THE INFLUENCE OF STOCKING DENSITY ON *SILURUS GLANIS* (LINNAEUS, 1758) GROWTH PERFORMANCE IN A RECIRCULATING AQUACULTURE SYSTEM

Săndița (Ion) Plăcintă[1*], V. Cristea[1], Iulia Rodica Grecu[1], Mirela (Crețu) Mocanu[1], M.T. Coadă[1], Alina Antache[1], Elena Bocioc[1], Șt.M. Petrea[1]

[1] Department of Aquaculture, Environmental Science and Cadastre "Dunarea de Jos" University of Galati, Romania

Abstract

The paper presents the aspects of stocking density influence on catfish juvenile's growth performance in recirculating system. The experiment was made during 29th July -7th September 2011 on the pilot recirculating system of Aquaculture, Cadastre and Environmental Science Department from Food Science and Engineering Faculty - Galati. Juveniles catfish with an average body weight of 8.61 ± 0.24 g formed the biological material for this experiment. The experimental design consisted in the evaluation of two variants of stocking densities, in duplicate: first variant with a density of 2.78 kg/m3 and second variant with 1.46 kg/m3 stocking density. At the end of the experiment, the following average body weights were recorded: 31.84 g and 31.45 g at first variant, respectively 33.48 g and 34.70 g at second variant. Specific growth rate (SGR) and the feed conversion ratio (FCR), calculated as the mean value of the two repetitions is presented as follows: for V1: SGR=3.40 g%/day; FCR= 0.89 feed/g biomass growth, respectively for V2: SGR= 3.52 g%/day; FCR= 0.79 g feed/g biomass growth. The technological indicators underlay that stocking density significantly affects, ($p<0.05$), the mean individual body mass of tested specimens in both variants.

Key words: catfish, recirculating aquaculture system, stocking density, technological performance indicators

INTRODUCTION

The European catfish *Silurus glanis L.*, is characterized by its rapid growth, large body weight and high content of protein in the tasty boneless flesh, qualities which recommend this specie for intensive production [1]. The intensive fish growth in recirculating systems involves inevitably the practice of higher stocking densities comparing to those from natural environment. For this reason, the scientific, public and governmental attention have has focused on stocking density, being considered a key factor that may affect fish pathology in intensive systems [2].

Stocking density has a significant effect on growth performance and feed conversion. Thus, reducing the growth rate is often associated with high stocking densities levels and has been studied by many authors (Refstie 1977 and Holm 1986) [3]. The main determinant factors that may influence the relation between density and growth rate of a certain species are: age, size, feeding intensity, water quality, type of production system, growing units design (morphology, hydraulic). The main purpose of this paper is to assess growth performance of juveniles catfish (Silurus glanis), grown under different stoking densities in recirculating aquaculture system.

MATERIAL AND METHODS

The material base for this study consists of experimental recirculating system from the Department of Aquaculture, Environmental Science and Cadastre - ,,Dunarea de Jos'' University of Galati. Experiment was conducted between August and September 2011, for a period of 37 days.

Experimental recirculating system design includes the following components:

- 4 octagonal breeding tanks (EcoTank type) with a volume of 1 m^3;

*Corresponding author: sandita_placinta@yahoo.com
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- units for conditioning the water quality:
- water filtration units - mechanical filters ("drum filter, sand filter, filter with active carbon under-pressure), biological filter;
- denitrificator;
- UV lamp for water sterilisation; water aeration – oxygenation unit;
- installation for water distribution to culture ponds, is shown in Figure 1.

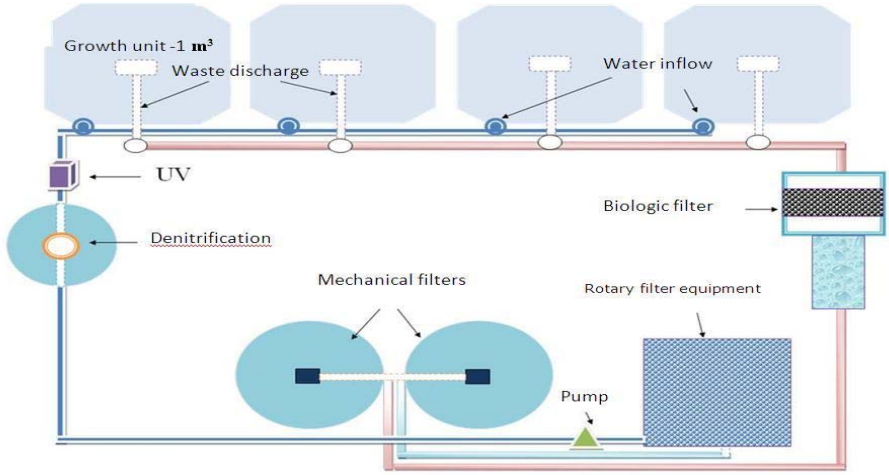

Figure 1 Configuration of the experimental recirculating system

Biological material was represented by a number of 546 juvenile catfish, with the average weight 8.61 ± 0.24 g, coming from Nucet Research Station, Dambotiva. Before starting the experiment, the catfish juveniles had been investigated in terms of ihtiopatology and formalin prophylactic baths were made.

