A study on drinking water quality in SE Romania

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Abstract

Water is a fundamental and indispensable constituent of the human body. Small changes produce serious disorders and insufficient water intake is much less tolerated than in other deficiency. The aim of this work is the study of drinking water quality indicators in selected localities in SE Romania (Galati, Braila, Buzau, and Vrancea counties). Water samples were taken from drinking water sources (tap water, well water, spring water, filtered tap water with biological filter), frequently used by the population (15 places). They were subjected to chemical and physico-chemical analysis in order to determine the physical, chemical parameters of quality that can have an impact on the residents' health. In five water sources (Independenta (tap), Independenta (spring), Lunca/Buzau, Liesti fountain at 40 m depth, and Galati (biologically filtered tap water) the pH is below 6.5, a value that does not fit into STAS acquis in force - SR ISO 10523-2009. Oxidability index values in the majority of cases are below the maximum allowed, of 5 mg O_2/L water, according to SR EN ISO 8467-2001; in some cases, the values exceed the limits as following: Independenta: 8 mg O_2/L; Lunca/Buzau: 10 mg O_2/L; Focsani spring: 9 mg O_2/L; Focsani tap: 8 mg O_2/L; Galati tap: 6 mg O_2/L.

Keywords: drinking water, water quality, parameters, SE Romania.

1. INTRODUCTION

Groundwater is an important natural resource necessary for human consumption, domestic usage, and various economic sectors and, due to its importance for human health, drinking water quality has to be permanently monitored, according to the European Union (EU) and national legislation quality standards [1,2].

Water has many roles in the body, the most important ones being [3]:

- the structural role, as the main component of the body;
- the reaction medium and the intervention for all metabolic processes - contributing to maintaining homeostasis which is essential for various processes, such as absorption, transport, diffusion, osmosis, excretion;
- role in the metabolism of macronutrients;
- source of Ca, Mg, Na, K, and other useful substances to the body, but sometimes of undesirable elements (toxic pathogens).

Due to the fact that the physico-chemical parameters represent an important monitoring tool of the drinking water quality, the aim of this work was to assess the water quality indicators in selected localities in SE Romania from Galati, Braila, Buzau, and Vrancea counties.

2. EXPERIMENTAL

Water samples were taken from various sources of drinking water (tap water, well water, spring water, filtered tap water with biological filter) (15 places), frequently used by the population in SE Romania counties (Figure 1). They were subjected to chemical and physico-chemical analysis in order to determine the physical, chemical parameters of quality that could affect the residents' health, according to Romanian legislation [3-5]. Conductivity, salinity, TDS, and pH measurement are performed with CONSORT C – 862 multiparameter; the volumetric analyses were done in order to obtain the chemical parameters of drinking water [6,7].

Fig. 1. The study area of drinking water quality indicators in Southeast of Romania (Galati, Braila, Buzau, Focsani)

3. RESULTS AND DISCUSSION

The results obtained in this study are presented as average values, together with the coefficient of variation (CV) and standard deviation.

The study was carried out on a set of 15 samples of drinking water from various sources (tap water, fountain and well water, spring water, filtered tap water with biological filter). The results obtained from chemical and physico-chemical analyses are presented in graphical forms.

The redox potential, E_{redox}, is an important parameter because it gives information on the reducing character of the analyzed samples which can be associated with the content of reducing substances. In Figure 2 the oxidative-reducing behavior of the analyzed waters is presented.

The environment redox character is measured by the redox potential, an experimentally measurable parameter, influenced by other parameters, among those the most important being the environment pH and the rH, the last one having physical significance in aqueous media only. The rH implication in the biological phenomena study consists in its intrinsic definition domain (42.4 units) comparing with that of pH one (14 units); the pH contributes therefore by 66 % only to the rH constitution [8].

