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STUDIES REGARDING CHEMICAL COMPOSITION OF SNOW IN BUCHAREST (WINTER 2011) CORRELATED WITH ENVIRONMENTAL POLLUTION

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Abstract

Environmental pollution became a problem nowadays and snow covers reflect the level of pollution in a certain area. In was developed a research in order to evaluate the levels of some pollutants for snow collected from different sites in Bucharest. For all samples were determined pH values. The quantitative determinations of nitrate, nitrite, ammonium, phosphate were performed spectrophotometrically and lead was quantified using atomic absorption spectrometry. For all snow samples it was also evidenced the presence of chloride, sulphate, sodium, potassium and calcium. The results were compared with those obtained last year.

INTRODUCTION

During the last decades, the environment has been strongly exposed to the effect of different harmful pollutants, especially from the atmosphere. Snow is a well suited medium for fingerprinting environmental pollution sources.

Snow can function as a significant source of water pollution since it accumulates a variety of contaminants from the atmosphere and roadways and therefore snow melt water could represent a serious pollution threat to the environment. These contaminants could be nitrogen and sulphur species, phosphates, heavy metals, organic pollutants, pesticides and salts used as de-icing agents. A very broad range of air pollutants represented mainly of nitrogen and sulphur oxides present acidifying effect, are toxic and can damage living organisms.

Environmental pollution by heavy metals has become one of the world's most serious problems and strict periodic surveillance of these contaminants is therefore advisable. The major problem for urban areas with intense traffic is the presence of lead. Automobile emissions are still considered an important source of lead contamination in snow even though lead concentrations in gasoline have been recently banned.

Lead is a well-known toxic heavy metal and the effects of lead on human health have been the subject of many scientific studies over the last decade [1-4]. Lead poisoning has severe adverse health impacts, and it has been linked to neurological,

neurobehavioral and developmental problems. Lead it has no essential function for plants, animals and microorganisms and affects some enzymatic systems, especially those that potentate haemoglobin synthesis [5].

Also, the presence of nitrate and nitrite in water and different food products has toxic effects, most common manifestation being methemoglobinemy, gastric cancer [6], different health disturbances (changes in vitamin level, thyroxin production and negative influence in reproduction) [7].

The purpose of the research that we carried out was to determine the concentrations of nitrogen species (nitrite, nitrate, ammonium), phosphate, lead in snowmelt waters collected from Bucharest and to compare the results with similar that was obtained last year [8].

The idea of this project appeared because Bucharest is one of the most polluted cities in Europe and environmental pollution is a significant matter that is important to be taken into consideration.

MATERIAL AND METHODS

Studied area

Snow samples were collected from four different points, as follows:

V1 - Botanic Garden, UASVM Bucharest

V2 - Unirii Square

V3 - Victoriei Square

V4 - Vatra Luminoasa Square

For comparison a water sample was analyzed: V5- drinking water from the UASVM network.

Samples

The samples were collected from $1m^2$ surface (depth and width) at two periods of time (31.01.2011-freshly fallen snow and 11.02.2011-snow in standing accumulation several days). 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. The determination of all species was performed in duplicates and the presented results are the average of the determinations.

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

- Nitrite was quantified by the Griess reaction, involving the formation of a pink-coloured azo derivative upon treatment of a NO_2^--containing sample with sulphanilic acid and naphthyl-1-amine in acidic medium.
- The phosphate concentrations were determined by the spectrophotometric method as molybdenum blue.
- Nitrate and ammonium concentrations were assessed spectrophotometrically. For nitrate was used phenoldisulphonic acid in alkaline medium to develop nitrate-characteristic yellow colour and ammonium ions were determined with the aid of Nessler reagent.
- 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 dilution, 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

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) [9] and also for surface waters (Table 3) [9]. The pH values for snow samples were generally between the ranges settled for drinking water. Nitrate concentrations are range between 1.60-6.43 mg/L, levels that are not dangerous taking into account that for drinking water the maximum admissible level is set at 45 mg/L. Nitrite concentrations for all samples are below 1 mg/L, value that was set for surface water (1^{st} category). Ammonium levels are between 0.28-6.24 mg/L, values that are higher than those obtained last year (0.51-3.75 mg/L) [8] and also much higher than limits set for drinking water.

The presence of different quantities of nitrogen species in the samples could be a consequence of the existence of nitrogen compounds in the air because 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 [10]. Nitrites appear as intermediates in the nitrogen cycle. They

are unstable and depending on the conditions, are transformed into nitrates or ammonia [11].

Table 1

Chemical parameters of snow (February 2011)

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	30.01.2011	5.74	1.76	0.15	0.28	<LD	18.45
	11.02.2011	6.81	2.03	0.21	0.42	<LD	20.32
V2	30.01.2011	7.07	2.78	0.73	5.43	<LD	106.82
	11.02.2011	7.02	2.35	0.50	4.66	<LD	153.34
V3	30.01.2011	6.73	6.43	0.30	0.32	<LD	147.84
	11.02.2011	7.02	3.75	0.67	2.03	<LD	189.53
V4	30.01.2011	6.95	3.21	0.48	5.95	<LD	63.26
	11.02.2011	7.25	1.60	0.25	6.24	<LD	88.63
V5	30.01.2011	6.83	<LD	<LD	<LD	<LD	<LD
	11.02.2011	6.76	<LD	<LD	<LD	<LD	<LD

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

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

Of particular concern is lead presence presumably originating in automobile exhaust. Lead levels ranges between 18.45-189.53 μg/L. For snow samples collected from botanical garden the values were below limits set for drinking water. The lead levels for samples collected from areas with intense road traffic are much higher and all of them exceed the value 50 μg/L. Anyway, samples collected this year accumulated less lead than those analyzed last year when for a snow sample it was recorded an astonishing and alarming value (1886 μg/L) [8].

Taking into account that in recent years large quantities of phosphate have been used in fertilizers, beverages, detergents [12, 13] we assumed that is possible to find this species into melt water. For all samples, the phosphate level was below the detection limit of the method, situation that was encountered last year with few insignificant exceptions.

Also, for all samples it was evidenced the presence of sulphate, chloride, sodium, potassium, calcium. The existence of these ions in snow melt waters could be a consequence of using different salts as de-icing agents but the results will be presented elsewhere.

CONCLUSIONS

Because the melt waters contain some or all of the major constituents usually found in surface water or groundwater and this reflect the level of environmental pollution, we developed a research during two years and we conclude:

1. Nitrogen species were evidenced in all snow samples and this is due the existence of nitrogen compounds in the air as a consequence of pollution.
2. Even if phosphate is a frequently encountered pollutant, in all samples it was below detection limit of the method.
3. The content of lead absorbed in the snow reached alarming levels but lower than those recorded last year.
4. The presence of different levels of sulphate, chloride, sodium, potassium, calcium was evidenced as a consequence of using de-icing agents.
5. In order to decrease environmental pollution in Bucharest it is recommended to reduce car traffic as much as possible.

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