QUANTITATIVE DETERMINATION BY ATOMIC ABSORPTION SPECTROMETRY FOR MACRO ELEMENTS OF MINERAL WATERS FROM ROMANIA

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ABSTRACT
In this paper there are presented the results of studies performed on characteristics of some existent mineral waters, in three different regions of Romania (West Region, Centre Region and North Region). Regarding this aim, the quantitative chemical analysis of macro elements: sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) was performed, using a flame atomic absorption spectrometer VARIAN Spectr AA 110 type. In this case, the flame emission and absorption method was used. As a conclusion, for sodium the maximum value recorded in mineral waters from the three regions taken into discussion, was obtained in sample A1 (294 mg/L) in the west region, for potassium the maximum reached was 47.4 mg/L in sample B3 in the north region, for calcium the maximum value was recorded as 330 mg/L in sample A3 from north region, and magnesium recorded the maximum value of 76 mg/L in sample B3 for north region. All samples studied, are within normal limits established by law.

Keywords: mineral water, atomic adsorption spectrometry (AAS), macro elements, flame emission and absorption method, quantitative determination.

INTRODUCTION

Mineral water is a water that has it's origin in underground deposit, protected from any pollution hazard, comes from an exploited source by one or many natural emergencies or drillings and it is embattled next to the source, with special hygiene precautions. At source, every mineral water gets a stable specific mineral composition. In water both mineral elements and oligoelements in important quantities are found (calcium, magnesium, sodium, bicarbonates, chlorides, sulphates). (VERNESCU, 1998)
Human body requires both metallic and non-metallic elements for healthy growth, development and the proper functioning of the body. The determination of these elements in beverages, water, food, plant and soil is thus of utmost importance and is currently the subject of studies by various researchers. (MOHAMMED, 2009; WHO, 1998 a, b)
Atomic absorption spectroscopy (AAS) is a spectroanalytical procedure for the quantitative determination of chemical elements employing the absorption of optical radiation (light) by free atoms in the gaseous state.
In analytical chemistry the technique is used for determining the concentration of a particular element (the analyte) in a sample to be analyzed. AAS can be used to determine over 70 different elements in solution or directly in solid samples employed in pharmacology, biophysics and toxicology research.
(HTTP://EN.WIKIPEDIA.ORG/WIKI/ATOMIC_ABSORPTION_SPECTROSCOPY)

To characterize mineral waters, their hardness, calcium (Ca) and magnesium (Mg) content, as well as the ratio of the latter are usually given. However, sodium (Na) and potassium (K) contents are generally not taken into account. Many mineral waters and drinking water supplies contain amounts of Na that can contribute to high blood pressure. (KISS, 2004**)**
Sodium is essential for the exchange of water between the cells and the intercellular medium. It is also important for the working of muscles, enabling contraction. Together with chlorine, sodium forms our normal salt, used to spice up our regular diet. To determine the amount of salt in a water it is not sufficient to measure the sodium content, but also the amount of chlorine. While too much salt is unhealthy, none at all can lead to serious malfunction in our body as well. (*** ISO 9964-1, 1993; HTTP://WWW.MINERALWATERS.ORG/INDEX.PHP?FUNC=F&PARVAL=CONTENT/NA)
Potassium is one of the major electrolytes and minerals in the body for men and women. Potassium is essential to all organisms and is the major cation in cell cytoplasm with wide variety of electrochemical and catalytic functions for enzyme systems. Potassium constitutes five percent of the total mineral content of the body; it is the major cation of the intracellular fluid and there is a small amount in the extra cellular fluid. With sodium, the other ”electrolyte”, K participates in the maintenance of normal water balance, osmotic equilibrium and acid-base balance. Potassium participates with Ca in the regulation of neuromuscular activity (*** ISO 9964-2, 1993; HTTP://WWW.COMPLETEH2OMINERALS.COM/STORE/PRODUCT/POTASSIUM_K/)
Calcium is an element that a human body needs for numerous functions, such as building and maintaining the bones and teeth, blood clotting, transmitting of the nerve impulses and regulating heart's rhythm. Ninety nine percent of calcium in a human body is stored in bones and teeth. The remaining one percent is found in the blood and other tissues. (UŽDAVINIENĖ, 2007)
Magnesium is an essential mineral for humans, playing a key role in many biological processes through its function in enzyme activities. For example, those involved in energy production, neuromuscular excitability, muscle contraction, blood coagulation, protein and nucleic acid metabolism. It has been suggested that aging, stress and various diseases may increase magnesium requirements. Inadequate intake and impaired absorption of magnesium are thought to contribute to disorders in humans such as osteoporosis, hypertension and atherosclerotic vascular diseases. (*** ISO 7980, 1986; HTTP://WWW.MGWATER.COM/BENEFITS.SHTML)

