MEDICAL SCIENCES

WATER COMPOSITION ASSESMENT FROM THE WATER SUPPLY AND MINERAL WATER

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Abstract. Water is a key factor conditioning our lives and the minerals dissolved in it are one of the main sources of supplementing their deficiency. Water makes up about 60% of the body weight of an adult human, while the human body does not store water, which is why it is very important to permanently refill it. Without water, it would be impossible to have many processes in the body such as digestion, regulation of body temperature, proper mobility of joints or intrabody transport of nutrients and metabolic products. Water supplied to the body comes mainly from two distribution channels, as bottled water or water from the water conduit. In recent years, there has been a significant increase in the consumption of bottled water, which is the result of ubiquitous advertising of drinking water in this form. However, there is a group of consumers who drink tap water.

The aim of the work was to compare the content of selected minerals in botteled waters purchased in stores and water from the water supply network. An attempt was made to answer the question whether the incurring of higher costs for the purchase of bottled water is justified in order to satisfy the body's needs for minerals or perhaps tap water meets these needs to a similar degree.

Comparison of the content of selected mineral components in tap water and bottled water shows that in most cases tap water is not inferior to the content of the determined minerals in bottled water.

Keywords: water quality, water composition, mineral waters, tap water.

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Introduction

Water is the most important factor determining the possibility of living in a given environment, because it is a fundamental element of natural ecosystems, affects the climate through the hydrological cycle, is the living environment of organisms, dissolves and transports chemicals, which has a huge impact on the functioning of living organisms, including humans (*Astel, 2014)*. Water is about 60% of the body weight of an adult human

(*Ziemiński, 2006)*. In the human body, water is the basic component of all cells and tissues. Without water it would be impossible to digest or intrabody transport of nutrients and metabolic products, proper joint mobility or body temperature regulation *(Jarosz, 2012)*. Water consumers very often say that water is of poor quality due to its hardness and the symptom to be scale settling in the kettle or heater of the washing machine. Water hardness is the sum of dissolved calcium and magnesium ions *(Zdanowicz, Płatek, 2013)*. The research carried out shows that while in the case of a washing machine or a kettle, soft water is indicated, the effect on human health is reversed (*Wojtaszek, 2006)*. The most important minerals found in the waters include magnesium, sodium, sulphate chlorides and fluorine (*Wojtaszek, 2012; Wojtasik, Jarosz, Stoś, 2012; Czerwińska, Gulińska, 2005); Kurzepa, Hordyjewska, 2014); Sapek, 2009; Salomon, Regulska-Ilow, 2013)*. The rules for monitoring the quality of water intended for consumption are specified in the Regulation of the Minister of Health from December 7th , 2017 on the quality of water intended for human consumption *(Rozporządzenie Ministra Zdrowia z dnia 7 grudnia 2017 r.)*, while the requirements for mineral waters are regulated by the Ordinance of the Minister of Health from March 31st , 2011 on natural mineral waters, spring waters and table waters *(Rozporządzenie Ministra Zdrowia z dnia 31 marca 2011 r.)*.

Material and methods

In order to compare water from the water supply network with bottled waters under the content of selected mineral components, information about their content on the labels of bottled waters was used. Research on the content of compared minerals in tap water was carried out in the laboratory of the State Sanitary Inspection. For the comparison, 10 waterworks were selected, of which 4 had the highest values of the parameter under assessment, 3 had average values, while the next three were waterworks with the lowest value of the parameter under examination. In the case of bottled waters, the waters with numbers 7, 8, 9 and 10 were the waters identified on the label as spring waters. The other bottled waters were specified by the producer as mineral waters. The content of minerals in bottled water is known as total mineralization expressed in mg / l. The State Sanitary Inspection (SSI) does not perform general mineralization tests, because this parameter is not mentioned in the Regulation of the Minister of Health from December 7th, 2017 on the quality of water intended for human consumption as an obligatory parameter when supervising the quality of water intended for consumption. SSI performs the electrolytic conductivity test of water, which is expressed in µS / cm. The obtained results of electrolytic conductivity of water can be related to the mineralization of total water in spite of different units, because the conductivity expressed in µS /cm is of the same order of magnitude as the value of water mineralization in mg / l *(Bodora, 2016)*.

