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Some Chemical Characteristics of Sediments from Carp Fishponds Treated With Different Fertilizers

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Abstract. The bottom sediments of earthen carp fishponds treated with mineral or organic fertilizers and areas ranging from 0.38 to 7.0 hectares were analyzed. The analyses included determination of basic chemical characteristics in the 0-0.15 m sediment layer like organic matter and organic nitrogen in percentages of dried substance, ammonium and nitrate nitrogen in $mg.kg^{-1}$ dried substance too. The sediments of the fishpond fertilized with ammonium nitrate showed highest concentrations of ammonium and nitrate nitrogen. There was an increased level of organic matter in sediments of organically manured and of other fishponds with area of 2.4 and 7.0 hectares correspondingly. The control fishpond showed higher level of organic nitrogen than the others did. The degree of macrophyte coverage determined the content of organic matter and organic nitrogen while the kind of applied fertilizer influenced the concentrations of inorganic nitrogen forms in sediments.

Keywords: fishponds, bottom sediment, organic and mineral fertilization.

Introduction

The manuring of fish ponds with mineral and organic fertilizers is one of most frequently applied intensification measure in practice of fish farming. The controlled addition of mineral fertilizers can increase the natural productivity of waters, expressed by quantity of plankton and benthos, which are playing an important role in supplementing the fish food shortage (GAS & JANA, 2003). The development of these food resources is directly connected with availability of the basic nutrients nitrogen and phosphorus. The necessary balance between nitrogen and phosphorus and their ratio in the water column depends also on the processes in sediment, which are controlling the nutrient cycle, and distribution in the aquatic ecosystems.

In that sense the bottom sediments, absorbing mineral fertilizers are playing an important role in the fertilization. Colloidal bound nutrients are released thus gradually increasing pond productivity. The bottom depositions serving the exchange between organic substances and nutrients might act as source or depot of organic and mineral resources.

The understanding of properties as well as reactions and processes of the soils might be very useful for pond's aquaculture (BOYD, 1995b). GARD & BHATNAGAR (2002)

showed an increase of organic nitrogen and ammonium ion levels after manuring. In that sense the goal of the study is to reveal the effect of mineral and organic manuring on some indicative characteristics of bottom sediments from fishponds.

Materials and Methods

The investigation was carried out on earthen carp fishponds with area size varying from 0.38 to 7.0 ha belonging to the institute of fishery and aquaculture in town of Plovdiv. The traditional technology for breeding of warm water fish species in polyculture was applied.

During the vegetation period two of the ponds were treated either with mineral (pond No 8) or organic (pond No 24) fertilizer, while the third pond No 29 was not manured. The Table 1 presents a scheme of pond fertilization and composition of bred fish polyculture.

The monthly sampling from a 0-0.15 m sediment layer was carried out in May-September interval of year 2009 by means of modification of Kachinski core sampler.

Table 1. Scheme of studied ponds with applied fertilizers and farmed fish species

Pond No	Area, ha	Applied fertilizer kg.ha^{-1}	Farmed fish species
8	0.38	466 ammonium nitrate 20 superphosphate	Common Carp, Silver Carp
28	2.4	2000 manure	Common Carp, Silver Carp, Grass Carp
29	7.0	without manure	Common Carp, Grass Carp, Silver Carp, Northern Pike, Wels

The sediment analysis includes determination of organic substances in percents of dried matter (%), after Bosworthetal (www.geo.arizona.edu/nyanza/pdf/BharmalLaurent); of organic nitrogen (%) by Kjeldahl method after mineralization with selenium by means of semiautomatic system for analysis of DK-6 type for decomposition and UDK-132 for distillation of VELP-Scientifica firm; of mobile nitrogen forms determined spectrophotometrically after its preliminary extraction from soil by solution of KCl (after TOMOV *et al.*, 1999); determination of inorganic forms of phosphorus by double lactate method of Egner - Riem (after TOMOV *et al.*, 1999)

By means of the "Statistica 7.0" package Wilcoxon paired t-test for significance testing of the differences between ponds and treatments was applied.

Results and Discussion

Organic substances. The average seasonal percentage of organic substances in the surface slit layer varied from 5.16% to 7.29% with higher values recoded in pond No 29 (Fig. 1). Probably this is related to the regular overgrowing of this pond with soft and hard aquatic plants vegetation during the vegetation season (up to 50% coverage of water surface) and impossibility to remove it due to large size of the pond (7.0 ha). The application of organic fertilizer is the reason for accumulation of organic substances in the sediments of pond No 28 (2.4 ha), where relatively high percentage is recorded (6.9%) The percentage of organic substances in two mentioned ponds is significantly higher than in pond No 8 ($8 < 28$ $P = 0.0012$; $8 < 29$ $P = 0.011$) where the average seasonal level of organic matter in the surface bottom layer is about 5.2%. Therefore, we can conclude that the mineral fertilization does not increase the organic matter in the surface sediment layer. The recorded average values are from 30 to 82% higher than the reported by BOYD (1995a) average content of organic matter in ponds (4%).

