WATER QUALITY EVALUATION OF CYPRINID POND BASED PRODUCTION SYSTEM EFFLUENT

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Abstract

Aquaculture is the fastest growing food production sector, according to FAO report. Romanian aquaculture has an estimated production of 10000 tones per year, most of it being provided by cyprinids pond aquaculture production systems. However, pond aquaculture rises certain problems regarding the sustainability, as large concentrations of nitrogen and phosphorus may be recorded in effluents. Therefore, the aim of our study is to evaluate the sustainability of a single pond based cyprinids production system, situated in Galaţi - Romania, by analysing the water quality of the effluent. Water samples were collected from the pond effluent and the following analysis were determined: temperature (T°C), dissolved oxygen (DO), pH, nitrites (NO_2), ammonia (NH_3),orthophosphates (PO_4),total zinc (Zn) chlorides (Cl^-), bicarbonates (HCO_3^-), electro conductivity (EC) and total dissolved solids (TDS).The results were compared to the present national legislation (HG no. 202/2002) regarding the water quality in cyprinid farming and also to water quality criteria for aquaculture. Statistical analysis included normality test Kolmogorov Smirnov in order to determine the distribution of the registered data and Pearson correlation coefficient was applied for the analyzed parameters. The main conclusion of this research was that the technological water of the studied fish pond is suitable for fish rearing and sustainable for the environment, in terms of temperature, DO, pH, Cl^-, HCO_3^-, Zn, EC and TDS. However, NO_2, NH_3 and PO_4 concentrations were above the admissible limit imposed by the romanian legislation. Therefore, in order to improve sustainabily it is recommended that various modern multi-trophic technics should be applied, so that phosphorus and nitrogen compounds are valorized at maximum capacity.

Key words: aquaculture, sustainability, nitrogen, phosphorus

INTRODUCTION

Different anthropogenic activities influence negatively the quality of surface waters and 80% of used water flows back into surface water bodies in the form of sewage [6]. The global industry is one of the fastest growing food production sectors, with an average annual increase of 5.8% [2]. Expansion and intensification of land-based aquaculture farms can cause the release of a large quantity of wastewater [5]. The high nutrients load (such as nitrogen and phosphorus) of the aquaculture effluent can cause water pollution by inducing eutrophication [3]. As well, the disc arched nutrients cand cause degradation of benthic and pelagic habitats. Therefore, continous monitoring of aquaculture water quality effluent is imperative. The aim of our study is to evaluate the sustainability of a single pond based cyprinids production system by analyzing the water effluent in terms of temperature (T°C), dissolved oxygen (DO) pH, nitrites (NO_2), ammonia (NH_3), orthophosphates (PO_4), total zinc (Zn) chlorides (Cl^-), bicarbonates (HCO_3^-), electro conductivity (EC) and total dissolved solids (TDS).

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MATERIALS AND METHODS

The sampling area was represented by Mălina Pond (Fig. 1), which is a single pond based cyprinids production system, situated in the South-Est part (Galaţi city) of Romania. The rearing pond has total surface of 24 ha and an average depth of 1.7 m. Water inlet and outlet is executed by the hydrotechnical system, respectively by the pumping groups.

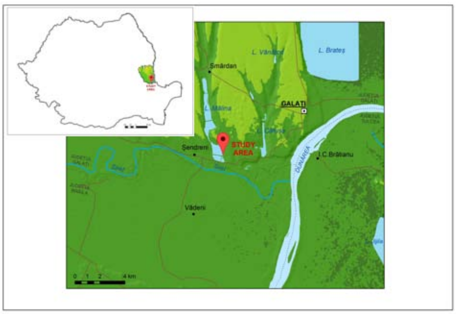

Fig. 1 Representative map of the sampling area

Water samples (n=25) were collected in decontaminated flasks (volume 500 ml), according to SR ISO 5667-6/1998, during spring season (april-may) 2018, from the pond effluent. The samples were stored on ice and transported to the laboratory. The analysis were performed at MoRAS Research Center, within Reform Research Hub, Faculty of Food Science and Engineering, "Dunărea de Jos" University of Galaţi.

For the determination of temperature, DO, pH, EC and TDS WTW multi-parameter 720 set was used. For the determination of NO_2, NH_3, Cl^- and HCO_3^- the water auto analyzer Skalar San System was used. For the determination of PO_4 molecular spectrometer SpectrocuantNova 400 and for determination of Zn atomic spectrometer Analytik Jena Contraa 700 was used.