Fish were randomly distributed in the 4 breeding tanks of the recirculating system, as follows: in the first variant were introduced 182 fish/tank with an initial biomass of 1528g (2.78 kg/m^3) and in second variant, 91 fish /tank, with an initial biomass of 800 g (1.46 kg/m^3). The initial individual weight values distribution for all variants showed a significant similarity with the normal distribution ($p>0,05$ with the test KS). Feeding intensity during the experiment was 6% per body weight per day, in four meals per day. The food used was Nutra PRO MP-T – extruded pellets with the diameter of 1.7 mm and with 50% protein content (Tab. 1).

Table 1 The biochemical composition of Nutra PRO MP-T feed pellets

Content	***M.U.***	Quantity
Crude protein	%	50.0
Lipids	%	20.0
Cellulose	%	0.7
Ash	%	0.7
Phosphor	%	1.3
Vitamin A	(UI)	12000
Vitamin D	(UI)	1800
Vitamin E	(mg)	180
Digestible Energy	(MJ/kg)	19.7
Vitamin C	(mg)	500

The monitoring of the main physico-chemical parameters of water (oxygen, temperature, pH and nitrogen compounds), during the experiment, was performed with the following equipment: Hanah HI 98 186 oximeter, WTW 340 pH meter, Spectroquant Nova 400 spectrophotometer, using Merck kits.

Somatic measurements were made on the beginning and on the end of the trial at 40 fish/experimental variant determining full-length -LT (cm)- and body mass - W (g). Correlation between length and body weight was made by using Microsoft Office Excel 2010 - POWER method.

At the end of the experiment, after all fish were weighed and measured, the following technological efficiency indicators were calculated: growth rate, food conversion ratio, specific growth rate and the protein efficiency ratio using the following equations:

- Weight gain (W) = Final weight (Wt) – Initial weight (W0) (g)
- Food conversion ratio (FCR) = Total feed (F) / Total weight gain (W) (g/g)
- Specific growth rate (SGR) = 100 x (ln Wt - ln W0) / t (% BW/day)
- Protein efficiency ratio (PER) = Total weight gain (W) / amount of protein fed (P) (g)

The statistical analysis was performed with the help of the programme SPSS 17.0 for Windows. The normality of the distribution was verified with the help of the Kolmogorov-Smirnov Z test. The statistical differences between variables were tested with the help of the test T-test.

RESULTS AND DISCUSSIONS

High stocking densities generates large amounts of metabolic waste [4]. In this direction, the main technological requirement that must be achieved in a recirculating aquaculture system is to ensure that environmental conditions largely correspond with the eco-physiological peculiarities of culture species [5]. During the experimental period, the temperature was within the optimal range of 25 - 28^{0}C, (Brown et al., 1989), the oxygen concentration (DO) fluctuated between 4.53 ± 0.22 and 6.88 ± 0, 05 mg / l, admissible for Silurus glanis species (Turcket and Boyd 1998) and the pH ranged from 7.58 ± 0.10 to 8.12 ± 0.07 (Figure 2).

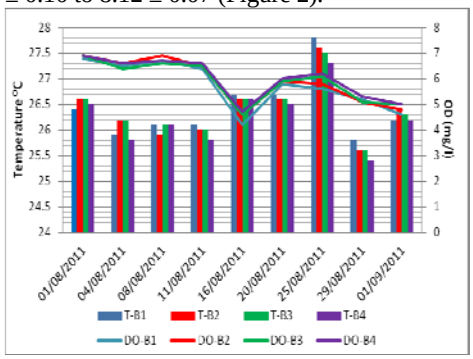

Figure 2 The dynamics of dissolved oxygen concentration and the temperature variation during the experiment

Nitrogen compounds concentrations were maintained within the allowable catfish growth limits and summarized in the table below:

Table 2 Synthetic table regarding the mean values (± SD) of nitrogen compounds from the recirculating system

	V_1		V_2	
	B_1	**B_2**	**B_3**	**B_4**
$N\text{-}NO_3$	64.12± 18.01	60.88 ± 16.62	58.23 ± 19.03	60.66 ± 18.42
$N\text{-}NO_2$	0.04± 0.05	0.05± 0.08	0.03± 0.04	0.04± 0.05
$N\text{-}NH_4$	0.15± 0.13	0.13± 0.12	0.04± 0.03	0.09± 0.08

Significant growth rates were obtained in both experimental variants, V1 (B1, B2 tanks) and V2 (B3, B4 tanks), in terms of a 93.41% survival in V1 case, respectively 95.05% survival in V2 case. At the start of the experiment, the average stocking density of culture biomass was 2,78kg/m^3 in the first variant(B1, B2) and 1,46kg/m3 in the second variant (B3, B4) and at the end of the experiment, 3.86 kg/m^3 at V1 and 4.7 kg/m^3 at V2.