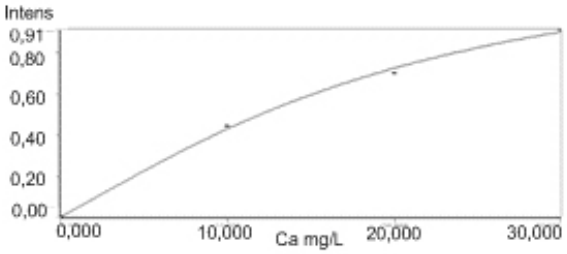
MATERIAL AND METHOD

Absorption/flame atomic emission spectrometer VARIAN Spectr AA 110; Flame type: air/acetylene; acetylene flow: 1,50 L/min.
The sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) elements determination by atomic adsorption spectrometry was performed with the atomic emission method, because this method exhibits ppm (mg/L) sensitivity.
The water samples were taken from three different regions of Romania, as follows:
West Region: Mineral water source 1 (A1); Mineral water source 2 (B1); Mineral water source 3 (C1).
Centre Region: Mineral water source 1 (A2); Mineral water source 2 (B2); Mineral water source 3 (C2).
North Region: Mineral water source 1 (A3); Mineral water source 2 (B3); Mineral water source 3 (C3).

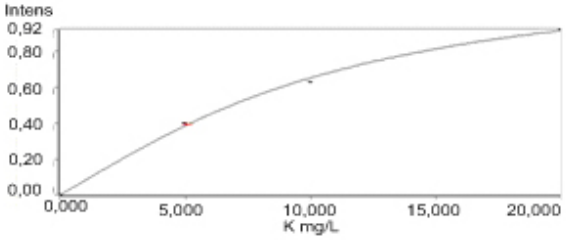
The work parameters obtained at the apparatus calibration in order to determinate sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) elements, are shown in *Table 1*, and the calibration afferent curves are shown in *figure 1*.

Table 1. Work parameters at Na, K, Ca, Mg by air-acetylene flame atomic adsorption spectrometry determination, using Spectr AA-110

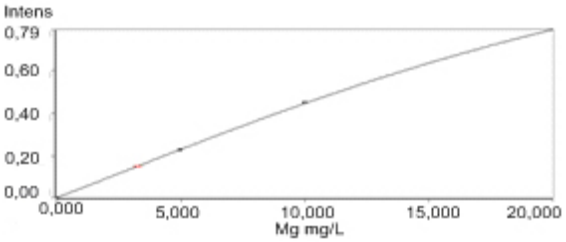
Experimental conditions	Analyzed element			
	Na	K	Ca	Mg
Sample taking	Manually			
Calibration way	Concentration			
Measure units	mg/L			
Method used	Flame emission			Flame adsorption
Standard precision [%]	1	1	1	1
Sample precision [%]	1	1	1	1
Expansion factor	1	1	1	1
Mediating degree, points	5	5	5	5
Wavelength, [nm]	589	766.5	422.7	202.6
Slot width, [nm]	0.2	0.2	0.2	1
Voltage on lamp, [V]	53	72	82	75
Electricity on lamp [mA]	5	6	6	8
Standard 1, [mg/L]	10	5	10	5
Standard 2, [mg/L]	15	10	15	10
Standard 3, [mg/L]	20	15	20	15
Standard 4, [mg/L]	25	20	25	20
Standard 5, [mg/L]	30	-	30	-
Measurement time, [s]	10	10	10	10
Pre-reading time, [s]	10	10	10	10
Air flow, [L/min]	3.5	3.5	3.5	3.5
Acetylene flow [L/min]	1.50	1.5	1.5	1.50
Burner's height, [mm]	13.5	13.5	13.5	13.5