The correlation between redox potential and pH is: $E_{redox} = 0{,}029 \ (rH - 2pH)$ where pH and rH values are represented in Figure 3 a and b, respectively. It is noticed that there are several water samples - Galati biologically filtered water, Liesti water, Independenta - which have the highest values of redox potential. The rest of the water samples show low values of E redox, which indicates a reducing character due to the certain content of organic substances. E_{redox} is dependent on pH, partial oxygen pressure (especially when low), the presence of H_2S, other reducing agents in water, and dissolved organic substances.
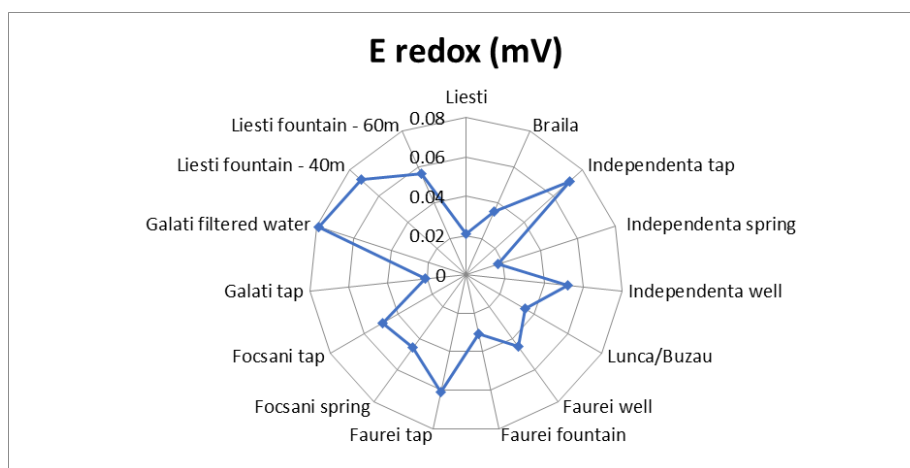
Fig. 2. Redox potential of samples from tap water, well water, spring water, filtered tap water with biological filter

The pH values (Fig. 3a) show the buffering capacity of the water and also give indications on the nature of the salts present in the water. A slightly basic pH indicates the presence in water of salts with slightly basic hydrolysis.

The pH values are included in most water samples in range 6 and 7.5. In some water sources (Independenta (tap), Independenta (fountain), Lunca / Buzau, Liesti fountain at 40 m depth, Galati (biologically filtered tap) the pH value is below 6, a value that does not fall within the STAS in force: STAS 6325/75 and SR ISO 10523/97.
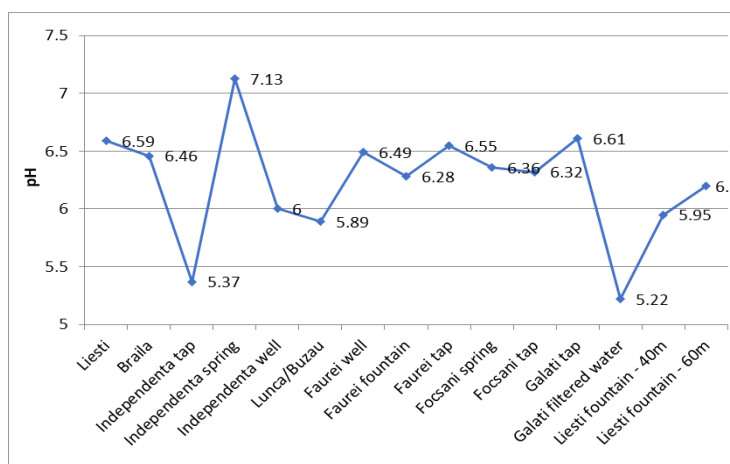
a)
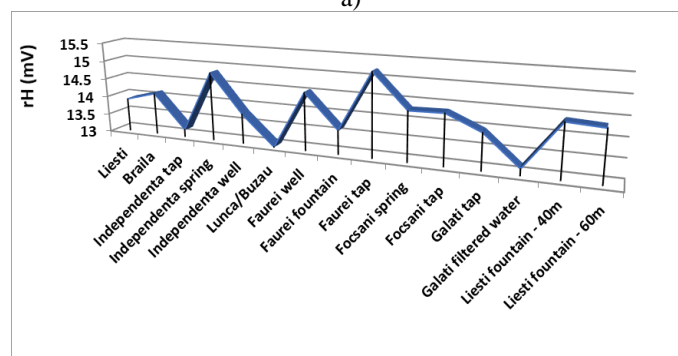
b)

Fig. 3. Values of pH (a) and rH (b) for the analyzed water

According to STAS 3662 – 62, the allowed value for the Ca(2+) ions in drinking water is 100 mg/L. The exceptionally allowed value of calcium is 180 mg/L. The allowed value in the case of Mg(2+) ions in drinking water is 50 mg/L, according to STAS 6536 - 87, and the exceptionally allowed value is 80 mg/L.

