

## NATURAL MINERAL BOTTLED WATERS AVAILABLE ON THE POLISH MARKET AS A SOURCE OF MINERALS FOR THE CONSUMERS. PART 1. CALCIUM AND MAGNESIUM

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### ABSTRACT

**Background.** Natural mineral waters may be an essential source of calcium, magnesium and other minerals. In bottled waters, minerals occur in an ionized form which is very well digestible. However, the concentration of minerals in underground waters (which constitute the material for the production of bottled waters) varies. In view of the above, the type of water consumed is essential.

**Objective.** The aim of the study was to estimate the calcium and magnesium contents in products available on the market and to evaluate calcium and magnesium consumption with natural mineral water by different consumer groups with an assumed volume of the consumed product.

**Material and methods.** These represented forty different brands of natural mineral available waters on Polish market. These waters were produced in Poland or other European countries. Among the studied products, about 30% of the waters were imported from Lithuania, Latvia, Czech Republic, France, Italy and Germany. The content of calcium and magnesium in mineral waters was determined using flame atomic absorption spectrometry in an acetylene-air flame. Further determinations were carried out using atomic absorption spectrometer - ICE 3000 SERIES-THERMO-England, equipped with a GLITE data station, background correction (a deuterium lamp) as well as other cathode lamps.

**Results.** Over half of the analysed natural mineral waters were medium-mineralized. The natural mineral waters available on the market can be characterized by a varied content of calcium and magnesium and a high degree of product mineralization does not guarantee significant amounts of these components. Among the natural mineral waters available on the market, only a few feature the optimum calcium-magnesium proportion (2:1). Considering the mineralization degree of the studied products, it can be stated that the largest percentage of products with significant calcium and magnesium contents can be found in the high-mineralized water group.

**Conclusions.** For some natural mineral waters, the consumption of 1 litre daily may ensure the recommended intake levels of calcium and magnesium in some consumer groups to a considerable degree. For 1-3 -year-old children it is recommended to consume less than 1 litre daily of natural mineral waters containing an excess of 700 mg of calcium and 80 mg of magnesium in 1 litre.

**Key words:** *natural mineral water, minerals, calcium, magnesium, daily intake*

### STRESZCZENIE

**Wprowadzenie.** Naturalne wody mineralne należą do produktów, które mogą stanowić istotne źródło wapnia, magnezu czy innych związków mineralnych. Składniki mineralne w wodach butelkowanych występują w formie zjonizowanej, co daje dobrą ich przyswajalność. Niemniej jednak stężenie składników mineralnych w wodach podziemnych stanowiących surowiec do produkcji wód butelkowanych jest bardzo zróżnicowane. Wobec powyższego istotne znaczenie ma jaką wodę butelkowaną spożywamy.

**Cel.** Celem badań było oznaczenie zawartości wapnia i magnezu w badanych wodach oraz ocena pobrania wapnia i magnezu z naturalną wodą mineralną przez różne grupy konsumentów przy założonej ilości spożywanego produktu.

**Materiał i metody.** Materiał badawczy stanowiły naturalne wody mineralne (o różnym stopniu zmineralizowania), 40 różnych marek, dostępne na polskim rynku. Badane produkty były wyprodukowane w Polsce, jak i pochodziły z innych

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krajów europejskich. Wśród badanych produktów około 30% stanowiły naturalne wody mineralne pochodzące z Litwy, Łotwy, Czech, Francji, Włoch i Niemiec. Ponad połowę badanych produktów stanowiły wody średnizmineralizowane. Zawartość wapnia i magnezu w wodach mineralnych oznaczano techniką płomieniowej spektrometrii absorpcji atomowej (ASA) w płomieniu acetylen-powietrze. Oznaczenia wykonano przy użyciu spektrometru absorpcji atomowej – ICE 3000 SERIES - THERMO - Anglia, wyposażonego w stację danych GLITE, korekcję tła (lampa deuterowa) oraz odpowiednie lampy katodowe.

**Wyniki.** Naturalne wody mineralnych dostępne na polskim rynku charakteryzują się zróżnicowaną zawartością wapnia i magnezu, a wysoki stopień mineralizacji produktu nie zawsze gwarantuje znaczące ilości tych składników. Spośród naturalnych wód mineralnych występujących na rynku zaledwie kilka charakteryzuje się optymalną proporcją wapnia do magnezu (2:1). Uwzględniając stopień mineralizacji badanych produktów można stwierdzić, że największy odsetek produktów o znaczącej zawartości wapnia i magnezu występuje w grupie wód mineralnych wysokozmineralizowanych.

