

LEVELS OF MAGNESIUM, CALCIUM AND OTHER INORGANIC COMPOUNDS IN WATER OF THE WELLS IN RURAL AREAS OF BOTOȘANI COUNTY

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Keywords: water mineral content, ratio Ca/Mg.

Abstract. In the rural areas of Botoșani county, the wells are sources of water for 91% of the population. Taking into account the fact that the levels of magnesium (Mg) and calcium (Ca) in drinking water can influence the population health, we determined the concentration of these macro-elements in the water of some wells was observed in 10 rural localities (Răchiți, Corni, Vârfu Câmpului, Dersca, Drăgușeni, Rădăuți Prut, Dobîrceni, Albești, Prăjeni, Frumușica) of Botoșani county. In 100 water samples there were sampled the following quality parameters of drinking water Ca, Mg, Na, K, total hardness (D_t), chlorides (Cl), bicarbonates (HCO₃). Concerning the mineral content of water, we notice the high values of Mg concentration (the maximum concentration 91.27 mg/l) and Ca concentration (the maximum concentration 412 mg/l). Waters in the analyzed wells can be a source of essential elements for consumers.

Introduction

Macro- and micro-elements are essential for life, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K) ensuring the proper functioning of some important physiological mechanisms. Associations regarding the drinking water quality and population health are in the pipeline, specialists in public health taking interests sustained in this respect .

It was proved that there is a causal relationship between drinking water hardness and morbidity by cardiovascular diseases, too. So, many studies reported a decrease of the myocardial infarct or sudden death risk in the areas where water had a high hardness, high levels of Ca and Mg^{3,4}.

In heart function, Ca has a special role, the decrease of its concentration (CMA = 30-100 mg/l), leading to arrhythmias, disorders in blood coagulation processes, worsening rickets.

In the same way, Mg has also an important role in cardiac automatism, in

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cases of magnesium deficiency (CMA = 10-40 mg/l) increasing the risk of morbidity of the newborns and hypertonic crisis.

Instead, in case of too much calcium in the body, cell permeability decreases, and, as a result, there appears hypotonia, and, in case of too much magnesium, the nervous system is negatively influenced.

The study is motivated by the fact that, for 91% of the population in the rural area of Botoșani county (about 250000 persons), the wells are the main sources of drinking water supplies⁵. The groundwater extracted through wells can be naturally inadequate from the physico-chemical parameters point of view, naturally or frequently, it is polluted from anthropogenic sources. Water consumption with a certain chemical composition for a long time can influence morbidity and mortality by some diseases in those areas.

1. Material and methods.

In 2008 there were investigated 100 individual sources (10 wells for every locality) in the rural area of Botoșani county, situated in Răchiți, Corni, Vârfu Câmpului, Dersca, Drăgușeni, Rădăuți Prut, Dobîrceni, Albești, Prăjeni, Frumușica. In choosing the localities for this study, was taken into account to cover the largest area of Botoșani county. These wells have variable depth (10 – 25 m) and they are placed in households or near them.

In all the water samples were determined the concentration of the four essential macro-elements Ca, Mg, Na, K, total hardness (D_t), chlorides (Cl), bicarbonates (HCO_3).

Tab. 1 - Minimum and maximum values of Mg concentration in water

Locality	Maximum (mg/l)	Minimum (mg/l)
Răchiți	43.32	38.02
Corni	43.70	35.12
Vârfu Câmpului	44.14	34.12
Dersca	41.89	31.56
Drăgușeni	83.25	35.17
Rădăuți Prut	43.27	34.18
Dobîrceni	84.12	49.14
Albești	63.09	49.18
Prăjeni	66.03	50.14
Frumușica	91.27	56.16

All the chemical analysis took place in the laboratories of Botoșani Public Health Department and were realized according to the standardized methods indicated in

the *Law 458/2002* concerning drinking water quality. In order to determine Ca, Mg, (D_t), were used complexometric methods: complexation of calcium ions with the ethylenediaminetetraacetic sodium salt (EDTA – complexone III) at pH = 12, in the presence of murexide [STAS 112778/1980]. Magnesium was dosed by the spectrophotometric method based on the colour reaction with titanium yellow [STAS 6674/1977]. The titration with silver nitrate Mohr method in the presence of potassium chromate indicator was used in order to appreciate the chloride levels [SR ISO 9297/2001], and by titration with hydrochloric acid bicarbonates were dosed. The spectrophotometric flame method is the most indicated in order to determine the Na and K concentration in water samples [STAS 3223-2/1980] (Carl Zeiss Photometer, model 111). The study contained also the analysis of correlation between the Mg concentration and other macro-elements present in drinking water.

Tab. 2 - Minimum and maximum values of calcium concentration in water

Locality	Maximum (mg/l)	Minimum (mg/l)
Răchiţi	156.03	123.22
Corni	140.12	118.52
Vârful Cămpului	130.99	115.00
Dersca	127.62	101.00
Drăguşeni	62.17	40.23
Rădăuţi Prut	44.99	20.02
Dobîrceni	66.67	21.01
Albeşti	120.00	54.13
Prăjeni	128	61.11
Frumuşica	115.22	57.12

Tab. 3 - Values of calcium concentration in wells water in Rădăuţi Prut

Well number	Ca (mg/l)
1	200.02
2	233.37
3	267.35
4	258.11
5	250.17
6	357.16
7	327.67
8	300.00
9	300.17
10	301.56

2. Results

The maximum and minimum values of Mg concentration are present in table 1. Almost 50% of the samples contained Mg in concentrations higher than 50 mg/l, the maximum values ranging between 43.27 and 91.27 mg/l.

Concerning calcium determinations, we can remark concentrations higher than 100 mg/l at 78% of the samples. (tab. 2).

