Assessment of two population densities in the pre-fattening of *Clarias gariepinus* with semi-humid feed

J. Llanes and J. Toledo

Empresa de Desarrollo de Tecnologías Acuícolas, Carretera Central km 20 1/2, Loma de Tierra, Cotorro, La Habana, Cuba

Email: jellanes@telemar.cu

A total of 540 young fish of *Clarias gariepinus*, with 10.0 + 0.02 g of initial average weight were used to study the effect of two population densities (80 and 100 fish/m^3). Cement tanks and semi-humid feed based on silages of fishery by-products were used in the pre-fattening. The fish were distributed according to completely randomized experimental design in two treatments, with three repetitions. No differences were found in the growth indicators (final weights of 105.1 and 96.3 g), feed conversion (2.2 and 2.3) and survival (83.3 and 87 %) between the experimental densities. The productivity was higher ($P < 0.01$) for 100 fish per m3 (8.3 kg/m^3). It is concluded that the pre-fattening of *Clarias gariepinus* in cement tanks with semi-humid diet, based on fishery silages, is not affected when increasing the density from 80 to100 fish/m^3 and allows increasing productivity per culture area.

Key words: *clarias, population densities, semi-humid rations.*

The use of semi-humid feeds, based on silages of fishery and cattle by-products, has been an option for the sustainability of fresh water fish farming in Cuba, mainly for rearing *Clarias gariepinus*. At present, increasing the production of this species from the intensification of its culture using this type of feed is of great interest.

In a pre-fattening study at productive level (stage from 10 to 100 g of weight) of *Clarias gariepinus* in cement tanks with 600 m^3 capacity, Oliva *et al*. (2007) applied a feeding strategy of 70 % of commercial feedstuff and 30 % of semi-humid feed based on silages of fishery by-products (SF). These authors did not find significant effect on the growth indicators, feed conversion and survival, when increasing the population density from 80 to 100 fish/m^3. This allowed higher productivity with higher density.

Guthemberghe *et al*. (2004) stated that the most frequent problem when intensifying a culture is the high concentration of metabolites dissolved in the medium. This causes chronic deficiencies in the water quality indicators and can be worse with the use of alternative feeds.

The objective of this study was to assess the effect of two population densities (80 and 100 fish/m^3) when using cement tanks with semi-humid rations based on SF during the pre-fattening stage.

Materials and Methods

The study was conducted in the non-conventional feed production plant "El Clarias", belonging to the Aquaculture Technology Development Company, located in Cotorro municipality, La Habana province, Cuba. A total 540 young fish of *Clarias gariepinus*, with 10.0 + 0.02 g of initial average weight were distributed according to completely randomized design in six cement pools of 1 m^3 of capacity (three aquatories per treatment), at a rate of 80 and 100 fish/m^3.

The semi-humid feed was used according to the requirements established by Vidotti *et al*. (2000) for the species. It was described according to the methodology reported by Toledo *et al*. (2009) (table 1). The SF was prepared with residues of filleting the clarias milled in a meat miller JAVAR 32. Later, 2 % of sulfuric acid and 98 % (p/v) were added and stored for 7d.

During the bio-experiment, the water flow was standardized at 1.4 L/min and the values of temperature and dioxide concentration dissolved with an Ox meter HANNA were taken. The pH was measured with a HANNA pH meter. The proximal analysis of the SF and that of the plant feedstuff was conducted by triplicate, according to AOAC (1995). The CP was calculated with the crude caloric coefficients referred by Brett (1973).

The fish were fed twice a day (09:00 and 16:00 h), according to feeding rate 8 % of the body weight during 60 d. The ration was adjusted every 15 d, and, at the end of the experiment, the animals were weighed individually to calculate the zootechnical indicators referred by Oliva *et al*. (2007):

Final weight (FW)

Daily weight increase = FW-initial weight (IW)/culture time

Specific growth rate (SGR) = In FW– In IW/culture time x 100

Feed conversion factor (FCF) = feed added/weight gain

Survival = final number of animals/initial number of animals x 100

Productivity = number of fish x final weight/tank volume

The analysis of variance of simple classification was applied for processing the data. The INFOSTAT system, version 1 was applied (Balzarini *et al*. 2001).

Table 1. Composition of the semi-humid diet (g/100g)

Ingredients	Plant feedstuff	Semi-humid diet
Fish silage	-	40.00
Soybean meal (43.78 % CP)	50.00	-
Maize meal	15.75	-
Wheat bran	30.00	-
Soybean oil	3.00	-
Common salt	0.25	-
Premixture of vitamins and minerals	1.00	-
Plant feedstuff	-	60.00
Total (%)	100.00	100.00
Analysis calculated in dry basis		
DM	90.15	65.32
CP	31.15	35.01
Crude energy MJ/kg	17.81	18.84

The assumptions of normality and homogeneity achieved were proved except for survival when the transformation arc sin √ %was conducted.

Results and Discussion

The water temperature of the tanks varied from 26.1 to 27. 6 ºC. The concentration of dioxygen dissolved was kept between 5.11 and 6.02 mg/L. The pH had minimum variations (7.85 - 8.01), with indicators within the interval of ranges convenient for culturing the species according to Graaf and Janssen (1996). The data suggest that the water quality was not altered due to the biomass increase when the mean was higher than 8.28 kg/m^3 (100 fish/m^3).