**Wnioski.** W przypadku części naturalnych wód mineralnych spożycie w ilości 1 litra dziennie może w znacznym stopniu zapewnić zalecane pobranie wapnia i magnezu dla wybranych grup konsumentów. Odnośnie naturalnych wód mineralnych o zawartości powyżej: 700 mg wapnia lub 80 mg magnezu w jednym litrze zaleca się spożycie w grupie dzieci w wieku 1-3 lat w ilości odpowiednio mniejszej niż 1 litr dziennie.

**Słowa kluczowe:** naturalna woda mineralna, składniki mineralne, wapń, magnez, dzienne pobranie

## INTRODUCTION

A proper supply of mineral compounds, including calcium and magnesium, is very important for the proper development and functioning of the human body. These components play important physiological roles, for example, they constitute the material for bones, influence the course of metabolic processes and regulate the water-electrolyte balance [2, 7, 13, 27]. Many studies have shown that a deficiency in these components in diets increases the likelihood of the occurrence of many illnesses [11, 19].

Natural mineral waters may be an essential source of calcium, magnesium and other minerals [3, 10, 24, 29]. An amount such as 150 mg of calcium and 50 mg of magnesium in one litre of water is recognized as significant [2, 28]. In bottled waters, minerals occur in an ionized form which is very well digestible [20–23]. Moreover, other studies have shown that the bioavailability of calcium and magnesium from natural mineral waters is comparable to that of milk [8, 9, 21].

The Polish bottled water market is very well-developed and offers a dozen products, both of national origin and imported. Pursuant to a valid Regulation of the Minister of Health on natural mineral waters, spring waters and potable waters [25], which is compatible with the regulations of the European Union [5], natural mineral waters are distinguished among other bottled waters due to their mineral composition stability as well as properties of physiological importance with a beneficial effect on human health. However, the concentration of minerals in underground waters (which constitute the material for the production of bottled waters) varies. Depending on geological conditions, the mineral composition and occurrence of gases in the rocky environment, especially carbon dioxide, the overall content of soluble mineral compounds may be from 20 to over 200 g in a litre of water [1, 14, 15]. In view of the above, the type

of water consumed is essential. When making a choice of this type of product, consumers usually do not pay attention to mineral composition or nutritional value of a purchased product and often rely on their habits or sensory properties. However, the sensory properties of waters result from their chemical composition [18].

Among the minerals of bottled waters, special attention should be paid to calcium and magnesium. Previous studies have shown that bottled waters, including natural mineral waters, are one of the main drinks consumed by children and youth [6, 16, 17]. Although the recommendations regarding sufficient daily water consumption in the form of drinks and other food products for children and adults are from 1250 mL to over 2 litres/day, depending on population group [12], the results of previous investigations show that consumers drink considerably less [4].

The aim of the study was to estimate the calcium and magnesium contents in products available on the Polish market and to evaluate calcium and magnesium consumption with natural mineral water by different consumer groups with an assumed volume of the consumed product. For this reason the study was focused on determination of the following:

- the real content of calcium, magnesium in the studied products,
- the percentage of calcium and magnesium intake with natural mineral water in comparison with the Recommended Dietary Allowances (RDA) of these components in different age groups.

## MATERIAL AND METHODS

Forty different types of bottled natural mineral water available on the Polish market were the study material. These represented forty different brands of natural mine-

ral available waters on Polish market. These waters were produced in Poland or other European countries. Among the studied products, about 30% of the waters were from Lithuania, Latvia, Czech Republic, France, Italy and Germany. Experimental samples were taken randomly. An individual sample consisted of two package units of studied water originating from different production lots.