Figure 4 presents the values of calcium and magnesium ions concentration in analyzed drinking water. In the majority of drinking water samples, the values of calcium concentration are within the limit accepted by the regulation. A very high value of the concentration of calcium ions is noticed in the fountain water from Independenta (700 mg/L). There are quantities of Mg(2+) ions that exceed 500 mg / L of water (Independenta fountain, Lunca / Buzau, and Faurei fountain). In the tap water sample from Focsani Mg (2+) is 300 mg/L, and at Liesti and Faurei samples Mg (2+) concentration is 200 mg/L. In the other water samples analyzed, the concentration of magnesium ions is below 100 mg/L.
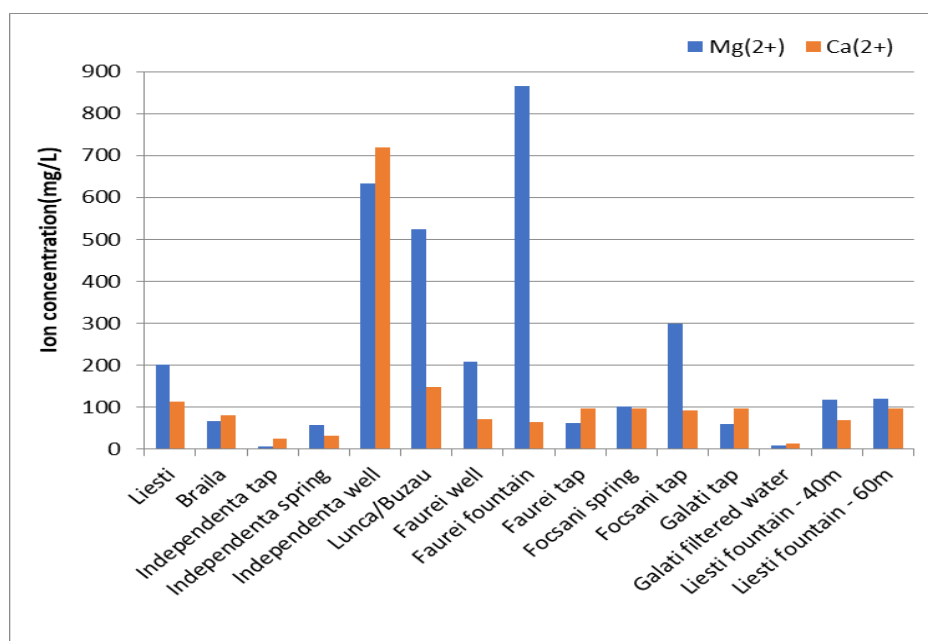

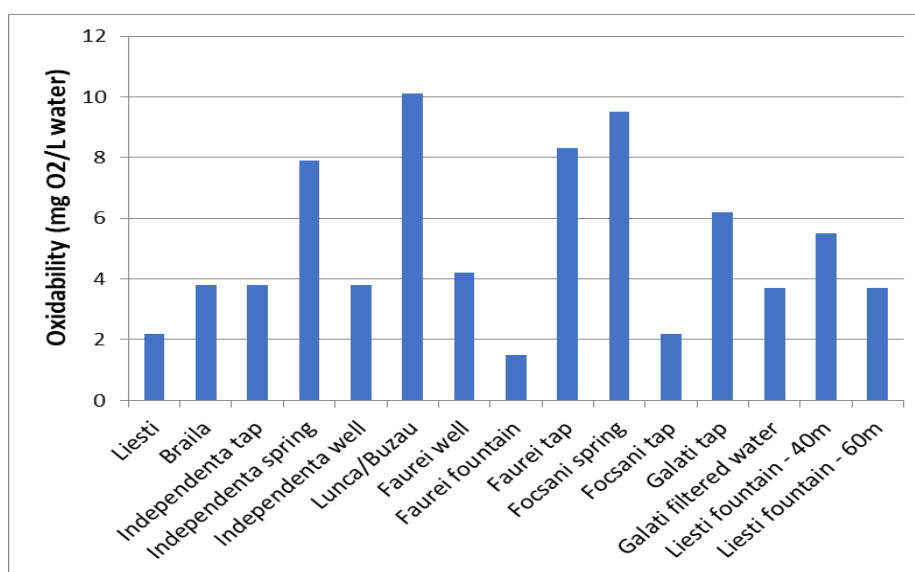*Fig. 4. Magnesium and calcium ions concentration in drinking water*

Fig. 5. Oxidability values of drinking water

The values of the oxidability index are in most cases below the maximum allowed limit, 5mg O_2/L water, according to STAS 3002/85 and SR ISO 6060/96. The highest oxidability was found in

the water collected from the village of Lunca / Buzau, Focsani (spring), Independenta (spring), and Faurei tap (Fig. 5). Higher oxidability values indicate a high content of easily biodegradable natural organic substances.

