

THE INFLUENCE UPON THE VARIATION OF THE MAIN PHYSICAL-CHEMICAL WATER PARAMETERS UPON THE BREEDING OF THE SPECIES *POLYODON SPATHULA* IN A RECIRCULATING AQUACULTURE SYSTEM

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Abstract

The experiments carried out regarding the topic „Research concerning the evaluation of the technological plasticity of the species *Polyodon spathula* (Walbaum, 1792) in a recirculating aquaculture system” are among national priorities concerning the development technology in the condition of recirculating aquaculture system. The purpose of this paper is to monitor the main physical-chemical parameters of water which can modify the metabolic processes of the culture biomass.

The experiment was carried out as a pilot programme in the “Recirculating aquaculture system engineering” Laboratory, within the Aquaculture, Environmental Sciences and Cadastre Department. The value of main physical-chemical parameters of the quality of water, both when water is introduced and evacuated out of the breeding system, which fit into the optimum limits for the breeding of sturgeons.

Key words: polyodon, recirculating system, physical-chemical parameters

INTRODUCTION

The breeding of the species *Polyodon spathula* (Walbaum, 1792) in environment conditions controlled by processing and recirculation of technological water (recirculating system) represents a challenge for the Romanian aquaculture.

It is well-known that the sustainability of a recirculating production system depends on a multitude of technological desiderata, among which we can remind the following: maintaining a good quality of water, maintaining a corresponding feeding rhythm level, as well as applying a technological management adequate to the metabolism of culture species, of the factors which influence this process [1], [2].

Due to qualitative techniques of quality water control, the recirculating aquaculture systems are considered an ideal alternative for sturgeon breeding, being part of the group of very valuable fish. It is well-known that the demands regarding the quality of water within a recirculating aquaculture system

vary considerably according to the following elements: species, water source, running speed of water, fish density, life stage and previous exposure to stress [3].

MATERIALS AND METHODS

The research from the present paper is part of the experimental investigations-like category carried out in a pilot recirculating system, within the Aquaculture, Environmental Sciences and Cadastre Department, between 1st of September to 7th of October 2010.

The design of the experimental production system contains the following elements (figure 1):

- Breeding unities;
- Water distribution installation to the breeding model;
- Quality water conditioning units represented by:
 - Water filtration
 - Water sterilization
 - Water aeration and oxygenation

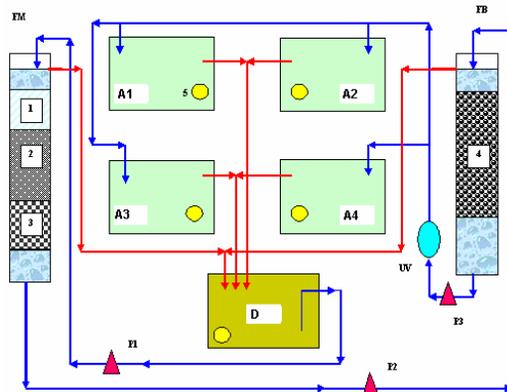


Fig. 1 The scheme of the recirculating system (A1-A4)-Tanks, D-Decantation apparatus, (P1-P3)-pumps, UV- sterilization lamp, FM- mechanical filter, FB- biological filter, 1-sponge, 2-sand, 3-grit, 4-bactobolt, 5-arinozzle

A 112 days old group of 64 exemplars of *Polyodon spathula*, having reached a larval stage in the research pilot station within the Aquaculture, Environmental Sciences and Cadastre Department, and from the Centre of Researches and Development of Aquaculture Nucet, was tested by being administrated two types of straw. Densities of biological material at the beginning of the experiment was 16 fish / aquarium. The temperature, the dissolved oxygen and the water pH were monitored on a daily basis with the help of a Hach-Lange Sc 1000 equipment, while the control of the nitric compounds was periodically determined by a iar controlul compusilor azotului au fost

determinati periodic cu Spectroquant Nova 400 spectrophometer, using Merk-like kits, for $N-NH_4^+$, $N-NO_2^-$, $N-NO_3^-$. Water samples were taken at entry (I) and exit (II) water system.

RESULTS AND DISCUSSIONS

The results obtained were interpreted from the point of view of the culture species echo physiological demand regarding the quality of water (lethal or stressing physiological limits) and the regulations Order 161/2006 which includes water the fish breeding use into II, III quality categories (table 1).