In Răchiți, Ca concentration in well water registered the highest value 357.16 mg/l (table 3).

In order to appreciate the water degree of mineralization (table 4.) were made determinations of some chemical parameters, respectively D_T , Cl, HCO_3 .

Tab.4 - The analytical data of mineralization (P. Vieru, extract from Analysis report, DSP Botoșani laboratory, 2008)

Locality	Total hardness (0G)	Chlorides (mg/l)	Bicarbonates (HCO_3 mg/l)
Răchiți	40.88	148.75	512.75
Corni	48.50	152.0	530.0
Vârfu Câmpului	39.40	144.0	510.0
Dersca	37.29	150.0	500.0
Drăgușeni	28.16	20.0	500.0
Rădăuți Prut	11.87	30.0	262.5
Dobârceni	38.05	23.0	504.0
Albești	26.01	38.0	454.5
Prăjeni	30.5	32.0	156.0
Frumușica	27.8	36.0	457.0

Tab.5 - The medium values of of Ca/Mg ratio in water (P. Vieru, extract from Analysis report, DSP Botoșani laboratory, 2008)

Locality	Ca/Mg ratio
Răchiți	3.62
Corni	3.20
Vârfu Câmpului	2.96
Dersca	3.05
Drăgușeni	0.74
Rădăuți Prut	0.53
Dobârceni	0.79
Albești	0.52
Prăjeni	0.51
Frumușica	0.79

The importance of Ca/Mg ratio in water is well known, and that the 2:1 optimum value offers protection against the cardiovascular diseases⁶. The medium values of this ratio for the water proofs analyzed varied between 0.79 and 3.62 (tab. 5).

Sanitary standards concerning drinking water quality provide a sodium maximum admitted concentration of 200 mg/l, to protect persons that have counter indications concerning sodium consumption. Na ion concentration in drinking water situated much over the admitted limits. Na flam-photometric measurement revealed values which varied between 215 mg/l and 412 mg/l with an average of 313.5 mg/l (tab. 6).

Tab. 6 - Values of Na in the water of the wells analyzed water (P. Vieru, extract from Analysis report, DSP Botoșani laboratory, 2008)

Locality	Na (mg/l) medium values
Răchiți	289
Corni	412
Vârful Câmpului	215
Dersca	312
Drăgușeni	400
Rădăuți Prut	256
Dobârceni	408
Albești	410
Prăjeni	324
Frumușica	411

K⁺ ions concentration, not normalized in the *Law concerning drinking water quality*, varied between 5,63 mg/l and 9,74 mg/l. Potassium actions as a couple together with sodium, adjusting the osmotic pressure and the status of blood acidity. Potassium deficit leads to cardiac decompensations. The 3/1 optimal value of Na/K, gives protection against cardiovascular diseases. In conclusion, we can say that the water in the wells analyzed contains insufficient quantities of K in order to maintain Na/K optimal values. K concentration, not-normalized in the *Law concerning drinking water quality*, varied between 5.63 mg/l and 9.74 mg/l.

3. Discussions

Metals are naturally present in groundwaters and they appear in high concentrations as a result of pollution. The mineral composition of groundwaters, especially water hardness because of the Ca and Mg salts, is influenced by the petrographic composition of the subsoil. Younger, sedimentary rocks, rich in Ca

and Mg with a variable content of alkaline earth metals, allow their transfer in water, which becomes highly mineralized, with high hardness. This is the explanation of Ca and Mg concentration variation in the water of the wells studied, our results indicating especially increased levels of these mineral elements.

Both Mg and Ca are in water as ions, which are easily absorbed in the physiological processes which take place at the gastrointestinal tract, comparing with metals related to the organic compounds from food⁷. It is appreciated that Mg in drinking water can assure 20%-40% from the daily necessary, Mg intake on this way can prevent the Mg deficit at persons who drink water with an increased content on this element.

The analytical data certify the fact that wells water is an important source of magnesium for the population resident in Drăgușeni, Rădăuți Prut, Dobîrceni, Albești, Prăjeni, Frumușica villages, Ca/Mg ratio being in the most of the cases at the optimum value of 2:1. In the other studied localities, the ratio between macro-elements in the wells water indicated values higher than those recommended.

Recent studies reveal the fact that sodium in drinking water and higher values of Na/K ratio associated with increased incidence of hypertension⁹. Na measurement in water is especially imposed in the areas where the population makes the stock from underground sources, these being generally more mineralized than surface sources. Water from the analyzed wells had often values which were higher than the admitted limit of 200 mg/l.

Besides the essential macro-elements, chlorides, the total hardness and bicarbonates registered values which reveal the intense mineralization of the analyzed water proofs (tab. 4).

Taking into account the important changes in the chemical composition of groundwater, a direct consequence of pollution, there is necessary monitoring the quality of wells water, in generally, of rural water sources.

The long deficiency drinking water consumption, or with an excess of macro- or micro-elements can influence the population' health, taking into account their implication in many diseases. Knowing the chemical water particularities from individual sources allows tracing some associations between different water compounds and noninfectious fluid pathology specific to those areas.

Establishing such associations needs taking some measures which must concern mainly choosing other drinking water sources, which may offer a "healthy water" for population, according to the sanitary standards, from the micro-biological point of view.

Conclusions

The chemical analysis of 100 water proofs taken from 10 villages (10 wells for every locality) in rural areas of Botoșani county, revealed increased levels of Ca

and Mg.

Consuming drinking water with high increased concentrations of essential elements, especially Ca and Mg, can be an important contribution at the daily ingestion of these metals, for rural consumers.

Values registered by other chemical parameters (D_T , Cl, HCO_3) show the high degree of water mineralization in the analyzed wells.

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