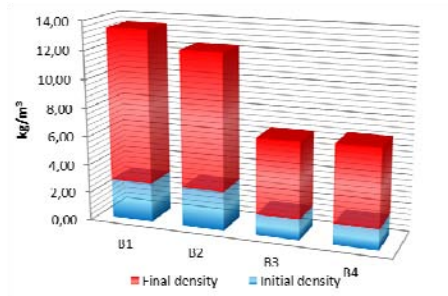

Figure 3 Graphic representation of the initial and final densities

By analysing the data summarized in Table 3, it was seen that the tested densities did not influence the nutrients retention and feed conversion, as confirmed by close values of both experimental variants feed conversion rate (FCR): thus, in the first variant, it was recorded a 34.0 g%/day growth rate and a feed conversion rate (FCR) of 0.89 FCR g / g and at the second variant a SGR of 3.52 g %/day an d an FCR of 0.79 g/g.

Table 3 Synthetic table regarding technological performance indicators of catfish growth in recirculating aquaculture system in different conditions of intensity

Growth performance indicators	V1			V2		
	B1	B2	Average	Average	B3	B4
Initial biomass (g)	1528	1528	1528	802.25	802.5	802
Initial numbers of fish	182	182	182	91	91	91
Mean individual weight (g/ex)	8.40	8.40	8.40	8.82	8.82	8.81
Final biomass (g)	5540	5220	5380	2949	2914	2984
Final numbers of fish	174	166	170	86.5	87	86
Initial stocking density (kg/m^3)	2.78	2.78	2.78	1.46	1.46	1.46
Final stocking density (kg/m^3)	10.70	9.49	10.10	5.36	5.30	5.43
Survival (%)	95.60	91.21	93.41	95.05	95.60	94.51
Mean final fish weight (g/ex)	31.84	31.45	31.64	34.10	33.49	34.70
Individual weight gain (g)	23.44	23.05	23.25	25.28	24.68	25.88
Total weight gain (g)	4012	3692	3852	2146.75	211.5	2182
Specific growth rate (SGR) (%/day)	3.48	3.32	3.40	3.52	3.49	3.55
Daily growth rate - (g/kg/day)	0.63	0.62	0.63	0.68	0.67	0.70
Feed conversion ratio FCR (g/g)	0.85	0.92	0.89	0.79	0.81	0.78
Protein efficiency ratio PER (g/g)	2.36	2.17	2.26	2.52	2.48	2.56

By applying the formula $W = a\,TL^b$ it was determined the correlation between body mass (g) and total length (cm) (W-TL) for each variant, both at the beginning and at the end of the experiment. Generally, the index "b" values range between 2 and 4, mostly 3 and reflect the state of biological material in environmental conditions [7]. In Figure 4, is presented the correlation between length and individual average weight, where it can be observed a proportional dependence, revealing more homogeneous population at the end of the experiment than at its beginnings.

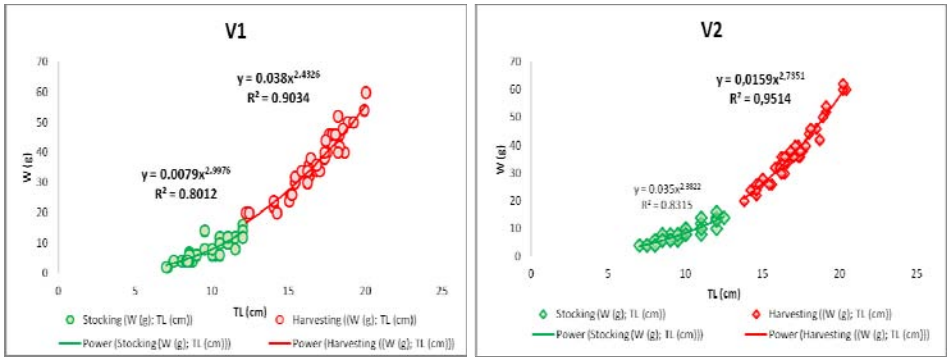

Figure 4 Length - weight regression of juvenile catfish from both experimental variants

CONCLUSIONS

This study regarding the growth of juveniles catfish, in a recirculating system, indicated a positive correlation between stocking density and growth performance, fact that is also mentioned by other authors [1], [6] thus confirming the possibility of obtaining a maximum production, in a

recirculating system, by assuring environmental and feed conditions for covering the physiological needs of juveniles catfish.

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