Statistical analysis was performed using Origin Pro and it included normality test Kolmogorov-Smirnov, followed by variance test Anova.

RESULTS AND DISCUSSIONS

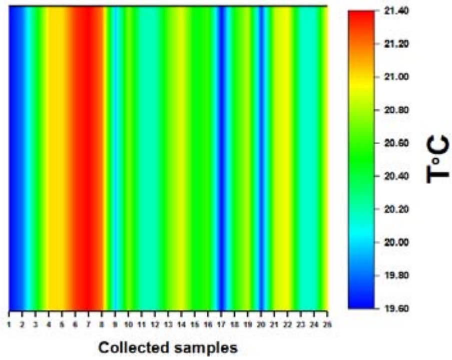

Fig. 2 Water temperature in pond effluent

Water temperature of the pond effluent registered values in the range of 19.6 – 21.4°C (Fig. 2), witha mean value of 20.52±0.53°C. Normality test revealed that the data had a normal distribution ($p=0.96$) and the differences between samples were significant ($p<0.05$). In pond systems the water temperature is closely related to the atmospheric thermic regime dynamics.

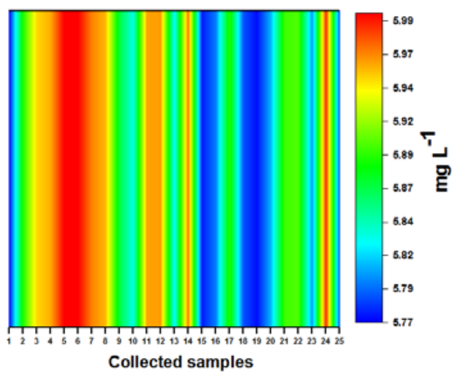

Fig. 3 DO concentration in pond effluent water

DO concentration in the pond effluent water registered values in the range of 5.77 – 6 mg L^{-1} (Fig. 3), with a mean value of 5.88±0.08 mg L^{-1}. Normality test revealed that the data had a normal distribution ($p=0.34$) and the differences between samples were significant ($p<0.05$). The mean registered value for the concentration of DO was within the limit (≥5 mg L^{-1}) imposed by the national legislation (HG 802/2013) for the technological water in cyprinid farms [7]. A value >5 mg L^{-1} is the recommended concentration of DO, according to water quality criteria for aquaculture [1].

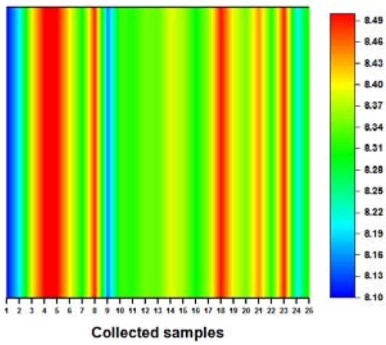

Fig. 4 pH values in pond effluent water

pH values in the pond effluent water were within the range of 8.1 – 8.5 (Fig. 4), with a mean value of 8.35±0.10. Normality test revealed that the data had a normal distribution (p=0.53) and the differences between samples were significant ($p<0.05$).These differences can be attributed to the pressence of aquatic macro vegetation (*Phragmites australis*), which manifests an active nitrification process at the root level and, therefore, eliminating low concentrations of nitric and carbonic acid in the technological water and thus, lowering the pH. The mean pH value registered in the pond effluent water was within the imposed range (6-9) by the national legislation (HG 802/2013) for the technological water in cyprinid farms [7].

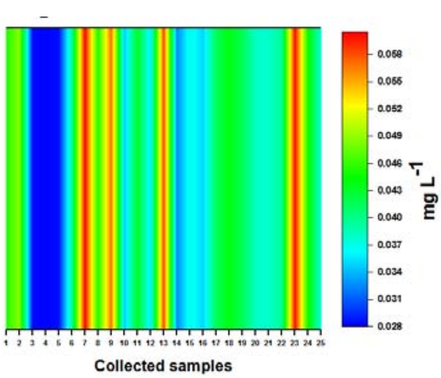

Fig. 5 NO_2 concentration in pond effluent water

NO_2 concentration in the pond effluent registered values in the range of 0.027 – 0.060 mg L^{-1} (Fig. 5), with a mean value of 0.041±0.009 mg L^{-1}. Normality test revealed that the data had a normal distribution (p=0.56) and the differences between samples were significant ($p<0.05$). The mean registered value for NO_2 concentration in the pond effluent water was above the recommended limit (≤0.03 mg L^{-1}) imposed by the national legislation (HG 802/2013) for the technological water in cyprinid farms [7]. These higher values can be attributed to the presence of hydrophilic vegetation, which is responsible for the oxidation of NH_3 into NO_2.