Results

General mineralization / specific conductivity of water

The easiest to remember and compare in the store while shopping, and at the same time giving information whether the water we are interested in will better satisfy the needs of our body for minerals from that which is supplied by waterworks is a parameter of general mineralization, which must be given on the label of water intended for sale as water consumer. Figure 1 shows that the predominance of mineral content in bottled waters over water from the water supply network is largely unpredicted. Only in the case of two highly mineralized waters (bottled water No. 2 and 5), the difference in the content of minerals between bottled water and tap water is clear and the intake of such waters may have a greater impact on the human body than tap water. However, it should be taken into account when making a choice that water with a high degree of carbonation is not recommended for certain groups of consumers with health problems, such as kidney disease. In most cases, however, bottled waters, most frequently purchased by consumers, have a degree of mineralization similar to tap water, being at the same time many times more expensive than it.

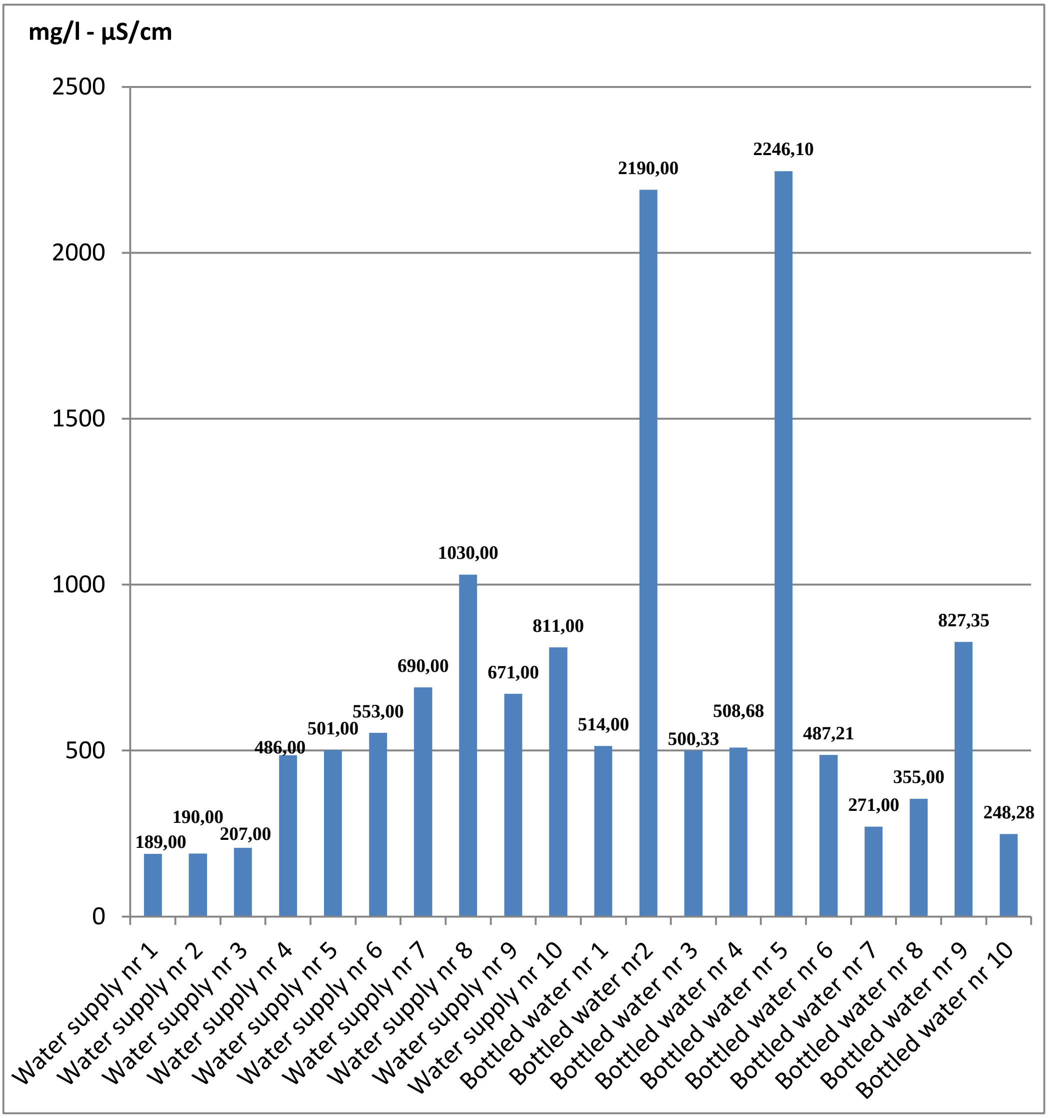

Fig. 1. Summary of total mineralization / conductivity of water from the water supply network with bottled water

Magnesium content in waters

At the juxtaposition of magnesium ions, a similar situation was found as in the case of mineralization. Bottled waters with numbers 2 and 5, which are highly mineralized waters, have much more magnesium ions than the other waters that are compared with each other. Analysing the results of research, bottled waters obtain a higher average (25.69 mg / l) content of the compared macro-component than water originating from the water supply network (9.06 mg / l). Prepared waters can be divided into mineral and spring water. For mineral waters, the average Mg content is 34.70 mg / l and for spring waters 12.17 mg / l. The separation of bottled spring waters from the waters shows that the content of Mg ions is similar to the content in tap water.

Sodium content in waters