Table 1 The physical-chemical parameters of the water, tolerated by sturgeon

Parameter	Limits		
	Minimum	Optimal	Maximum
pH - upH	6,5	7- 7,8	8- 8,5
O ₂ - mg/l	6	7- 12	14
mg KMnO ₄ - mg/l	5	35-50	55-60
CBO5 - mg/l	5	6	7
Ca ₂ ⁺ - mg/l	30	90-120	160
Mg ₂ ⁺ - mg/l	5	10-40	50
Cl ⁻ - mg/l	6	30	40
NO ₃ ⁻ - mg/l	1	2,5 - 4	20
NO ₂ ⁻ - mg/l	0	0-0,005	0,1
PO ₄ ³⁻ - mg/l	0,005	0,05-1,5	3
SO ₄ ²⁻ - mg/l	0-15	20 - 40	70-80
NH ₃ - mg/l	0-0,001	0,001	0,01
NH ₄ ⁺ - mg/l	0,05-0,5	0,05	2
CO ₃ ²⁻ - mg/l	0	urme	10-20
CO ₂ - mg/l		10	
HCO ₃ ⁻ - mg/l	20-100	200 - 400	600
Alkalinity -ml HCl/l	0,2	2 - 4	6
Hardness (°D)	8	12 -18	20
Fixed res. - mg/l		100	
Susp. - mg/l		15-25	

Temperature of water

Temperature is the most important factor which affects fish behaviour, breeding and the feeding rhythm.

The optimum thermal interval for the breeding of the species studied is of 18-22°C. Within this temperature, fish have a maximum breeding performance; they efficiently transform the food and are more resistant to disease. The higher their sensibility regarding the sudden temperature variations is, the smaller their age. When the water temperature drops under 4°C the sturgeons no longer feed themselves and die; when the water temperature increases below 26°C there are signs of suffocation or digestive problems etc.

The temperature of water recorded during the experiment varied between 20,66°C and 24,82°C with an average value of 23,09±1,4°C (figure 2).

Water reaction (pH)

In a recirculating aquaculture system, pH is an important parameter which needs to be continuously monitored and controlled as the water reaction influences a multitude of parameters, as well as the speed of numerous biological and chemical processes.

Water pH represents the concentration of hydrogen ions from water and, according to this, the water has an acid or alkaline aspect. It is in a strict dependence with CO₂ from water, bicarbonates and carbonates.

In the case of an optimum pH (6,5-8,5 upH), the culture biomass is actively

feeding, has maximum breeding performance an a good sanitary condition.

During the experiment, for both the entrance (I) and the exit (II) of water from the technological system, the pH was constant, the values recorded being optimum for the fish breeding (between the interval 7,3-7,9 upH, with an average value of 7,59±0,16 upH (figure 2).

Dissolved oxygen

The quantity of DO is indirectly proportional to temperature; in the case of high temperatures, the quantity of oxygen decreases. The necessary quantity of oxygen is being indicated by the species echo physiological requests, fish size, feeding rhythm and temperature.

The low quantities of dissolved oxygen concentrations can become lethal for the culture biomass, even when the deficit is for shorter periods (several minutes). This is possible because the quantity of dissolved oxygen into water depends, besides on temperatures, on other factors as well such as the culture species, the fish individual average weight and the total biomass/unity of volume water. A DO concentration smaller than 5 mg/l will lead to a stress condition of the fish, and a level of less than 2 mg/l will inevitably lead to their death.

The value of dissolved oxygen recorded during the experiment varied between 8,32 si 9,83 mg/l with an average value of 8.84± 0.36 mg/l (figure 2).

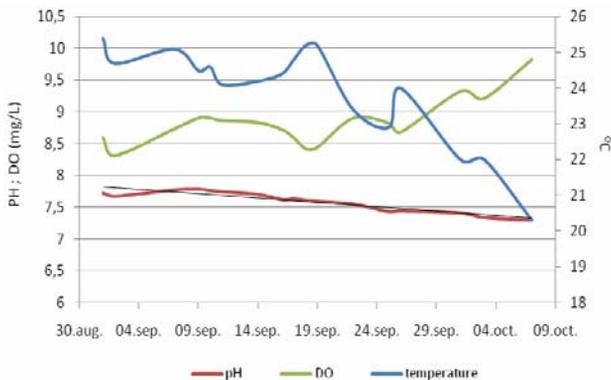


Fig. 2 The dynamics of main water quality parameters during the experiment

Nitrogen compounds

The ammonia is the main residual compound, result of the metabolic activity of fish. Both the unionized form of the ammonia as well as the nitrites, in small quantities, can be very toxic for fish.

Irrespective of the type of intoxication, the effect of ammonia upon sturgeons acts on the breeding rhythm, inflames the gills, mucous hyper secretion, bleeding at the level of the gills and tegumentation. The liver and the kidneys are atrophied 25-38% of the initial mass of these organs.

