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QUANTIFICATION OF ENVIRONMENTAL POLLUTION IN BUCHAREST BY ASSESSMENT OF CHEMICAL QUALITY PARAMETERS FOR SNOW

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Abstract

During the last decades, the environment has been strongly exposed to the effect of different harmful pollutants, especially from the atmosphere. A laboratory study has beens developed to monitor the environmental pollution by examining the chemical quality parameters of snow collected from Bucharest in February 2010 and, for comparison, from neighbor less polluted neighboring areas. The analyses performed on snow samples indicate the presence of substantial quantities of contaminants such as nitrite, nitrate, ammonium, heavy metals.

INTRODUCTION

The necessity to protect the environment is increasing over day by day because of the accelerated pollution as a consequence of the exploitation of natural resources and industrialization, unchecked use of chemicals and pesticides and increased the number of vehicles circulating daily. Urbanization brings along many changes in nature including pollution.

We must use our resources, knowledge and through all means check the pollution level in water, air, soil, vegetation and other natural resources to ensure health and life for us and our future generations.

Today, the measurement of environmental pollutants is a matter of routine, but this is not the case of temporary snow covers. There are some, but not many, similar studies on precipitation that were developed in time [2, 5, 14, 15].

The meltwaters contain some or all of the major constituents usually found in surface water or groundwater. On the other hand, the snow cover suggestively illustrate the level of pollution in a certain area.

The accumulation of heavy metals in the environment can have middle-term and long term health risks, and strict periodic surveillance of these contaminants is therefore advisable.

Lead as a well-known toxic heavy metal, has been receiving much attention for its widespread distribution and potential risk to the environment. The effects of lead on human health have been the subject of many scientific studies over the last decade [3, 10, 11, 12].

Lead accumulates in the human body through the food chain and endangers human health [6] moreover that as far as it known till today, it has no essential function for plants, animals and microorganisms. It inhibits the thiolic groups of some enzymatic systems, especially those that potentate hemoglobin synthesis [1].

Also, nitrate and nitrite levels are as hazardous as these species are dangerous for human health. Nitrate generally has low human toxicity, but becomes a hazard when it is reduced to nitrite by bacterial action in the human gastrointestinal tract. Thus, the toxic effects of nitrate are due to its endogenous conversion to nitrite which is involved in the occurrence of methemoglobinaemia (inability to transport oxygen to tissues), gastric cancer [9] and different health disturbances (changes in vitamin level, thyroxin production and negative influence in reproduction) [16]. Methemoglobinemy is also known as “blue baby syndrome” because its first manifestation is the bluish color of the infant’s skin.

Bucharest is a city populated by over two million people with a great pollution generated by traffic. This is sustained by Bucharest’s Environmental Protection Agency (APM) that ranks it first in the latest top of polluted cities in the European Union states, leaving Sofia, Athens or Rome behind. As a consequence, the environmental pollution in Bucharest is a significant matter that is important to be taken into consideration.

The aim of our paper aim was to evaluate the pollution level in Bucharest by the assessment of nitrogen species, phosphate and lead contents of the snow cover in February 2010.

MATERIAL AND METHODS

Studied area

Eight snow samples were collected from eight different points, as follows:

V1 - Botanic Garden, UASVM Bucharest
V2 - Unirii Square
V3 - Victoriei Square
V4 - Vatra Luminoasa Square
V5 - Bucharest-Constanta highway
V6 - melted snow from the streets
V7 - snow collected from the Fundulea, field away from the streets
V8 - drinking water from the UASVM network

Samples

The samples were collected from 1m^2 surface (depth and width) at two periods of time (08.02.2010-one day after snowing and 18.02.2010-ten days after snowing). The major snow samples were firstly collected in pre-cleaned polypropylene bags; representative samples of 3 kg were obtained and after melting they were transferred in polyethylene bottles rinsed with distilled water. The samples were subsequently stored at 4°C for as short a time as possible before analysis to minimize physical and chemical changes. The samples were allowed until they reached room temperature before analysis. The chemical analysis of the snowmelt water was performed by using methods similar to those used for surface water sources samples.

Reagents

Analytical reagent-grade chemicals were employed for the preparation of all solutions.