The high content of sodium is possessed by highly mineralized bottled waters and one of the spring waters (Table 1). Water No. 9 shows much higher sodium content among tap water than other tap water. The obtained average value of sodium content for tap water is 15.82 mg / l, and for bottled water 32.98 mg / l. When bottled waters are divided into mineral and spring waters the average sodium ion contents is of 36.1 mg / l and 28, 32 mg / l respectively.

Chlorides content in waters

The comparison of chloride content shows that larger amounts of this element have tap water (Table 1). Advertisements of bottled waters often have an aspect of physical activity. It should be noted that during physical exercise sweat is released, and with it chloride ions in the form of NaCl salt. It has been shown that in such circumstances chlorine losses would be better complemented by tap water with an average of 36.27 mg / l than bottled water, in which chlorides have an average of 15.76 mg / l. Among bottled waters, mineral waters contain an average of 10.61 mg / l of chloride, while the spring waters are 25.94 mg / l.

Sulphates content in waters

The average values of sulphate content we get at 52.55 mg / l for tap water and 27.62 mg / liter for bottled water. In concentrated mineral waters, the average sulphate content is 36.99 mg / l, while in spring waters 13.57 mg / l (table 1). Much of the water content is much higher here, however, it should be remembered that the physiological significance of water with a content of 250 mg / l of sulphates (*Wojtaszek, 2006)* is greater. Among the water distribution channels, there are large spans in the content of sulfur ions within each group.

Fluoride content in waters

The saturation with fluorine ions of water from the water supply (on average 0.31 mg / l) and water purchased in the store (average 0.30 mg / l) is similar. Only in three of the compared waters (2 from the water supply network and one from bottled waters) there are significant quantities of fluorine (Table 1). Consumption of these waters with a normal diet should not, however, lead to exceeding the acceptable daily intake of this mineral.

