significantly from one treatment to another (p<0.05). T1 produced the highest levels of protein (17.76 ± 0.17) and body lipids (9.69 ± 0.23) in fish.

Feeding Frequency

Survival and growth : The survival rate ranged from 94.44 ± 9.62 to 100%. The highest value was recorded in the six meals a day fish. The growth parameters (Table 4) varied according to the effect of the treatments. Final average weights ranged between 678.23 ± 43.90 and 1009.45 ± 17.51 g, daily weight gains ranged from 6.30 ± 0.56 to 10.41 ± 0.17 g / d, and specific growth rates ranged from 1.72 ± 0.10 to 2, ± 0.05% / d. The six meals a day treatment provided the best growth performance in fish. The Tukey HSD test reveals that the growth performances obtained by the fish fed with three meals a day are not significantly (p > 0.05) different from those obtained at the six meals a day treatment. The highest yields were obtained in fish treated with six meals a day followed by three meals a day which allowed to have respectively 9.76 ± 1.15 and 11.39 ± 0.18 t / ha / year. The highest condition factor (1.08 ± 0.10) was obtained with six meals a day treatment.

Feed utilization : For 2 days, the fish showed each feeding a desire to eat. Indeed, these fish rushed on the food and even fed themselves in the presence of the distributor, something that they did not do for three meals a day and six meals a day treatments. Table 5 shows that the best results of food utilization: 1.58 ± 0.04 FCRand 2.11 ± 0.05 for the PER, havebeen obtained by the fish subjected to treatment six meals a day. These values are significantly different (p <0.05) from those obtained in other treatments.

Body composition: Table 6 shows a body increase in protein and lipid rates and a decrease in the rates of moisture and ashes at the end of the experiment on fish for all treatments. The fish subjected to 6 meals a day, are the best levels of body proteins (17.88 ± 1.22), and body lipids (16.35 ± 1.25). These rates are significantly different (p <0.05) from those obtained with other treatments.

DISCUSSION

In all the trials carried out, the physico-chemical parameters of the water (temperature, dissolved oxygen and pH), remained unchanged. The lack of correlation between treatment and water quality may be due to the fact that the distribution modalities of food in pond have remained below thresholds that could have a significant effect on the quality of the water. Survival rates remained within a range of sizes similar to those usually observed under nearly identical rearing conditions (Monentcham, 2009; Tillon,1957; Tillon, 1959). At the end of this experiment, it appears that all tested rations generate growth effects on young Heterotisniloticus. It is however more appropriate to feed these fingerlings following a ration of 5% of fingerlings total weight for the first month, 4% of fingerlings total weight for the second month and 3.5% of fingerlings total weight thereafter, rather than with a fixed rate during the duration of the breeding. In the last case, when the ration rate is 5%, theweight growth of the fish is fast at the beginning of the experiment, but it slowed down after two (2) months. However, this treatment has a relatively higher feed conversion rate. This indicates that at each feeding, the amount of food distributed was too high and would have favored an increase in food intakes causing problems of digestion in fish and growth retardation. For a ration of 3% of fingerlings total weight, over the duration of the test, the feed conversion rate is low, and the weight growth is relatively lower. This shows that the food distributed was insufficient and could not satisfy the food requirements of the fish in pond. This fact is explained by frequent struggles engaged by the fish during feeding for this rationing. The best growth results obtained in fish subjected to T2 treatment are similar to those of Marek (1975). This author suggests that reducing the rationing rate with the increasing size of nourished fish. This suggestion is confirmed in several studies using fish of various species: Brett *et al*. (1975) and Elliot (1976) with slamonids, Lovell (1975) and Hogendoon (1983) with catfish, Caulton*et al*. (1977) and Melard (1986) and with tilapias. Analysis of the body composition of the fish shows that the rationing rates applied allow an increase in the protein content and in body lipids. This increase is more apparent for treatments whose rationing rate is above 3%.The feeding frequency test shows that growth and food efficiency increases in fish as the frequency of distribution of the food increases, the frequency of six (6) meals per day resulting in the best results of growth and food utilization in fish. This study therefore demonstrates the positive effect of increasing the daily frequency of distribution of the food from three (3) to six (6) meals in *Heterotisniloticus* fingerlings. These two frequencies of distribution of the food allow rapid growth with good performance of food utilization. There is still a slight advantage for six meals a day in the survival and body composition of the fish at the end of the experiment. These results corroborate several previous studies on different species including those of Tung *et al*. (1991); Bocek*et al*. (1992); Kayano*et al*. (1993) and Pouomogne (1994) on Nile tilapia *Oreochromisniloticus*. Studies in tilapia by Tung *et al*. (1991) have shown that at higher frequencies metabolic activity of phosphofructokinase and 6-phosphogluconate dehydrogenase is greater in tilapia fed six meals per day rather than two.No data yetexist on enzymaticactivities in *Heterotisniloticus* to verifythisprinciple, but itcould have a digestive tract betteradapted to high frequencies of feedingsince the resultsregistered in ourwork are not contradictory to the observations of the authors. In any case, the opportunity to increase or decrease the frequency of mealsis in principle, a function of the transit speed of food in the digestive tract, whichin variableaccording to the fishspeciesconsidered (Windell, 1978) This knowledge has the advantageto harmonize the expenses of the fishfarmwith the increase of itsproductivity.

Conclusion

The results obtained at the end of this study, show that the best results of growth and food utilization are obtained in *Heterotisniloticus* fingerlings with well-defined modalities of food contribution. The suggested modalities for this effect are therefore to give 5%, 4% and 3.5% of the fish totale weight, respectively the first month, the second month and the last one during the rest of breeding cycle. This daily meal should be distributed between 3 and 6 times in a fair way.

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