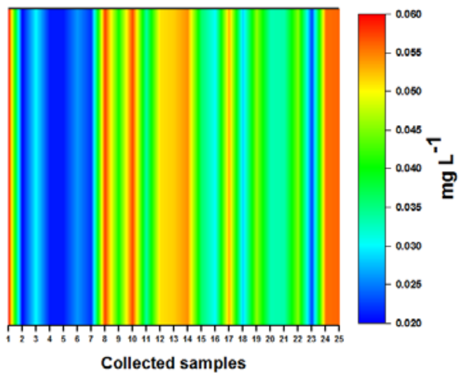

Fig. 6 NH_3 concentration in pond effluent water

NH_3 concentration in the pond effluent registered values in the range of 0.021 – 0.06 mg L^{-1} (Fig. 6), with a mean value of 0.039±0.01 mg L^{-1}. Normality test revealed that the data had a normal distribution (p=0.52) and the differences between samples were significant ($p<0.05$). The mean registered value for NH_3concentration in the pond effluent water was above the limit (≤0.025 mg L^{-1}) imposed by the national legislation (HG 802/2013) for the technological water in cyprinid farms [7]. This phenomenon can be caused by the decomposition of uneaten fish feed.

In case of PO_4 concentration in the effluent pond water, the registered values were within the range of 0.6 – 0.8 mg L^{-1} (Fig. 7), with a mean value of 0.57±0.02 mg L^{-1}. Normality test revealed that the data had a normal distribution (p=0.68) and the differences between samples were significant ($p<0.05$). The mean registered value for PO_4 concentration in the pond effluent water was above the limit (0.4 mg L^{-1}) imposed by the national legislation (HG 802/2013) for the technological water in cyprinid farms [7].

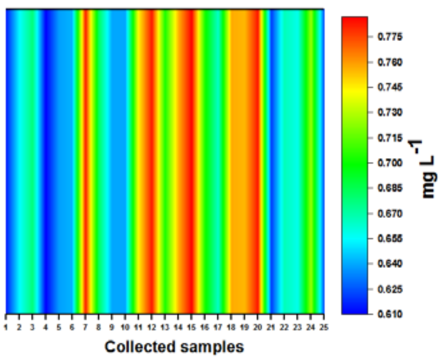

Fig. 7 PO_4 concentration in pond effluent water

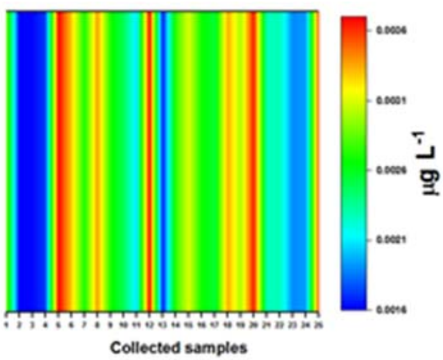

Fig. 8 Zn concentration in pond effluent water

Zn concentration in the pond effluent water registered values in the range of 0.0016 – 0.004 µg L-1 (Fig. 8) with a mean value of 0.0026±0.0006 µgL^{-1}. Normality test revealed that the data had a normal distribution ($p=1$) and the differences between samples were significant ($p<0.05$). The mean registered value for Zn concentration in the pond effluent water was above the limit (≤1 mg L^{-1}) imposed by the national legislation (HG 802/2013) for the technological water in cyprinid farms [7].

In case of Cl^- concentration in the pond effluent water, the registered values were between the range of 471.78 – 488.23 mg L^{-1} (Fig. 9), with a mean value of 478±5.17 mg L^{-1}. Normality test revealed that the data had a normal distribution ($p=0.92$) and the differences between samples were significant ($p<0.05$). The elevated values of Cl^- concentration in the pond effluent water can be attributed to the application of pond disinfection treatments, with the use of higly soluble substances such as lime chloride. Most fish species survive in waters with Cl^- concentration up to 600 mg L^{-1}, however the fish growth rate is negatively influenced [1]. Cl^- concentration in cyprinid farms technological water is not regulated by the national legislation.