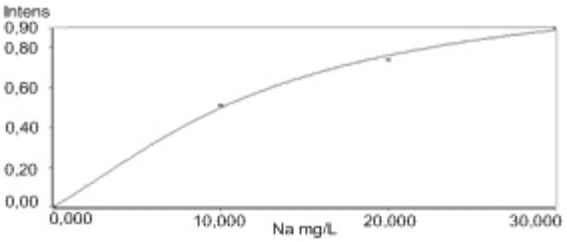
Calibration curves for Ca



Calibration curves for K



Calibration curves for Mg



Calibration curves for Na

Figure 1. Calibration curves obtained for the analyzed elements

RESULTS

Flame atomic adsorption analysis of the samples taken from the three different regions taken into discussion, has led to the following results shown in *Table 2*.

Table 2. Emission atomic adsorption determination of Na, K, Ca, Mg

Chemical element mg/L	Mineral water samples								
	West Region			Centre region			North Region		
	A1	B1	C1	A2	B2	C2	A3	B3	C3
Na	294	121	1.1	93	27.4	88	19.2	223	25.1
K	9.2	5.1	0.29	12.9	1.1	8.9	3.4	47.4	4.7
Ca	133	98	76	274	76	84	330	184	141
Mg	40.5	33.5	2.7	85	32	38.5	5.4	76	45

Flame atomic adsorption analysis of mineral waters permitted the quantitative determination of the elements (Na, K, Ca, Mg) from the three regions of Romania, taken into discussion, as follows:

West region (A1, B1, C1) samples - Na, K, Ca, Mg

Sodium exhibits the maximum value for sample A1 (294 mg/L), sample B1 recording a value of (121 mg/L), the lowest value for sodium being recorded by sample C1 (1.1 mg/L). For potassium, the maximum recorded value was obtained in sample A1 (9.2 mg/L), sample B1 recorded a 5.1 mg/L value for the same element, and the minimum potassium value for calcium was recorded for sample C1 (0.29 mg/L). The maximum value for calcium was recorded for sample A1 (133 mg/L), sample B1 recorded a value of 98 mg/L, and the minimum obtained value was for sample C1 (76 mg/L). Magnesium recorded a maximum value in sample A1 (40.5 mg/L), sample B1 recorded a value of 33.5 mg/L, the minimum for magnesium being recorded in sample C1 (2.7 mg/L).

Centre region (A2, B2, C2) samples - Na, K, Ca, Mg

For the centre region, sodium recorded a maximum value of 93 mg/L for sample A2, the minimum recorded value being obtained in sample B2 (27.4 mg/L), while a value of 88 mg/L was obtained for sample C2. Potassium for this region reaches the maximum value in sample A2 (93 mg/L), sample b2 records the minimum value (1.1 mg/L), and for sample C2 a value of 8.9 mg/L was obtained. Calcium recorded the maximum value for sample A2 (274 mg/L), for sample C2 was obtained a value of 84 mg/L, while the minimum value recording was for sample B2 (76 mg/L). In the case of magnesium, the maximum value recorded was 85 mg/L for sample A2, the minimum recorded being in B2, sample (32 mg/L), while for sample C2 a value of 38.5 mg/L was obtained.

North region (A3, B3, C3) samples - Na, K, Ca, Mg

In the north region, the maximum value obtained for sodium element was recorded in sample B3 (223 mg/L), sample C3 recorded a value of 25.1 mg/L and the recorded minimum for this region was 19.2 mg/L in sample A3. Potassium reaches the maximum value in sample B3 (47.4 mg/L), sample C3 records a 4.7 mg/L value, the minimum value for this element being obtained in sample A3 (3.4 mg/L).

Calcium records the maximum value in sample A3 (330 mg/L), the minimum for this element being reached in sample C3 (141 mg/L), while sample B3 recorded a value of 184 mg/L. In the case magnesium element, for the north region, the maximum value recorded was in sample B3 (76 mg/L), for sample C3 was obtained a value of 45 mg/L, the minimum recorded being obtained in sample A3 (5.4 mg/L).