The regulations of the World Health Organization (WHO) state that the TDS values for plain water must be: minimum 100 mg/L, optimal 200-400 mg/L, and maximum 500 mg/L. TDS varies from source to source. TDS in the Galati sample - biologically filtered tap water - has a very low value of 125 mg / L. The tap waters from Galati, Focsani, Faurei, and Braila have the TDS values in the optimal range indicated by WHO. As can be seen in Fig. 6, the drinking water samples from Independenta, Lunca/Buzau, and Faurei show very high concentration values of salts completely dissolved.
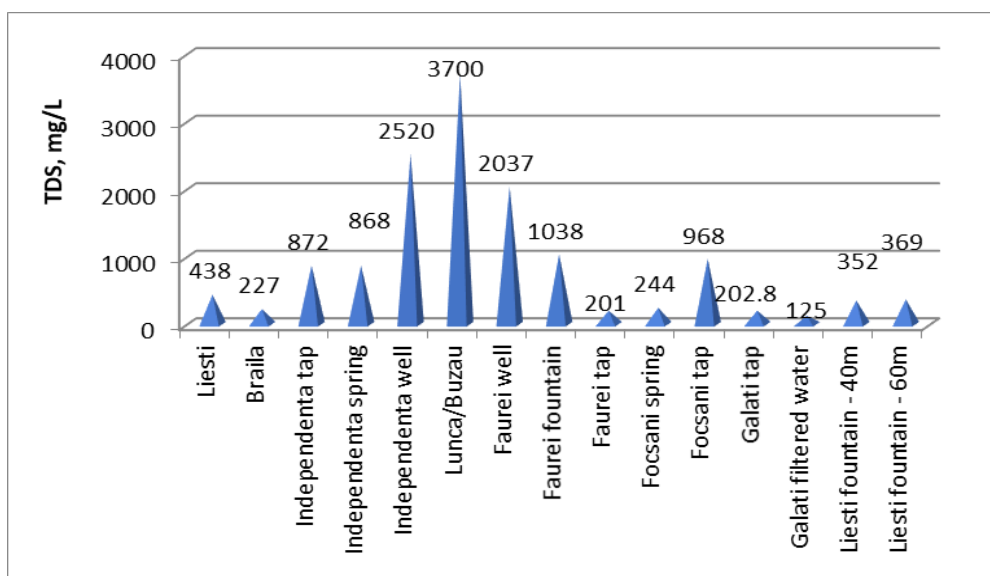

Fig. 6. TDS values (salts completely dissolved) of drinking water

In the correlation diagram of the studied parameters (Table 1), it is noticed that there is a good positive correlation between TDS, pH, rH, Mg (2+), and the oxidability index. Comparing the TDS, Ca (2+), and Mg (2+) indices, a moderate positive correlation is observed (0.49 and 0.62). The higher the concentration of calcium and magnesium, the higher the content of dissolved salts. There is also a very good positive association between rH and pH (0.73) and a good negative correlation between pH and E redox, *i.e.* the higher the pH, the lower the E redox. This correlation argues the behavior of the parameters represented in the above figures.

Table 1. Correlation diagram between principal analyzed parameters of drinking water

	Oxidability index, (mg KMnO₄/L)	E redox(mV)	pH	TDS (mg/L)	rH	Ca(2+)	Mg(2+)
Oxidability index, (mg KMnO₄/L)	1.000						
E redox(mV)	-0.098	1.000					
pH	0.192	-0.773	1.000				
TDS (mg/L)	0.205	-0.153	-0.136	1.000			
rH	0.195	-0.134	0.732	-0.377	1.000		
Ca(2+)	-0.063	-0.001	-0.060	0.487	-0.094	1.000	
Mg(2+)	-0.236	-0.257	-0.026	0.620	-0.316	0.497	1.000

