Journal of Young Scientist, Volume III, 2015
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

PHYSICO-CHEMICAL AND MICROBIAL ANALYSIS OF POND WATER FROM USAMV DENDROLOGICAL PARK - BUCHAREST

Mihai FRÎNCU, Corina DUMITRACHE,Andrei Cristian DUMITRIU

Scientific Coordinators: Prof. PhD Carmen CÎMPEANU Lect. PhDConstanţa MIHAI

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64, Fax: + 4021.318.25.67, Email: frincumihai18@yahoo.com

Corresponding author email: frincumihai18@yahoo.com

Abstract

The aim of this paper was to evaluate the water quality of the pond from Dendrological Park of our university. In this respect we used physical, chemical and microbiological analysis indicators, according to the Water Framework Directive (2000 /60 / EC). The physico-chemical parameters that we determined were: temperature, turbidity, electrical conductivity, pH and oxygen regime. Microbiological analyzes were performed to determine both the total counts of mezophilic bacteria (which grow at 22 ^{0}C and 37 ^{0}C) and the presence of Enterobacteriaceae, especially E. coli (grow on specific medium at 37 ^{0}C). Monitoring of all parameters was carried out between July 2014 - March 2015. The results indicate low levels of alterations caused by human action and deviate only slightly from normal.

Key words*:pond water quality, physico-chemical parameters, mesophilic bacteria, E. coli.*

INTRODUCTION

The purpose of this study was to evaluate the water quality of the lake from University Dendrological Park.

The pond was created artificially two and a half years ago, by excavating a volume of soil, up to a maximum depth of 2m. The amount of soil removed was used to achieve an alpinarium located near the pond. The bottom of the pit was covered with impermeable PVC liner. The basin was filled with water from the distribution network. Until now, the water was not changed or refreshed. The biocenosis developed in this aquatic system is largely based on microorganism populations, so it's structure is unsaturated one. For this reason, the exchange of matter and energy between biocenosis and biotope are minimal and therefore the degree of self-regulation is very low. Trophic network is undeveloped, dominating the lower trophic cycles (organic matter - saprophytic bacteria or mineral matter - chemoautotrophic and chemolithotrophic bacteria). On spring time, the lake is breeding habitat for frogs.

To assess water quality in order to inhabit the pond with new species of plants and fish were studied following physico-chemical parameters: temperature, turbidity, electrical conductivity, pH, oxygen and nutrient regime (nitrite, nitrate). Monitoring of all parameters was performed between July 2014 - March 2015, being able to observe their evolution in time.

MATERIALS AND METHODS

Water quality monitoring involves making measurements that provide information necessary for an accurate assessment of water statement in relation to different effects and variable.

Water samples were collected in sterile containers with a capacity of 100ml, for all sampling stations during the four sessions, three in 2014 (July, September, November) and the other sampling session in March 2015. Samples were taken the morning after noon.

Determination of EC

Electrical conductivity is a measure of the concentration of substances ionized water and is used as the indicator of the degree of mineralization of water. Electrical conductivity (EC) was measured using conducometric sensor (Figure 1). Conductivity calibration was performed with 1 M KCl solution.

Figure 1. Determination of the EC with conductometric sensor

Determination of pH

The pH neutrality defines alkaline or acid water as having values from 0 to 14. Values between 0-6 characterize an acid pH, the 7 designates a neutral pH and alkalinity is between 8-14. Determination of pH was performed using pH sensor (Figure 2). Before taking readings, sensor calibration was performed in solutions of known pH (4, 7, and 9).

Determination of oxygen regime

The oxygen regime shows interest in terms of water pollution. To determine the oxidizability were analyzed following indicators:

- Dissolved oxygen and oxygen saturation water (DO);
- Biochemical oxygen demand after 5 days at 20°C (BOD5);
- Chemical oxygen demand COD-Mn (using potassium permanganate).

Determination of Dissolved Oxygen (DO)

Figure 2. Determination of pH with pH sensor

DO in the water is fixed to manganese hydroxide, manganic hydroxide to form. Manganic hydroxide is reacted with potassium iodide, iodine is released in an amount equivalent to the oxygen dissolved in the water. The iodine is then titrated with sodium thiosulfate in the presence of starch.