Table 1

Comparision of magnesium content in water from the water supply network with bottled waters

	Magnesium	Sodium	Chlorides	Sulphates	Fluorides
Water supply nr 1	9,70	1,20	11,30	110,00	0,05
Water supply nr 2	18,00	1,80	1,80	95,00	0,06
Water supply nr 3	5,10	2,00	15,90	3,80	0,07
Water supply nr 4	1,00	10,20	46,20	2,30	0,12
Water supply nr 5	1,40	11,00	143,00	48,20	0,13
Water supply nr 6	5,80	19,50	74,70	1,50	0,35
Water supply nr 7	4,90	21,00	3,00	52,40	0,43
Water supply nr 8	19,00	22,20	19,30	94,00	0,74
Water supply nr 9	24,00	57,00	2,10	53,40	0,16
Water supply nr 10	1,70	12,50	45,40	65,00	0,98
Bottled water nr 1	15,60	7,79	25,70	42,60	0,21
Bottled water nr2	59,80	128,00	2,90	30,00	0,51
Bottled water nr 3	32,80	10,00	7,80	40,50	0,40
Bottled water nr 4	12,82	9,20	5,32	12,60	0,06
Bottled water nr 5	73,21	54,71	10,30	6,15	0,14
Bottled water nr 6	14,00	6,85	11,60	90,12	0,18
Bottled water nr 7	5,29	8,87	4,35	13,50	0,22
Bottled water nr 8	9,36	2,62	5,20	27,00	0,21
Bottled water nr 9	27,95	100,00	90,00	<1	0,96
Bottled water nr 10	6,08	1,78	4,20	13,78	0,12