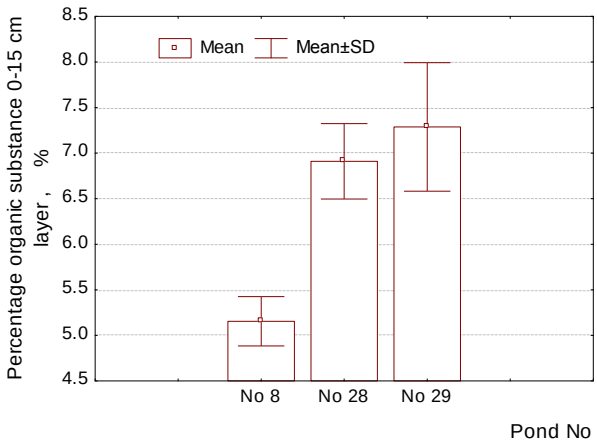

Fig. 1. Average seasonal percentage of organic matter (OM, %) in 0-0.15 m sediment layer of three investigated ponds.

Organic nitrogen. The average seasonal values of percentage of organic nitrogen in sediment layer 0-0.15 m vary from 0.29% (pond No 28) to 0.37% (pond No 29) (Fig. 2). The percentage of organic nitrogen in pond No 29 is significantly higher than in pond No 8 (29>8, P = 0.008), while the differences between ponds No 8 and 28 (P = 0.65) and ponds No 28 and 29 (P = 0.11) we are not statistically significant.

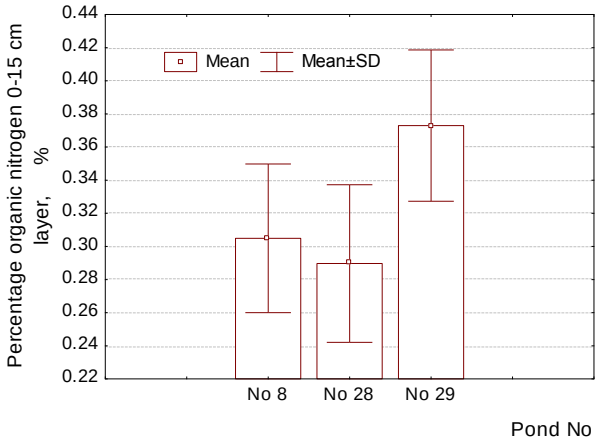

Fig. 2. Average seasonal percentage of organic nitrogen (ON, %) in 0-0.15 m sediment layer of three investigated ponds.

The obtained values for organic nitrogen are close to those reported in previous investigations (HADJINIKOLOVA *et al.*, 2007). Bearing in mind that the total content of organic nitrogen in soil surface layers is varying between 0.1% - 0.85% (ATANASOV *et al.*, 1979), the stock of organic nitrogen in bottom sediments of fish ponds might be estimated as "average" one. In freshly formed depositions like the bottom sediments of fish ponds a big part of organic nitrogen is mineralized by nitrification or lost by denitrification (BHARMAL & LAURENT, 2004**).**

Inorganic nitrogen forms. The average seasonal concentration of ammonium nitrogen in the sediment layer 0-0.15 m varies between 23.91 and 67.19 mg.dm^{-3}. The concentration in pond No 8 is significantly higher than in pond No 28 (P = 0.025) and in pond No 29 (P = 0.043) (Fig. 3). The differences of ammonium nitrogen concentration between ponds No 28 and No 29 are not significant (P = 0.11). This leads to the conclusion that application of mineral fertilization influences ammonium nitrogen directly, what is in accordance with investigations of GARD & BHATNAGAR (2002).

The average seasonal concentration of nitrate nitrogen (Fig. 4) is varying from 4.79 (pond No 29) to 11.05 mg.dm^{-3} (pond No 8). The highest stock of inorganic nitrate is encountered in sediments of pond No 8, where mineral fertilization was applied. The concentration of nitrate ions in this pond is 2.3 times higher than in the control pond and by 18.8% higher than in pond No 28, where organic fertilizer was applied. Independent from the mentioned large differences for nitrate concentrations there were no statistically significant differences detected between investigated ponds No 8, 28 and 29.

Inorganic phosphorus. The average seasonal values of phosphate ions (Fig. 5) are varying in the range 42 (pond No 8) – 63.55 mg.dm^{-3} (pond No 29). The highest stock of inorganic phosphorus compounds is observed in sediments of pond No 29, which is by 33.9% higher than in pond No 8 (with applied mineral fertilizer) and by 8.9% higher than in pond No 28 (with applied organic manure).