The standard stock solution of 1000 ppm NO_2^- was prepared by dissolving 1.8500 g of KNO_2 in distilled water and the final volume was adjusted to 1000 ml.

The standard stock solution of 700 ppm NH_4^+ was prepared by dissolving 3.3035 g of $(NH_4)_2SO_4$ in distilled water and the final volume was adjusted up to 1000 ml.

The weighed amount of 0.4393 g KH_2PO_4 was dissolved in distilled water, the final volume was adjusted to 1000 ml and the obtained solution contained 100 ppm P.
A lead standard solution of 1000 ± 2 ppm (Merck) was used for calibration.

The working standards were prepared by dillution of the stock solution. The calibration curves for the analyzed species were linear for the studied concentration ranges.

Instrumentation and analytical methods

Prior to the analysis, all instruments were calibrated according to manufacturer's recommendations.

- pH was measured by using Inolab WTW pH-meter with combined glass electrode.
- Nitrite was quantified by the Griess reaction, involving the formation of a pink-colored azo derivative upon treatment of a NO_2^--containing sample with sulphanilic acid and naphthyl-1-amine in acidic medium. The measurements of pink complex were performed at 520 nm wavelength, after 20 minutes after the colour developed.
- The phosphate concentrations were determined by the spectrophotometric method using ammonium molybdate in sulphuric medium to form the phosphomolybdate complex that was reduced by ascorbic acid to a blue complex, molybdennium blue.

- Nitrate concentrations were determined by ionometric method. The measurements were performed by a Metler Tolledo ionometer with a nitrate selective electrode.
- The analyses of Pb in snow samples were performed by using furnace atomic absorption spectrometry (GFAAS). Before analysis, samples were digested in concentrated HNO_3. The measurements were carried out by an atomic absorption spectrometer Zeenit 700 from Analytic Jena equipped with autosampler AS52 S for dillution, monoelement lamp for lead. Also, the equipment has data processing soft Win AAS ver:3.16.0. The instrument is calibrated by the Romanian Metrology National Institute.
- The deionised water used for sample preparation was obtained by the ELIX 3 system and the ultrapure water was obtained using Simplicity UV system, both of them provided by Millipore.

RESULTS AND DISCUSSION

Snow samples collected during February 2010 were analyzed to determine the concentrations of various pollutants that are known to affect human health and also to evaluate the pollution level in Bucharest.

Samples were taken from intense circulated roads and from area less polluted, areas 50 km away from Bucharest, an isolated area with no car traffic and theoretically with no pollution.

The results of our survey are summarized below (Table 1). In order to have terms of comparison, we presented the optimum chemical parameters imposed by legislation for drinking water (Table 2) [7] and also for surface waters (Table 3) [7]. The suggestive representations of chemical parameters are presented in Figures 1, 2 and 3. Analyzing the results and graphical representations, it can be noticed that after staying in contact with noxious species, several days snow in most cases became enriched with hazardous species (nitrite and lead), thus proving the high level of pollution in our city.

The presence of significant quantities of nitrogen species in the samples was explained by the presence of nitrogen compounds in the air as a consequence of pollution (most of them are caused by the burning of fossil fuels). Nitrogen oxides, NOx, present in the air and originating in natural and anthropogenic sources (combustion, transportation) after the reactions with water came back to the earth surface in the form of acid rains [17].

Nitrites appear as intermediates in the nitrogen cycle. They are unstable and, depending on the conditions, are transformed into nitrates or ammonia [8].

The nitrate levels ranged between 5.24 and 27.86 mg/l, lower than the limits set for drinking water. The nitrite levels were between 0.02 and 0.84 mg/l, values determined probably by intense traffic and due to the presence of nitric oxides. Also, ammonium concentrations were higher and ranged between 0.51 and 3.75 mg/l.

The results of our research indicate that, in ten days, the nitrite levels of snow were increasing meanwhile ammonium levels were decreasing. It is possible that the ammonium ions to be oxidized into nitrite ions.

Of particular concern is the lead presence, presumably originating in automobile exhaust. Lead content of Bucharest snow ranges between 25.7 and 1886 μg/l, the highest concentration being recorded in Piata Unirii, an area with intense traffic, for a sample collected in 18.02.2010, after staying in contact with automobile exhaust for ten days. It can be noticed that, from all the six samples collected from Bucharest on 08.02.2010 (one day after snowing) only two contained lead below limits imposed by legislation, the other four significantly exceeding that limit (50 ppb).