The nitrites are toxic products for aquatic organisms [4], and their presence is permitted only for under 0,02 mg/l $N-NO_2^-$. In the case of nitrites, the maximum admitted concentration is of 0,1 mg/l. The excessive accumulation of nitrites in the sturgeons' organism has as an effect the delay of the evolution and the decrease of resistance to disease. The environment factors which affect the transformation of NO_2^- are the pH, the temperature, the content of dissolved oxygen, the microbial density and the inhibitory elements ([5], [6]).

The nitrites are stable products, result of the nitrification process. In general, there are not considered as being toxic, even if many aquatic organisms are sensitive to high nitrite concentrations. Within the aquatic systems, the quantity of nitrites is being kept under control by changing small volumes of water. The optimum values recommended for fish breeding in recirculating system are of 20 mg/l.

The quantities of $N-NH_4^+$ in the two sampling points varied between 0,08 and 0,41 mg/l (average: $0,30 \pm 0,16$ mg/l) for the entrance point into the filtration system and between 0,06 and 0,44 mg/l (average: $0,30 \pm 0,18$ mg/l), at the exit point of the filtration system (figure 3).

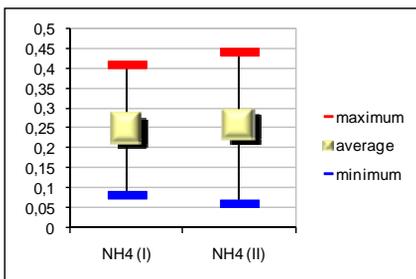


Fig. 3 Minimum, average and maximum values recorded water entry and exit system for $N-NH_4^+$ (mg/l)

The $N-NO_2^-$ concentration, at the entrance and exit point of the water from the filtration system was lower (0,02 mg/l) than the maximum value for fish breeding (0,2 mg/l), except for two analysis carried out at the beginning of the research; at this point, the $N-NO_2^-$ concentration becomes toxic for fish (0,38 mg/l entrance and 0,4 mg/l exit), presenting average value at entrance $0,13 \pm 0,14$ mg/l and exit $0,14 \pm 0,14$ mg/l (figure 4).

The value of nitrites both when water is introduced and evacuated out of the breeding system was under the maximum admitted concentration for sturgeons (20 mg/l), with an average entrance value of $11,6 \pm 3,14$ mg/l and average exit value of $11,5 \pm 2,94$ mg/l. (figure 5).

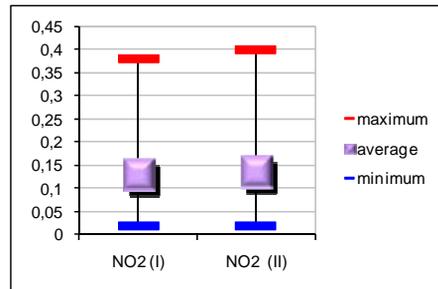


Fig. 4 Minimum, average and maximum values recorded water entry and exit system for $N-NO_2^-$ (mg/l)

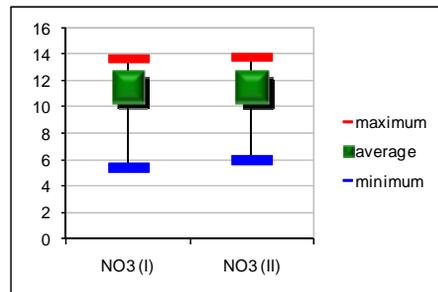


Fig. 5 Valorile minime, medii si maxime inregistrate la intrarea si iesirea apei din sistem pentru $N-NO_3^-$ (mg/l)

CONCLUSIONS

After the analysis of the physical-chemical parameters obtained, both regarding the optimum breeding values of the species *Polyodon spathula* as well as the regulations concerning the classification of surface water

in order to establish the ecological condition of water organisms (order no 161/2006) and correlated with the data from the literature of speciality for fish breeding waters, the following conclusions unfold:

- The temperature of water recorded an average value of $23,09 \pm 1,4$ °C which fit into the optimum limits for the breeding of sturgeons;

- pH of water registered an average value of $7,59 \pm 0,16$ upH which fits into the optimum limits for the breeding of sturgeons;

- the dissolved oxygen recorded an average value of $8,84 \pm 0,36$ mg/l which fits into the optimum limits for the breeding of sturgeons;

- the average values of $N-NH_4^+$, $N-NO_2^-$ and $N-NO_3^-$ fitted the admitted limits for the breeding of sturgeons.

We have noticed that, during the experiment, the physical-chemical parameters monitored for waters used for fish breeding fitted into the admitted limits, also respecting the admitted limits of the culture species.

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