CONSIDERATIONS REGARDING THE REARING OF EUROPEAN CATFISH, *SILURUS GLANIS L.* IN A FLOW-THROUGH PRODUCTION AQUACULTURE SYSTEM

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Abstract

This paper aimed to evaluate the productive potential of the intensive aquaculture rearing systems, flow-through type, in different conditions of stocking density maintenance of the fish biomass. For this purpose 92 catfish individuals were randomly distributed in two flow-through systems in such manner to create two different densities: 64 kg/m^3, respectively 28 kg/m^3. The catfish individual average weight was 619, 79±216, 49 g/exemplar for the first system and 560, 83± 193, 20 g/exemplar for the second system. At the beginning of the experiment the two fish groups were compared, in terms of average weight and tested for mean differences in order to have homogeneous populations. The t-test applied for independent variables revealed insignificant differences (p>0, 05) concerning initial individual weight. The biotechnological indicators emphasized a better growth of the catfish biomass maintained in lower stocking density. Also the higher stocking density induced an increase of variability coefficient and thus a larger weight differences between individuals from the first experimental variant.

Keywords: catfish, stress, intensive aquaculture

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. Although in our country is mostly raised in monoculture and polyculture using pond aquaculture technologies, the rapid development of intensive aquaculture systems, such as recirculating and flow-through systems, represents a premise for increase of catfish production. Its ability to adapt to different aquatic conditions and fast growth rate represent the most important attributes for intensive production. Also the intensive rearing technology offers the perspective for shortening the production cycle (from hatchling to market-size fish – 1.5 kg) to a period of 7–8 months [5], [6].

Some studies on the relationship between the degree of intensivity and technological efficiency of the biomass culture emphasized the possibility of obtaining maximum production through application of optimum stocking density in conjunction with providing the best environmental conditions and a sufficient amount of feed [10]. The practice of high stocking density as a technique to minimize the water volume and to maximize the production, has attracted a number of findings regarding the negative impact of stress due to technological density on growth and health status [2]. Other authors demonstrated a positive correlation between density and technological performance for some predatory fish as: arctic charr (*Salvelinus alpinus*) [4] or African catfish (*Clarias gariepinus*) [1].

However, for the majority fish species the physiological mechanisms influencing growth in the conditions of high densities are not well known. One of the objectives of this experiment was to determine if high stocking density influence growth rate and feeding efficiency for European catfish in the conditions of rearing in flow-through aquaculture systems.

MATERIALS AND METHODS

A 4-weeks experiment was conducted in two identical experimental flow-through aquaculture systems placed in a laboratory of the "Aquaculture, Environment Science and Cadastre" department of "Lower Danube" University, Galati. The 92 catfish exemplars were randomly distributed in the two experimental tanks (600 l/tank) corresponding to the two flow-through aquaculture systems: first system (FT1) was populated with 62 individuals and the second system (FT2) with 30 individuals. The technological water was partially reused after a mechanical and biological filtration with Eheim external filter, type 2080.

The principal attention in running the experiment was daily control of water quality parameters to maintain optimal ranges for *Silurus glanis*. The following water quality parameters were monitored weekly within the systems: pH; temperature; dissolved oxygen concentration. Every two days ammonium, nitrite, nitrate, calcium, phosphorus and total dissolved solids concentrations were checked and, if those parameters exceeded the critical levels, the water was exchanged in order to maintain the values within the experimental range. The following equipment was used to measure the water quality: oxygen concentration and percentage saturation were measured with the WTW Oxi 315 i, pH was measured with the pH meter WTW, model pH 340 and NH^+_4, NO^-_2 , NO^-_3, Cl_2, Ca, PO^-_4 concentrations were measured by using the Photometer Spectroquant Nova 400.

The ratio used for fish feeding in this experiment was 1 % per body weight per day. In the first days of the experiment fish were fed with 25% of the calculated ratio for adapting to the feeding level and, in following days, with 50, 75 and finally 100 % in the fourth day. The total amount of feed per day was administrating in three equal portions. The fish were fed with extruded 4 mm type Advance 2P pellets with 41 % protein content (the biochemical composition is presented in the table 1). Fish welfare (swimming behaviour, feed intake) was evaluate and registered every day.