However, the found lead levels were very high and dangerous because, after snow melting, the metal would pollute the soil, water and vegetation.

Table 1

Chemical parameters of snow (February 2010)

Sample	Sampling time	pH	NO_3^-, mg/l	NO_2^-, mg/l	NH_4^+, mg/l	PO_4^{3-}, mg/l	Pb, μg/l
V1	08.02.2010	6.53	<LD	0.02	1.91	<LD	74.3
	18.02.2010	7.49	6.21	<LD	0.74	<LD	121.5
V2	08.02.2010	7.22	6.21	<LD	1.91	<LD	25.7
	18.02.2010	6.62	<LD	0.04	0.87	0.47	1886
V3	08.02.2010	7.26	27.86	0.41	3.56	<LD	170
	18.02.2010	8.13	<LD	0.84	2.20	0.50	417
V4	08.02.2010	7.42	<LD	0.05	2.00	<LD	589
	18.02.2010	7.38	<LD	0.33	1.32	0.40	408
V5	08.02.2010	7.87	10.09	0.10	2.10	<LD	26
	18.02.2010	6.18	<LD	0.33	0.74	<LD	277
V6	08.02.2010	7.41	16.53	0.30	3.75	0.42	97.5
	18.02.2010	7.23	5.24	0.75	1.32	<LD	120
V7	08.02.2010	5.16	<LD	<LD	0.51	<LD	<LD
	18.02.2010	5.64	<LD	<LD	<LD	<LD	<LD
V8	08.02.2010	6.91	<LD	<LD	<LD	<LD	<LD
	18.02.2010	6.87	<LD	<LD	<LD	<LD	<LD

(<LD-below limit of detection of the method)

All chemical parameters of drinking water and snow collected from the Fundulea area were below the detection limit of the methods, which showed either the absence of the pollutants or their presence at harmless levels.

The pH values for snow samples were generally between the ranges settled for drinking water. The values recorded for the snow samples collected from Fundulea indicated an acidification tendency.

The phosphate levels assessed for snow samples were, in most cases, below the detection limit of the method. The presence of phosphate found in snow samples was possible to be hazardously and could not be correlated with environmental pollution. However, in recent years large quantities of phosphate have been used in beverages, detergents, fertilizers [4, 13].

The increasing phosphorus concentrations in the surface waters raise the growth of phosphate-dependent organisms that used high amounts of oxygen and prevent sunlight from entering the water, a phenomenon commonly known as eutrophication.

Table 2

Quality parameters for drinking water (STAS 1342-91)

Parameters	**Accepted values**	**Exceptionally accepted values**
pH	5.5-7.4	max. 8.5
NH_4^+ (mg/l)	0	0.5
NO_2^- (mg/l)	0	0.3
NO_3^- (mg/l)	45	-
PO_4^{3-} (mg/l)	0.1	0.5
Pb (µg/l)	50	-

Table 3

Quality parameters for surface waters (STAS 4706-74)

Parameters	**Water 1st class category**	**Water 2nd class category**	**Water 3rd class category**
pH	6.5-8.5	6.5-8.5	6.5-9.0
NH_4^+ (mg/l)	1	3	10
NO_2^- (mg/l)	1	3	-
NO_3^- (mg/l)	10	30	-
Pb (µg/l)	50	100	100