CONCLUSIONS

The waters taken into discussion, in west region, exhibit the maximum value for sodium in sample A1 (294 mg/L), for the centre region, the maximum value for sodium was recorded in sample C2 (88 mg/L) and for the north region, the maximum value was of 223 mg/L in sample B3. (*Figure 2*)

For potassium, he maximum value reached in the waters of west region, was 9.2 mg/L in sample A1, in the case of north region, the potassium exhibits the maximum value for sample A2 (12.9 mg/L) and for the north region, the maximum value was of 47.4 mg/L recorded for sample B3. (*Figure 3*)

Calcium in west region, recorded the maximum value of 133 mg/Lin sample A1, the maximum recorded value for waters from centre region was of 274 mg/L in sample A2, and for the north region, calcium exhibits maximum values in sample A3 (330 mg/L). (*Figure 4*)

Magnesium exhibits the maximum value in the waters from the west region in sample A1 (40.5 mg/L); the centre region reaches he magnesium in sample A2 (85 mg/L), and maximum reached for the northern region was recorded in sample B3, that is 76 mg/L. (*Figure 5*)

As a conclusion, for sodium the maximum value recorded in mineral waters from the three regions taken into discussion, was obtained in sample A1 (294 mg/L) in the west region, for potassium the maximum reached was 47.4 mg/L in sample B3 in the north region, for calcium the maximum value was recorded as 330 mg/L in sample A3 from north region, and magnesium recorded the maximum value of 76 mg/L in sample B3 for north region. (*Figure 6*)

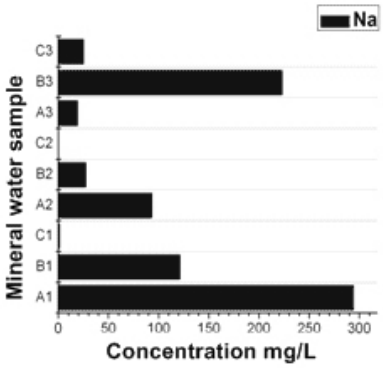


Figure 2. Na concentration in the mineral water samples, taken into discussion

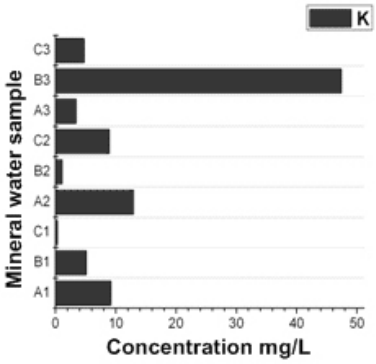


Figure 3. K concentration in the mineral water samples, taken into discussion

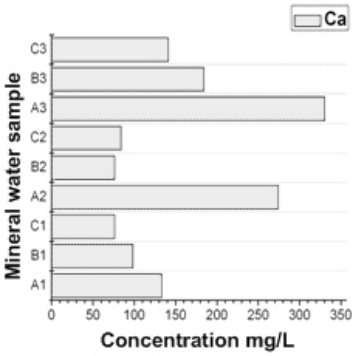


Figure 4. Ca concentration in the mineral water samples, taken into discussion

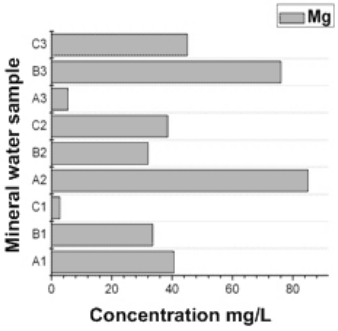


Figure 5. Mg concentration in the mineral water samples, taken into discussion

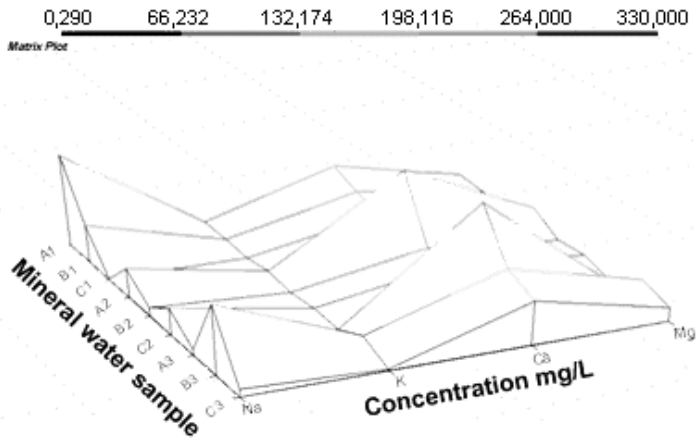


Figure 6. Na, K, Ca, Mg concentration in the mineral water samples from three regions of Romania

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