Tab. 1.Biochemical composition of the Advance 2P pellets

Crude protein	41	%
Crude fat	12	%
Cellulose	2,5	%
Ash	7	%
Phosphorus	0,9	%
Vit. A	10000	U.I. / kg
Vit. D3	1250	U.I. / kg
Vit. E	150	mg / kg
CuSO4	6	mg / kg

In the end of the experiment the fish were weighed, based on which the following parameters were calculated:

- Weight Gain (W) = Final Weight (Wt) - Initial Weight (W_0) (g)
- Food Conversion Ratio (FCR) = Total feed (F) / Total weight gain (W) (g/g)
- Specific Growth Rate (SGR) = 100 x ($\ln W_t - \ln W_0$) / t (% BW/d)
- Relative Growth Rate (RGR) = ($W_t - W_0$)/ t /BW) (g/ kg/ d)
- Protein efficiency ratio (*PER*) = Total weight gain (W) / amount of protein fed (g)

Statistical data processing

Statistical analysis was performed using the SPSS 15.0 for Windows. Distribution normality was verified using Kolmogorov-Smirnov test Z. Statistical differences between variables were tested using t test ($\alpha = 0.05$). The coefficient of variation (CV) was calculated as the ratio of the standard deviation to the mean in order to have a measure of dispersion.

RESULTS AND DISCUSSIONS

The fish belonging the two experimental groups had initial individual weight (±SD) of 619.79 ± 216.49 g / ex. for the first system, hereby noted FT1, respectively 560,83 ± 193.20 g/ex. for the second system, FT2. The initial stocking density was 64 kg/m³ for FT1, respectively 28 kg/m³ for FT2. In the end of the experiment the stocking density reached 70, 56 kg/m³ for the first system and 37.83 kg/m³ for the second system. The distribution of the individual initial and final weight of catfish showed, for both variants, no deviation from the normal distribution ($p>0,05$ with K-S test) as it could be seen in figure 1.

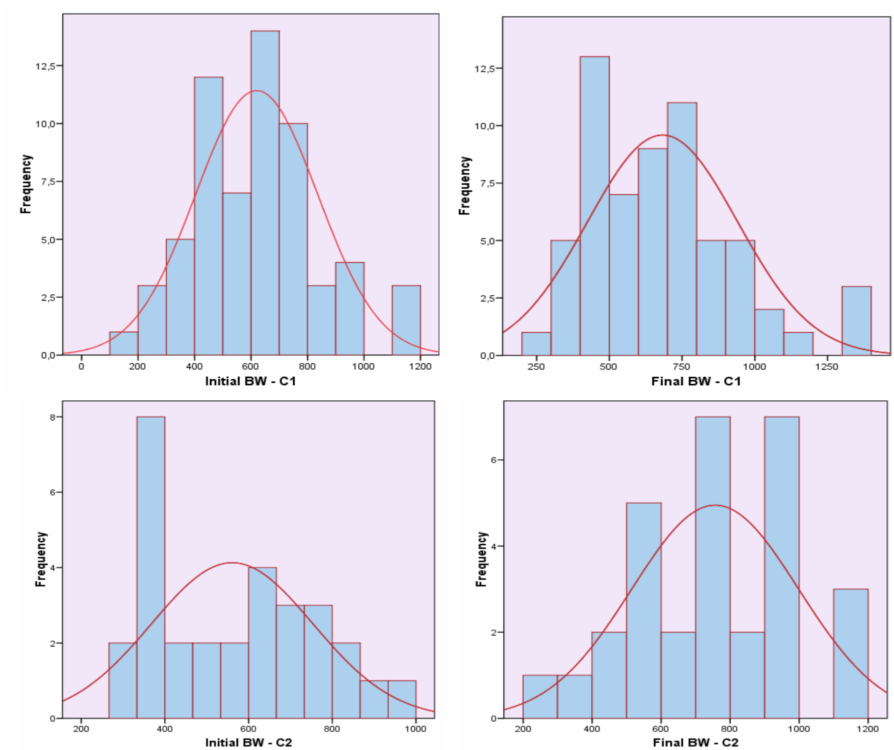

Fig. 1. Histograms for initial and final body weight (BW) of catfish *Silurus glanis* reared in different stocking densities

The two independent variables represented by the fish populations maintained in different stocking densities were tested even at the beginning of the experiment for mean differences using T-test for independent variables in order to confirm the similarity of the mean weight within the two groups. Test reveals insignificant differences ($p > 0.05$) between groups in terms of mean initial weight of catfish.

The coefficient of variation showed a different dynamic within the two growth units. Thus, if in the first tank we had an amplification of variability from 34% to 37% at the end of the experiment, in the second tank the coefficient of variation decreased from 34% to 32%. In our experiment the stocking density induced an increase in the coefficient of variation and therefore an emphasis of the group heterogeneity in the first system. Also, analyzing the biotechnological indicators, synthesized in the table 2, we have found significant differences between the biomass of the two variants regarding the individual weight gain (63 g/ex/FT1 comparing with 195g/ex/FT2). Also large differences could be noted for SGR - specific growth rate (0.32% BW/d/C1 comparing with 1% BW/d/C2), PER – protein efficiency ratio (0,74 g/g/FT1 versus 2,53 g/g/FT2) and FCR - food conversion ratio (2.9 g/g/FT1 versus 0.86 g /g /FT2).