Discussion

With the increase in the awareness of a healthy lifestyle among Poles, the amount of water consumed by them increased, in accordance with the doctors' recommendations that its consumption would be about 2 liters a day. A large part of this water is bottled water, which consumers reach because of better taste and easier opportunity to take it with them because of packaging. Consumers buying water in 55% of cases choose mineral water, 44% spring water and one table water in one percent (*Kłos, 2016)*. Water studies from selected water supply networks in Częstochowa county determining the content of selected mineral components in tap water were compared with the content of these components in bottled waters available in stores. The obtained results show that bottled waters in most of the studied cases do not significantly differ in the content of minerals from the bottled waters available in stores. A similar position can be found in the publication "Facts and myths about water for consumption", whose authors are Aleksander Astel and co-authors (*Astel, 2014)*. The above studies have led the authors to conclude that advertised bottled waters do not differ significantly considering the ionic profile of water from the water supply network. In the case of tests determining the content of mineral components in tap water coming from Częstochowa county, a significant impact on the obtained values may be due to the fact that all waters come from deep wells similar to those from which water bottling plants tap water, which then they pour into bottles. In the above-mentioned publication, magnesium content was tested in 44 confectioned waters. The obtained results showed average magnesium content close to the results, while for water, the average value was 9.06 mg / l of magnesium. This is consistent with the research results for Siedlce water from the water supply network where the average amount of magnesium was 9.53 mg/l (*Kalembasa, Jaremko, 2008)*. It is worth comparing these results with the characteristic values of curative waters that contain more than ten times more magnesium ions in their composition (Zuber water containing 331 mg / l Mg, Stołowianka water: 259 mg / l Mg and Dąbrówka: 64 mg / l Mg) (*Salomon, Regulska-Ilow, 2013)*. It should also be noted that in the publication by Aleksander Astel and co-athors (*Astel, 2014)*, the results of magnesium, sulphates, chlorides, sodium and fluorides obtained during the tests with the values on the labels were compared. Of the 44 tested bottled waters, 44 were found to contain less magnesium than the quantity declared on the label. Comparing further the values shown by the authors with the data available on the labels of water bottles reveal discrepancies in the values of subsequent minerals. In the case of sulphates, in 18 cases out of 44 samples it was found that the value given on the label is greater than that obtained during the tests. In the above-mentioned publication, apart from tap water, the water from the water supply network was also examined and the results obtained correlate with the results presented in Table 1. Comparison of these values shows a similar tendency, namely that the average content of sulphate ions in water from the water supply network is 52.5 mg / l is higher than in bottled waters for which the average value is 27.62. In the case of the results presented in the publication (*Astel, 2014)*, the average sulphate content in bottled water is 19.27 mg / l, while in confectionary waters 41.33 mg / l. The aforementioned curative waters such as Zuber, Stołowianka and Dąbrówka contain respectively: 50, 4 and 120 mg / l of sulphate ions (*Salomon, Regulska-Ilow, 2013)*. When analyzing the chloride content, there are also differences in the content of the tested and declared on the labels. The over-content of chlorides was found in 31 samples of bottled waters from among 44 tested (*Astel, 2014)*. In the presented studies, the average chloride content in tap water is 36.27 mg / l, and in bottled waters 15.76 mg / l. This is much more than the values obtained during other tests where the average values are respectively 19.17 mg / l for tap water and 7.07 mg / l for bottled waters (*Astel, 2014)*. This may be due to the fact that the content of chlorides in water largely depends on whether it has contact with contaminants and natural fertilizers *(Sapek, 2008)*. In the case of sodium and fluoride ions, which are not particularly desirable by consumers, the situation with their content in the test water, and what is on the label is the opposite of the previously analysed components. In the case of sodium ions, for 44 tested bottled waters in 32, the value obtained was higher than that stated on the label. The situation is similar in the case of fluorine, where its higher content during the tests was found in 26 cases out of 44 tested water than was indicated on the label. The sodium content in tap water of Częstochowa county is on average 15,8 mg / l, and in the case of tap water, analysed in the referenced publication, 12.77 mg / l. (*Astel, 2014)*. Bottled waters, on the other hand, have average sodium values of 32.98 and 44.69 mg / l respectively. Water in the Siedlec sewage system contains 4.18 mg / l sodium (*Kalembasa, Jaremko, 2008)*, while curative waters contain much higher amounts of sodium: 330 mg / l, Dąbrówka 415 mg / l, whereas Zuber contains as much as 6495 mg / l (*Salomon, Regulska-Ilow, 2013)*. Fluorine content tests in the case of the results used in this work and the results presented in LAB (*Astel, 2014)* show very similar values, because the average fluorine ion content in the water of Częstochowa county is 0.31 mg / l, and for bottled waters 0.3 mg / l. In the same water table, these values are on average 0.27 mg / l and 0.26 mg / l for bottled waters (*Astel, 2014)*. The analysis of the results presented in this work with the results found in other publications shows great similarities. Some differences in the average content of the compared components between the results presented in this work and the values in the compared publications probably result from the fact that the waters come from different regions of Poland. One more aspect is worthy to look at. In water quality surveys conducted by the State Sanitary Inspection, the content of compounds adversely affecting human health, including pesticides, is determined in order to check how much of them goes into waters as part of ongoing treatments to control harmful or unwanted organisms. Unfortunately, the non-tested element is the content of other harmful substances, among others, pharmaceuticals. This is an indicator that should be included in the panel of mandatory parameters tested in water intended for consumption. Conducted research by scientific institutes revealed the presence of antibiotics used in medicine and veterinary water in drinking waters. The presence of pharmaceuticals has been confirmed in the waters of all continents, in developed and developing countries (*Wanot, 2017; Lach, Stępniak, Ociepa-Kubicka, 2018)*. Consumption of antibiotics in water may contribute to neoplastic, mutagenic and teratogenic changes as well as disturbance of hormonal balance and immunity (*Wanot, 2017)*, and leads to drug resistance of many strains of bacteria, therefore expanding compulsory research into pharmaceuticals seems to be a necessity (*Szymonik, Lach, 2012).*

Summary

Water assessment led in order to compare the content of selected minerals from two different distribution channels showed that water from the water supply network does not differ significantly from bottled water in the case of compared parameters. The purchase of highly mineralized water is, of course, justified, because its composition is much richer in the ions necessary for the proper functioning of the human body. However, before buying, pay attention to the label placed on the bottle, because the manufacturer is required to put on it information about the mineral composition of water in it. A large part of water sold in stores has a similar nutritional value for our body as water, supplied with waterworks and which price is several hundred times lower. When choosing water in the store, one should be guided by the individual needs of the body and the state of health. Highly mineralized waters may be inadvisable, for example, for consumers with kidney disease, while in some conditions it is advisable to drink water containing significant amounts of a specific mineral.

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