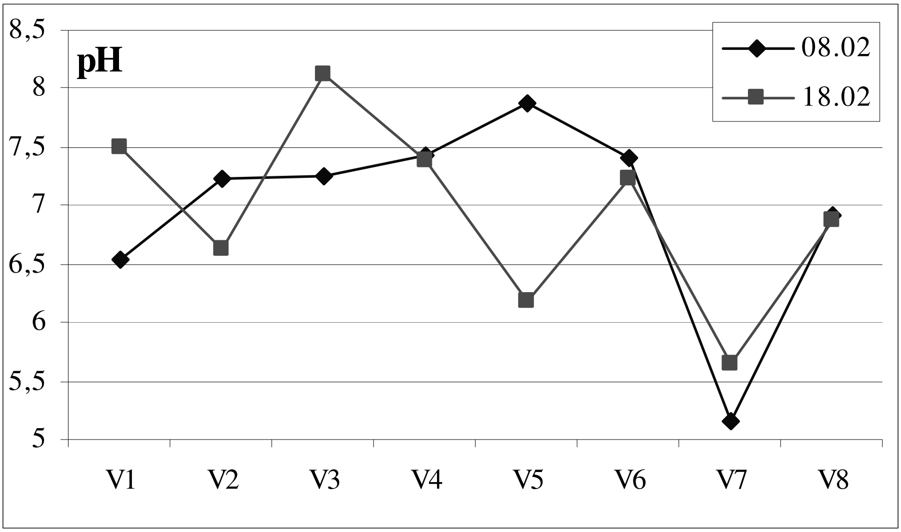

Fig. 1. pH variation in samples

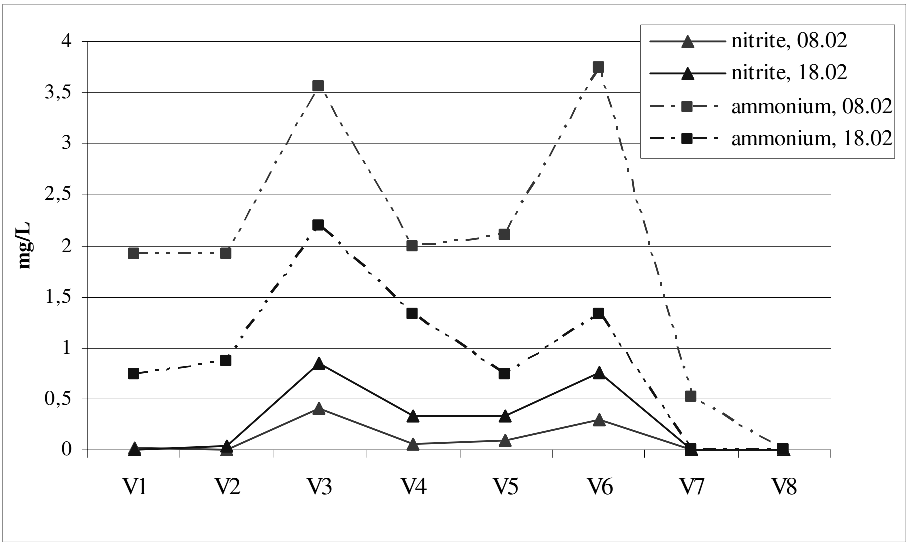

Fig. 2. Nitrite and ammonium levels in analysed samples

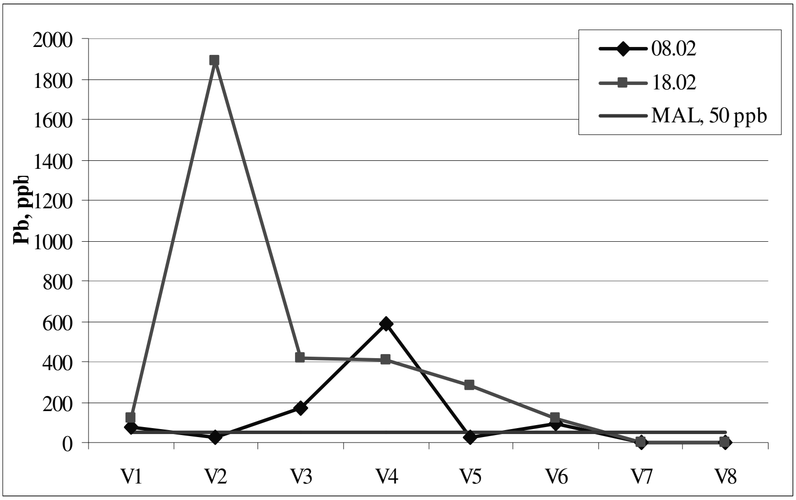

Fig. 3. Lead levels in analysed samples

CONCLUSIONS

1. In this study snow was used to estimate the pollution level in the environment of the Bucharest agglomeration and the conclusion is that our city is highly polluted with nitrogen species and lead.
2. The content of lead absorbed in the snow reached an alarming level which shows that air particles in metal concentrations can be disastrous. This is a signal which forces us to protect the environment, and strict periodic surveillance of these contaminants is therefore advisable.
3. The serious problems of pollution compared to Bucharest to take urgent action. Among them an important place must be given to creating green spaces, the planting of trees on the streets. We must not forget that we have the capital with the least green space per capita than the rules allowed in the EU.
4. Also, in order to decrease environmental pollution in Bucharest it is recommended to reduce car traffic as much as possible.