Figures 7, 8, and 9 present a comparison between tap water and filtered tap water with biological filter regarding the oxidability, the Ca and Mg concentrations, and TDS. We can see a depletion of filtered water in minerals (Ca and Mg) and dissolved salts (TDS) (figs. 8, 9). Studies have shown that water with a very low total mineralization does not have organoleptic capacities (it has any taste, smell, color), but it cannot satisfy the feeling of thirst.
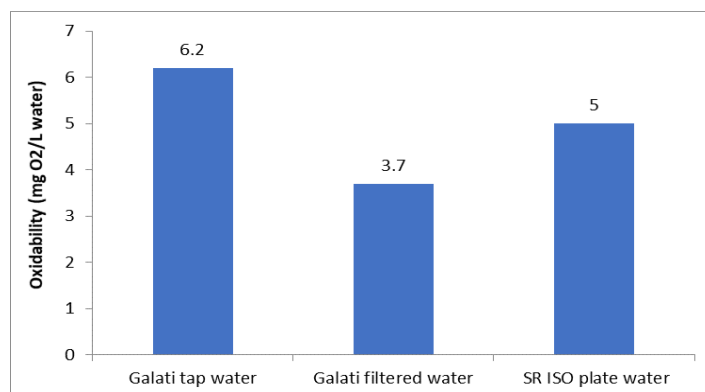

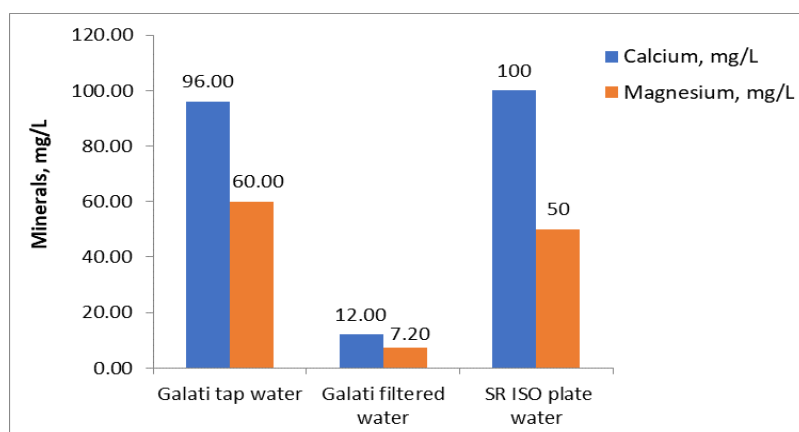*Figure 7. The comparison of oxidability values between tap water and biologically filtered water*

Fig. 8. The comparison of calcium and magnesium values between tap water and biologically filtered water
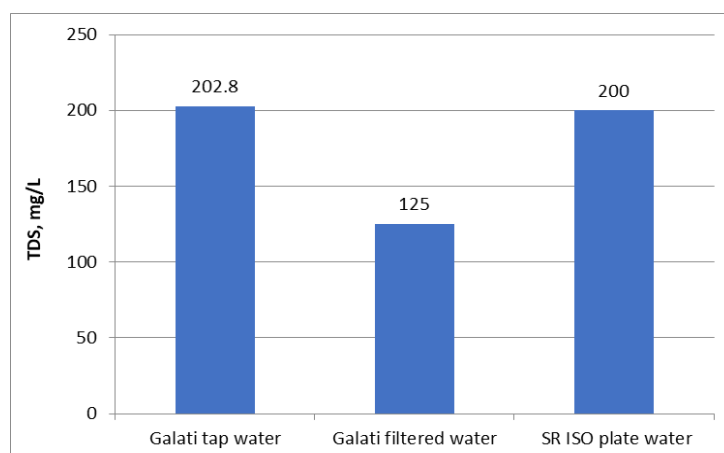

Fig. 9. The comparison of TDS values between tap water and biologically filtered water

Consumption of water with properties close to distilled water causes changes in the water circuit in the body leading to dehydration. If not sufficiently mineralized, the water does not contain the essential minerals that are absorbed through daily consumption of water.

4. CONCLUSIONS

Water for human consumption has great importance for the population's health and drinking water quality has to be permanently monitored according to the EU and national legislation quality standards.

The analytical evaluation of the main physico-chemical parameters of drinking water from the selected sources in SE Romania showed that the water is intensely mineralized. Due to the increased mineralization, water from underground sources can provide a daily intake of macroelements, especially calcium and magnesium. From the point of view of the content of calcium and magnesium ions, the studied waters are considered beneficial, considering the importance of these ions for the human body. According to some researchers, magnesium consumption increases the body's resistance to infections and improves intellectual performance. It promotes digestion and maintains the integrity of the teeth. Calcium-associated magnesium fights stress and depression.

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