Independent of recorded variations of average seasonal values for phosphate ions no statistically significant differences between investigated ponds No 8, 28 and 29 were found. In our case the treatment with

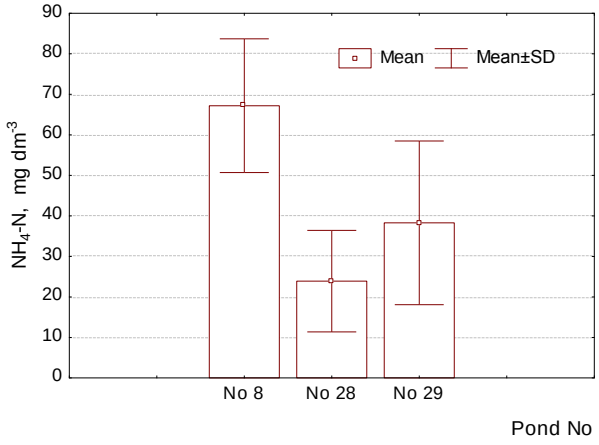

Fig. 3. Average seasonal values of concentrations of ammonium nitrogen (NH_4 - N, mg.dm^{-3}) in 0-0.15 m sediment layer of three investigated ponds

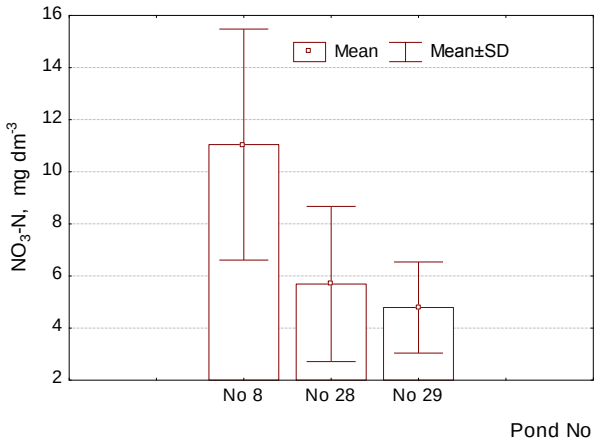

Fig. 4. Average seasonal values of concentrations of nitrate nitrogen (NO_3 - N, mg.dm^{-3}) in 0-0.15 m sediment layer of three investigated ponds

mineral phosphorus fertilizer does not directly influence the phosphate concentration in surface sediment layer, as observed for ammonium ions. One possible reason for this might be the binding of incoming with water phosphorus with calcium and iron ions in insoluble complexes. On the other hand, in principle the effect of fertilization depends on preliminary pond preparation and factors of aquatic environment like water temperature, oxygen concentration and pH (HADJINIKOLOVA, 2013).

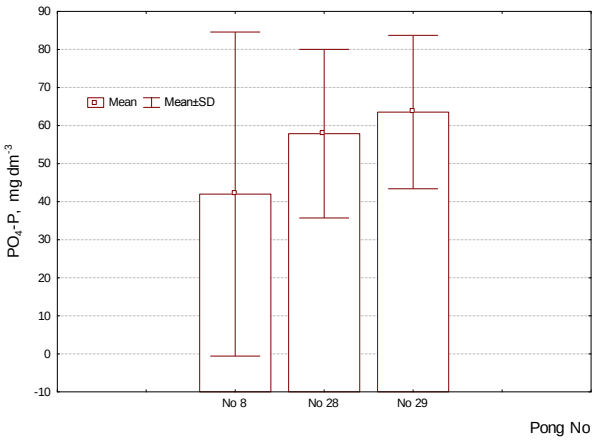

Fig. 5. Average seasonal values of phosphate phosphorus (PO_4 – P, mg.dm^{-3}) in sediment layer 0-0.15 m

Conclusions

The average seasonal content of organic substance in the surface silt layer of carp fish ponds varies from 5.16% to 7.29%, whose values are more strongly and significantly affected by organic in comparison with mineral manuring (pond No 8 < pond No 28 for P = 0.0012)

The organic nitrogen stock of sediment layer is in the range 0.29% - 0.37% and could be estimated as average compared to the reported total content of organic nitrogen in soil surface layers (0.1% - 0.85%).

Reported are variations of concentrations of ammonium ions from 23.91 mg.dm^{-3} (pond No 28 with applied organic fertilization) to 67.19 mg.dm^{-3} (pond No 29 control, without fertilization). Significantly higher ammonium concentrations are reported in pond No 8 than in pond No2 8 (P = 0.025) and then in pond No 29 (P = 0.043), which is indication for direct influence of mineral nitrogen fertilization on concentration of ammonium nitrogen in sediments.

The investigations do not show significant differences between studied ponds for their concentrations of nitrate nitrogen and phosphate phosphorus.

More clear differences between average seasonal concentrations of nitrate nitrogen of pond No 29 (4.79 mg.dm^{-3}) and of pond No 8 (11.05 mg.dm^{-3}) were observed, which indicated the tendency for higher stocks of

nitrate in pond No 8, where mineral nitrogen fertilization was applied. The average seasonal phosphate ion concentrations are varying in the range 42 $mg.dm^{-3}$ (pond No 8) – 63.55 $mg.dm^{-3}$ (pond No 29) indicating that the mineral phosphorus fertilization does not directly affect the concentration level of phosphates in the surface sediment layer.

Acknowledgements

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