All the fish were adapted rapidly to the semi-humid feed, confirmed the criteria of Toledo *et al*. (2009), who stated that the diets with SF have high palatability for the presence of soluble substances (free amino acids). On this respect, Dai *et al*. (2011) referred that the high population densities of *Clarias gariepinus*a take less time to respond and consume the feed.

The granulates' stability of the semi humid feed was good for rapid and competitive fish like clarias, submitted to super intensive cultures with restricted feeding systems. Llanes (2010) reported that after 10 min. of immersing in the water, the granulates had losses of 11.4 % DM and 16.0 % protein. This time is very superior to that used by the fish to capture the feed. Its use is suggested as alternative in the commercial rations that are complete from the nutritional point of view.

The mean values of the zootechnical indicators at the end of the experimental period are shown in table 2. No significant differences were found in the growth (FW, DWI and SGR), FCI and survival between the two densities studied. However, productivity was higher ($P < 0.01$) for the treatment with 100 fish/m^3.

These results are similar to that informed by Oliva *et al*. (2007), who reported 1.42 g/d of DWI and 8.6 kg/m^3 of productivity. But, they do not coincide with the FCI of 1.2 that is much more favorable, but attributed to the humidity contents of the semi-humid feed.

The available literature on the intensification of this species cultures from the use of semi-humid feeds is limited. These fish are of low commercial value and their exploitation in ground tanks is with low population density. Their feeding is through industrial

Table 2. Productive results of the pre-fattening of *Clarias gariepinus* in two culure population densities.

Zootechnical indicators	Population density (fish/m^3)		+ SE Sign
	80	100	
Final weight, g	105.11+ 1.82	96.28+ 3.67	NS
DWI, g/d	1.58	1.43	0.04
SGR, %/d	3.01	3.13	0.06
FCI (humid basis)	2.23	2.27	0.05
[1] Survival, %	1.16 (83.33)	1.22 (87.00)	0.09
Productivity, kg/m^3	6.97	8.28	0.31**

1 Data transformed according to arc sen √ %.
Original means between parentheses. ** $P < 0.01$

and agricultural by-products, mainly in Africa (De Graaf and Janssen 1996). Two studies conducted in Cuba, under similar conditions, demonstrated that achieving productivities of 0.54 (Hall *et al*. 2006) and of 0.86 kg/m^3 (Villega *et al*. 2007) is possible. These results are satisfactory for these culture conditions.

This indicates the development of the pre-fattening stage of *Clarias gariepinus* in cement tanks at higher densities with semi-humid feeds, which will reduce the importations of fish meal and commercial feedstuff and will increase the productivity per area unit.

Interpreting the effects of the sowing density on the productive indicators of any fish species is complex, as some factors influence on the results, such as water flow and quality, the composition and size of the ration, and the species, among others (Dai *et al*. 2011).

In this study, the facilities had water well, equal flow for all the compartments and total rechange every 12 h to guarantee that the levels of NH_4 +, NO_2- and NO_3- do not influence negatively on the productivity. Besides, it was assured that the dioxygen saturation stated over 40 %. It was proved that the epibranchial organ of the *Clarias gariepinus* is only increased at saturation levels inferior to 40 %, but not significantly (van de Nieuwegiessen 2009). Therefore, the possible effect of reducing the dioxygen saturation levels due to high densities was discharged.

The superintensive cultures demand complete commercial rations, with high levels of CP and digestible energy. The use of semi-humid diets with agricultural by-products may diminish the content and quality of these nutrients. It can also increase the dietetic fiber, propitiating higher fecal material and lower nutrients absorption, due to the speed rate of the chyme through the digestive tract (Botello *et al*. 2011). This influences negatively on the water quality and the final productivity (Guthemberghe *et al*. 2004).

The semi-humid feed used had the requirements for the species. In spite it was granulated, it was less stable with the physical effects, and had higher risks of affecting the water quality in respect to the commercial diets. Due to the lowest contents of DM (at about 65 %), higher volume of ration is needed to cover the requirements of protein grams per kilogram of live weight. So, when this feeding methodology is used for a high density culture, plant feedstuff with 35 % is necessary as they propitiate semi-humid diets, of 27-28 % of CP (humid basis). Lower amount of food is suggested and, therefore, lower organic matter.

Toko *et al*. (2007) referred that clarias may develop well at high densities due to the presence of an epibranchial organ for taking dioxygen from the air. They can also be relatively tolerant to poor conditions of the water quality and show an unusual performance in this type of culture.

Van de Nieuwegiessen (2009) stated that in recycling systems, the clarias from 10 to 300 g responded to a decreasing intensification of the culture (2 375 fish/m^3) and formed dense shoal with constant movements and low aggressiveness. This coincides with other studies of the species referring less aggressiveness at high densities (Toko *et al*. 2007 and Jamabo and Keremah 2009). This is a very important aspect as the territorial defense, the development of hierarchies and the individual authority in fish lead to higher mortality and high energy cost, which could be used for growing.

It is concluded that the pre-fattening of *Clarias gariepinus* in cement tanks with semi-humid feeds based on fishery silages is not affected when increasing the population density from 80 to100 fish/m^3. Besides, it allows increasing productivity per culture unit.

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