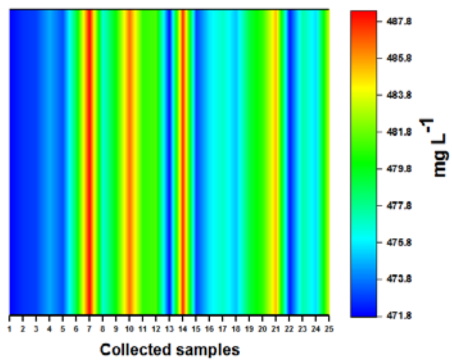

Fig. 9 Cl^- concentration in pond effluent water

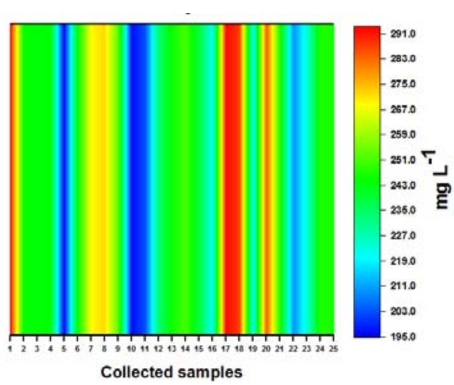

Fig. 10 HCO_3^- concentration in pond effluent water

HCO_3^- concentration in the pond effluent water registered values in the range of 292.8 -195.2 mg L^{-1} (Fig. 10), with a mean value of 244.01±28.20 mg L^{-1}. Normality test revealed that the data had a normal distribution (p=0.68) and the differences between samples were significant (p<0.05).

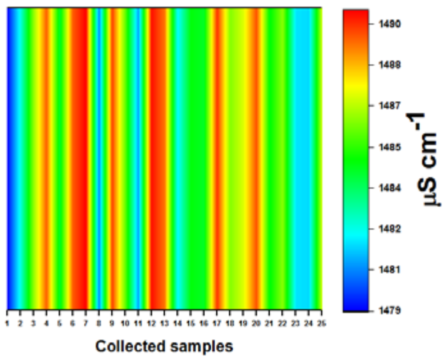

Fig. 11 EC in pond effluent water

EC of pond effluent water registered values within the range of 1479 – 1490 µS cm^{-1} (Fig. 11), with a mean value of 1485.41±3.40 µS cm^{-1}. Normality test revealed that the data had a normal distribution (p=0.53) and the differences between samples were significant (p<0.05).

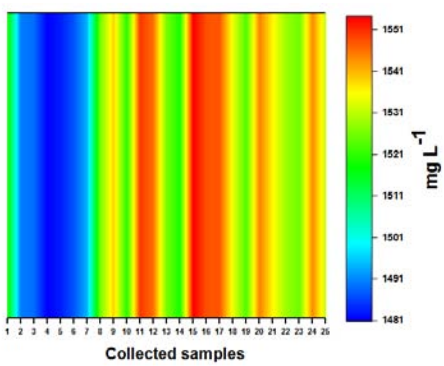

Fig. 12 TDS concentration in pond effluent water

TDS concentration in the pond effluent water registered values situated in the range of 1481 – 1550 mg L^{-1} (Fig. 12), with a mean value of 1523±23.12 mg L^{-1}. Normality test revealed that the data had a normal distribution (p=0.32) and the differences between samples were significant (p<0.05). In freshwater ecosystems, high concentrations of dissolved organic carbon can generate higher values of TDS concentration in the water column, compared to water EC.

CONCLUSIONS

The main conclusion of this study is that the technological water, respectively the studied pond effluent is suitable for fish rearing and sustainable for the environment, in terms of temperature, DO, pH, Cl^-, HCO_3^-, Zn, EC and TDS. However, NO_2, NH_3 and PO_4 concentrations were above the admissible limit imposed by the romanian legislation. Therefore, in order to improve sustainabily it is recommended the application of various modern multi-trophic technics, so that phosphorus and nitrogen compounds are valorized at maximum capacity.

As well, biological filtration of the pond effluent before outlet should be taken into consideration, in order bio remediate it.

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