In our experiment as well as in others reported by various authors ([3],[8]) inverse correlation between growth rate and stocking density has been found due to decrease of food utilization as a result of poor welfare status of fish maintained in a chronic stress situation.

Table 2. Biotechnological indicators for catfish rearing in different densities in flow-through aquaculture system

Fish growth performance	C1	C2
Initial stocking density	64	28
Final stocking density	70.56	37.83
Total feed given per tank (g)	11528.09	5047.47
Nr. exemplars	62.00	30.00
Fish stocked (g)	38426.98	16824.90
Mean initial fish weight (g/fish)	619.79	560.83
Fish harvested (g)	42335.46	22698.90
Mean final fish weight (g/fish)	682.83	756.63
Fish weight gained (g/fish)	63.04	195.80
Total fish gained (g)	3908.48	5874.00
Specific growth rate SGR (% BW/zi)	0.32	1.00
Daily growth rate - (g/kg/zi)	2.10	6.53
Food conversion ratio FCR (g/g)	2.95	0.86
Protein / tank	5302.92	2321.84
Protein efficiency ratio - PER (g)	0.74	2.53

In general fish biomass generates wastes proportionally with stocking densities which implies a lower quality of environmental conditions for crowding groups. In our case, the data regarding the dynamics of water quality showed that some of monitored parameters varied outrange of recommended values and those could be considered a factor for poor technological performance. From the table 3 it could be seen that dissolved oxygen, phosphate and calcium differed significantly ($p<0.05$) between the two experimental variants.

For *Silurus glanis* specie, dissolved oxygen level should not drop below 2 mg/dm^3 [9]. DO was maintained above critical concentration in both variants but lower range found in first experimental variant could be associated with chronic stress and lower technological performance in the higher density variant. Data related with hematological indices revealed an insignificant difference regarding hematocrit level which did not showed an increased value due to the crowding stress as we expected and significant differences between variants with respect to haemoglobin concentration which showed higher values in FT1 system. If we associate these results with water quality parameters it can be notice that lower oxygen concentration in the first experiment is a factor with great impact on the technological stress which explain poorer performance of fish biomass in terms of growth rate and food conversion factor.

Tab. 3. Descriptive and inductive statistics for main water quality parameters monitored within the two flow-through systems for *Silurus glanis* intensive rearing

Parameter	System FT1		System FT2	
	Mean	Std. Deviation	Mean	Std. Deviation
Temperature (^{0}C)	18,30	0,95	18,32	0,94
O_2 (mg/l)	2,70^a	1,18	4,29^a	2,13
pH	7,54	,09	7,55	0,08
TDS (mg/l)	628,54	28,69	580,79	30,52
NO2 (mg/l)	0,35	0,31	0,54	0,25
NO3 (mg/l)	2,70	2,58	4,55	2,95
NH4 (mg/l)	4,78	2,13	4,39	1,17
PO_4 (mg/l)	1,58^a	0,76	1,27^a	0,56
Ca (mg/l)	155,0^a	65,67	156,55^a	73,41

a – diferente semnificative la comparatia mediilor (p<0.05, testul T pentru variabile independente)

In the presents study, it may be difficult to reveal the origin of the outcome of the complex relationship of the above mentioned factors, associated with the stocking density. The fish size and age as well as social behaviour should be considered as major importance factors. Our previous experience regarding the rearing of European catfish in recirculating aquaculture system emphasized insignificant differences between different variants of stocking densities for fingerlings (unpublished data) due to competitive feeding behavior of individuals from higher densities.

Nieuwegiessen P. [7] stated that increasing fish (*Clarias gariepinus*) age/size welfare concerns shift to low stocking densities, where increased plasma cortisol levels and increased aggression were observed. In *Silurus glanis's* case we didn't observed a changed behavior or aggression signs in fish from higher density fact which confirms the potential for intensive production if the water quality correspond with physiological requirements of selected age and size of the specimens.

CONCLUSIONS

This work aimed to assess the productive potential of intensive flow-through aquaculture for different density maintenance of biological material.

Results reveal a better technological performance of specimens maintained at lower density.

Higher stocking density induced an increase in the coefficient of variability and therefore a higher level of heterogeneity in fish maintained in crowding condition.

The increasing of stock density of European catfish leads to the decreasing of growth rate. Mean final body weight of fish from lower density is 10% smaller than that of individuals from higher density ($P<0.05$). Those results however are induced also by some water quality parameters which differed significantly between variants.

Further investigations are needed to find the optimum density levels at which these parameters would be significantly improved during the intensive rearing of *Silurus glanis* yearlings.

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