In a Winkler glass was added water sample without this bubble. Immediately, using micropipettes, was added to 1 ml of manganese chloride and 1 ml alkaline mixture (KI + NaOH). The vial contents were homogenized by rolling over several times; after complete settling of the precipitate and the supernatant was removed and continued with the addition of 3 ml of HCl up to complete dissolution of the precipitate. Quantitative content was passed in an Erlenmeyer flask and titrated with 0.01N thio-sulphate to obtain straw yellow coloration: after adding 1 ml of starch solution, titration was continued until complete bleaching solution.

Determination of BOD5

Biochemical oxygen demand (BOD5) is the amount of oxygen consumed by the microorganisms over a period of time, biochemical decomposition of organic substances contained in water. The settling time is 5 days at a temperature of 20°C.

To determine the BOD5 we sampled water in two containers of known volume, under aseptic handling identical. The first sample is used to determine dissolved oxygen in water existing at the time of sampling, and the other was used to determine the biochemical oxygen present in the water after 5 days of storage in the dark at 20°C.

The calculation to determine the amount of BOD5 was performed using the following formula:

mg BOD5 / l = A – B

A = the amount of oxygen per litre of water existing in the sample at the time of harvest;

B = the amount of oxygen per litre of water existing in the sample after 5 days.

Determination of COD_{Mn}

Chemical oxygen demand (CODMn) is a global indicator of water pollution. COD determination method using K permanganate, is not recommended for water with high organic load.

In an Erlenmeyer beaker were added 100 ml of the water sample, 10 ml of H_2SO_4 and 10 ml of $KMnO_4$. The mixture is boiled for 10 minutes. After cooling, there were added 10 ml of $H_2C_2O_4$ to fading, followed by titration with $KMnO_4$ until the appearance of persistent pink colour. The amount of oxygen consumed was calculated using the following formula:

$$\frac{mgO_2}{dm^3} = \frac{v \bullet f \bullet 0{,}08}{v_1 - 2} \bullet 1000$$

V = ml of 0.01N sodium thio- sulphate used in the titration;

F = factor of the 0.01N sodium thio-sulphate solution;

0.08 = mg O2 equivalent of a ml of 0.01N thio-sulphate;

v1 = volume of glass, in ml;

2 = volume of reagents introduced for determining oxygen in millilitres.

Determination of turbidity (T)

Turbidity characterized water transparency due to the presence of fine particles in suspension not submitted in time.Determination of turbidity was performed using WTW turbid-meter Turb 355 T / IR Turb 355 by measuring and comparing subjective suspension turbidity water samples analyzed transparency to that of a standard sample (Figure 3). Turbidity was expressed in nephelometric turbidity units (NTU).

Figure 3. Determination of turbidity using WTW Turb 355 T / Turb 355 IR turbidimeter

RESULTS AND DISCUSSIONS

Analyzed parameters that define the physical and chemical contamination of the water pond from the Dendrological Park are presented in Table 1.

Analyzed water pH ranges from slightly alkaline (7.96-8.3 for the investigated months of the year 2014) to moderately alkaline (9,1 in March 2015). In general, water surface is characterised by a pH between 6.5 and 8.5. Higher values of pH recorded in March 2015 is due to both lower CO2 content and lower temperature (5.3 °C) compared with investigated months of 2014 year(Figure 4). The sampling in March was done in the afternoon when the CO2 content is lower. In fresh water, decreasing temperature increases pH. Waters with high

algal growth can show a diurnal change in pH. When algae grow and reproduce they use CO_2 . This reduction causes the pH to increase. This increase in pH may exceed 8.5, especially during the spring when nutrients are readily available. Therefore, if conditions are favourable for algal growth, the water will be more alkaline. Maximum pH usually occurs in late afternoon, and pH will decline at night when cellular respiration adds CO_2 to water (Tucker and D'Abramo, 2008).

Water temperature vary with sampling seasons, and presented values between 5^0C.-25^0C, being correlated with air temperature (Figure 5).