REFERENCES

1. Grecu I., M. Neamtu, L. Enescu, 1982. *Implicatii biologice si medicale ale chimiei anorganice*. Ed. Junimea, Iasi.
2. Iacoban C., 1996. *Unele aprecieri asupra metodelor de analiza a ionilor NH_4^+ si SO_4^{2-} in precipitatiile sub forma de zapada*. Simpozionul „Molidul in contextul silviculturii durabile”.

3. Jarup L., 2003. *Hazard of heavy metal contamination*. British Medical Bulletin, 68 (pp. 167-182).
4. Kamath D.K., V.C. Savanth, D.N. Suryanarayana, 1995. *A rapid and highly selective method for the estimation of pyro-, tri- and orthophosphates.* Talanta, 42(3) (pp. 365-373).
5. Kurzyca I., B. Walna, J. Siepak, 2009. *Reliability and comparability-crucial aspects of research on atmospheric precipitation*. Intern. J. Environ. Anal. Chem., 89(8-12) (pp. 901-916).
6. Liu J.G., K.Q. Li, J.K. Xu, Z.J. Zhang, T.B. Ma, X.L. Lu, J.H. Yang, Q.S. Zhu, 2003. *Lead toxicity, uptake, and translocation in different rice cultivars.* Plant Sci. 165 (pp. 793–802).
7. Mănescu S., M. Cucu, M.L. Diaconescu, 1994. *Chimia sanitară a mediului*. Ed. Medicală, Bucureşti.
8. Michalski R., I. Kurzyca, 2006. *Determination of Nitrogen Species (Nitrate, Nitrite and Ammonia Ions) in Environmental Samples by Ion Chromatography*. Polish Journal of Environmental Studies 15(1) (pp. 5-18).
9. Prakasa R., K. Puttanna, 2000. *Nitrates, agriculture and environment.* Curr. Sci., 79 (pp. 1163-1168).
10. Schell L.M., M. Denham, 2003. *Environmental Pollution in Urban Environments and Human Biology*. Annual Review of Anthropology, 32 (pp. 111-134).
11. Shparyk Y.S., V.I. Parpan, 2004. *Heavy metal pollution and forest health in the Ukrainian Carpathians*. Environ. Pollution, 130(1) (pp. 55-63).
12. Tong S., E. Yasmin von Schimding, T. Prapamontol, 2000. *Environmental Lead exposure: a public health problem of global dimensions*. Bulletin of the World Health Organisation, 78 (9).
13. Torres F.M., J.M. Estela, M. Miro, A. Cladera, V. Cerda, 2004. *Sequential injection spectrophotometric determination of orthophosphate in beverages, wastewaters and urine samples by electrogeneration of molybdenum blue using tubular flow-through electrodes*. Anal. Chim. Act., 510 (1) (pp. 61-68).
14. Tsarovski S., M. Tobiszewski, V. Simeonov, Z. Polkowska, J. Namiesnik, 2010. *Chemical composition of water from roofs in Gdansk, Poland.* Environ. Poll., 158 (pp. 84-91).
15. Vasilenko V.N., Artemov I.E., T.V. Belikova, A.A. Uspin, 2007. *Acid-base characteristics of Russian snow cover*. Russian Meteorology and Hydrology, 32(4) (pp. 283-286).
16. Vermeer I.T.M., D.M.F.A. Pachen, J.W. Dallinga, J.C.S. Kleinjans, J.M.S. Van Maanen, 1998. *Volatile N-Nitrosamine formation after intake of nitrate at the ADI level in combination with an amine-rich diet*. Environ. Health Perspect. 106 (pp. 459-463).
17. Walna B., I. Kurzyca, J. Siepak, 2004. *Local Effects of Pollution on the Chemical Composition of Precipitation in Areas Differing in the Human Impact.* Pol. J. Environ. Stud. 13 (pp. 36-42).