Table 1. Physico-chemical parameter values of the investigate pond water

Parameter	Unit measurement	Admissible level for drinking water	Standards	Sample values			
				Jul	Sept	Nov	March
pH	pH units	≥ 6.5 ≤ 9.5	SR ISO 10523/2009	8.3	7.96	8.1	9.1
Temperatures	°C		-	25.0	21.5	18.4	5.3
DO	mg O_2/l	6	STAS 6536-87	6.15	6.32	7.7	9.5
(CBO_5)	mg O_2/l	3	STAS 6536-87	1.05	1.7	1.92	1.52
(CCO_{Mn})	mg/l	5	SR EN ISO 8467/2001	3.95	5.32	6.12	4.67
NO_3^-	mg NO_3^-/l	50	SR EN 7890-3/2000	73.92	71.6	71.12	59.5
EC	µS/cm	250	SR EN 27888/1997	528	515	508	425
TDS	mg/l	100	STAS 9187:1984	337.9	329.6	325.12	272
Turbidity	NTU	≤ 5	SR EN ISO 7027/2001	4.3	2.58	1.84	4.2

The electrical conductivity showed values between 425 and 528 µS/cm at 25°C (Figure 6), exceeding twice the value of 250 µS/cm indicated by the Water Framework Directive for unpolluted waters. The recorded values reflect load conditions with salt water. Based on EC can appreciate the nitrate content in mg NO3/l, if the CE in µS/cm is multiplied by 0.14 (Smith and Doran, 1996). Therefore, the calculations were considered estimates of nitrate concentrations (Table 1). As can be seen analyzed the nitrate content of water varies between 59.5 and 73.9 mg/l, above 50 mg/l unpolluted water feature. Overtaking highlight an imbalance in the C:N ratio. This imbalance is quite natural if we consider that the aquatic ecosystem studied is undeveloped with lacking plants; only bacteria and cyanobacteria are the dominant species. Knowing the EC we can estimate the total content of dissolved solids (TDS) in mg/l, multiplying the CE in µS/cm with 0.64 (Rhoades, 1993).

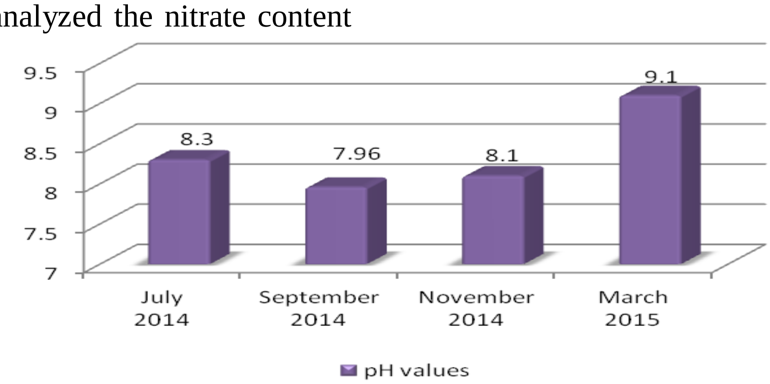

Figure 4. Seasonal pH variation of the pond water from the University Dendrological Park

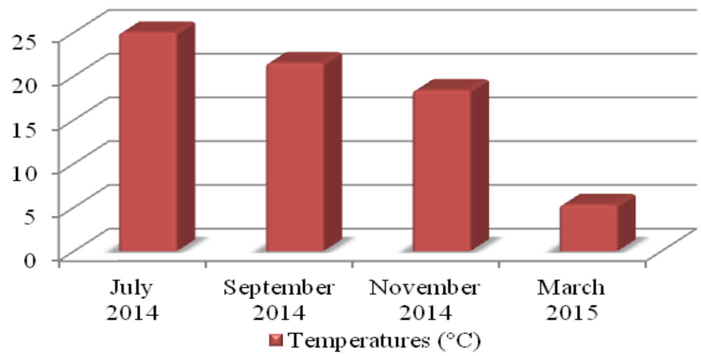

Figure 5.Seasonal temperature variation of the pond water from the University Dendrological Park

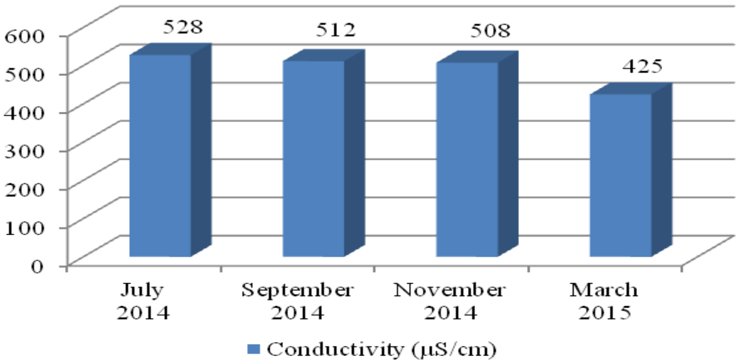

Figure 6..Seasonal Electrical conductivity variation of the pond water from the University Dendrological Park

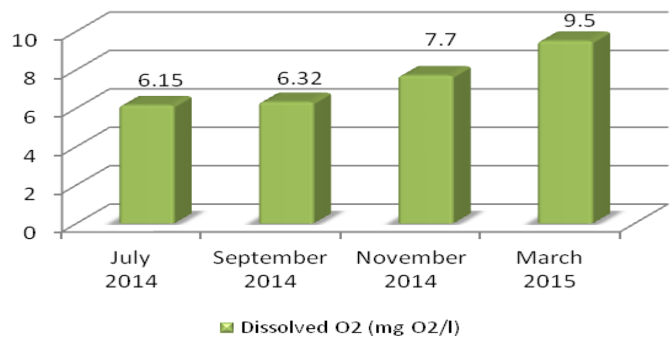

Figure 7.Seasonal dissolved oxygen variation of the pond water from the University Dendrological Park

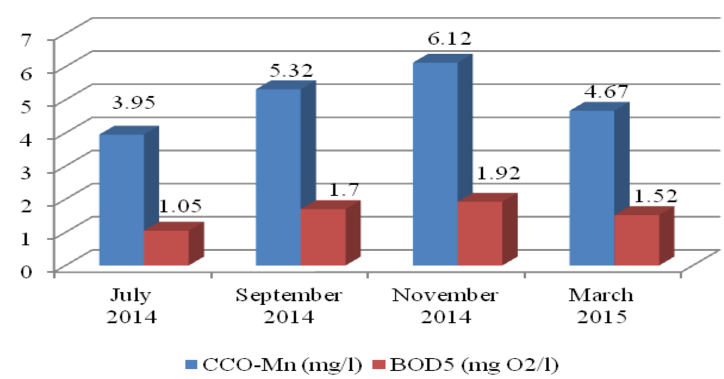

Figure 8.Seasonal COD and BOD variation of the pond water from the University Dendrological Park

Dissolved oxygen vary with the sampling season time. Recorded DO values range between 6.15 and 9.5 mgO_2 / l. The amount of dissolved oxygen varies indirectly proportional with temperature, with turbidity and organic matter values (Trufas, 1998). According to the standard values regarding to water surface quality (161/2006 Normative), the pond water analyzed during summer season fits to III-th quality class (DO range between 5-7 mg/l). DO determined during autumn belongs to II-nd quality class (> 7 mg/l), and the late autumn DO analysed belongs to I-st quality class (> 9 mg/l).

Organic load of the pond water was indirect determined by measure of COD_{Mn} and BOD_5 .The COD_{Mn} values range from 3.95 to 6.12 mgO_2 /l during the period of study and BOD_5 varied from 1.05 to 1.92 mgO_2 /l (Figure 8). Chemical and biochemical oxygen dements varies directly proportional to the amount of organic matter.

All the values obtained by determining oxygen consumption fit to domain that characterize drinking water (Table 1). Therefore organic matter content of the water is very small, and this fact it is perfectly correlate with lock of plant and animal populations of the investigated pond.

CONCLUSIONS

In general, the physic -chemical parameter values fit the investigated pond water into II-nd quality water class.

The significant seasonal fluctuations which occurred in quality water of the pond is due to poor aquatic biodiversity and therefore due to reduce self-regulation capacity and low ecosystem integrity.

In summer time, the pond water has a tendency to overheat (25°C) due to increasing air temperatures and low depth of the pond (about 1.5 m). Therefore decreasing DO penalise water quality with a quality class (classifying the pond water into III-th class).

The water nitrate contents are correlated with EC. The sampling during all the seasons showed than nitrate values are higher enough to classification the pond water into III-th quality class.

Biochemical and chemical oxygen demands are low, therefore those parameters qualify the water body into I-st quality class.

These uneven qualities of the water body demonstrate the unstable equilibrium of the pond and certify his very young age (about 2 years from creation).

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Lucrare de Licenta : " Evaluarea calităţii apei de suprafaţă din Parcul Dendrologic microbiologic si biochimic " - 2014. Absolvent Zamfir Radu ,Coordonatori Prof. Carmen Cimpeanu si SL Mihai Constanta