The content of calcium and magnesium in mineral waters was determined using flame atomic absorption spectrometry (ASA) in an acetylene-air flame. Further determinations were carried out using atomic absorption spectrometer - ICE 3000 SERIES-THERMO-England, equipped with a GLITE data station, background correction (a deuterium lamp) as well as other cathode lamps at a wave length of 422.7 nm and 285.2 nm suitable for calcium and magnesium. Calcium and magnesium contents were determined using the AAS validated methods. The applied concentrations of the Ca and Mg standard solutions covered the measurement range of the analytical method, which was characterised by the linearity of the calibration curves. The limits of the measurement range assumed for calcium and magnesium, the formula and the co-efficient of the standard curve were as follows:

$$\text{Ca} - 0.5-4.0 \quad y = 0.0455x + 0.0055 \quad 0.9995$$

$$\text{Mg} - 0.05-0.8 \quad y = 1.1205x + 0.058 \quad 0.9953$$

The likelihood ratio of the analytical methods was verified with an analysis of a certified reference material (Institute of Nuclear Chemistry and Technology). The following results were obtained: for calcium (g/kg) – certified value  $5.82 \pm 0.5$ , determined value  $5.78 \pm 0.58$ , recovery 99.1% and for magnesium (g/kg) - certified value  $2.24 \pm 0.17$ , determined value  $2.1 \pm 0.15$ , recovery 98.7%.

When determining the calcium content, a 10% water solution of lanthanum chloride was added to all the solutions under analysis, at a volume that would ensure a final concentration of  $\text{La}^{+3}$  of 0.5% [26]. Due to the influence of the present carbon dioxide on the accuracy of analyses, carbonated natural mineral waters were subject to de-carbonation prior to analyses.

The evaluation of minerals intake was carried out according to the Recommended Dietary Allowances [27]. Moreover, the daily consumption of natural mineral water was assumed at the level of 1 litre. The factors influencing component bioavailability in the body were not taken into account since they were not the focus of the study. The statistical analysis of results was carried out using Statistica 12 (StatSoft, USA).

## RESULTS AND DISCUSSION

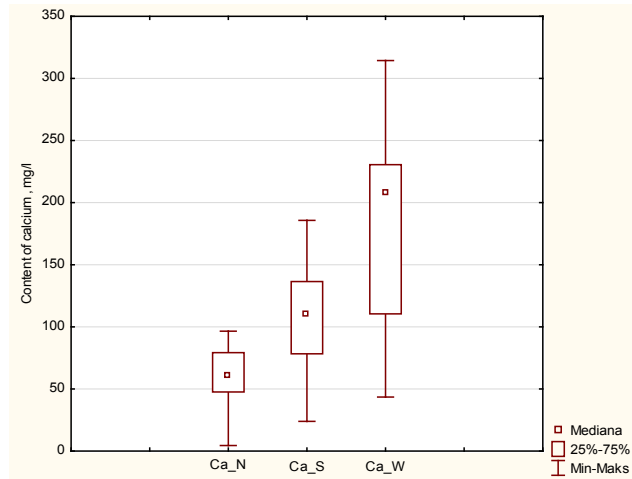
### Calcium and magnesium content in the studied products

The natural mineral waters available on the market feature a wide variation in the content of mineral

compounds. These values are as follows: for calcium from 4.48 to 314.36 mg/L, while for magnesium from 2.90 to 118.22 mg/L (Table 1). At such a wide volume range of these components, selection of a product by a consumer is of importance for nutrition. According to the current regulations, natural mineral waters are classified as low-mineralised, medium-mineralized and high-mineralised [25]. Over half (52%) of the waters were medium-mineralized, i.e. with the declared total

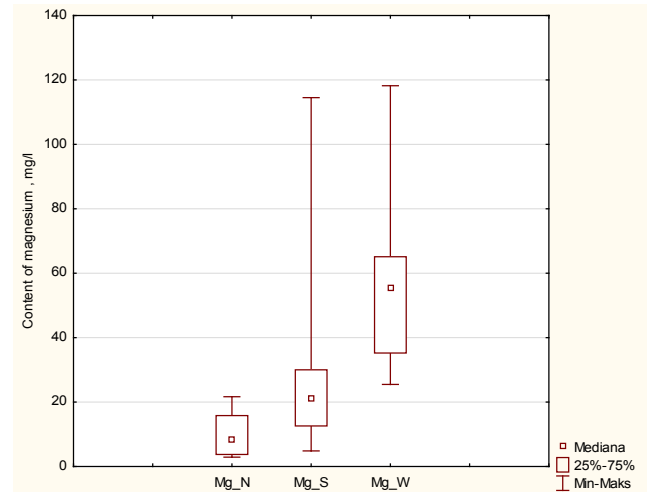
Table 1. Calcium and magnesium content in natural mineral waters

Trade name of product	Content of minerals, mg/L		Ratio Ca:Mg
	Ca	Mg	
<b>Low-mineralized natural mineral waters</b>			
Artic	90.61	8.23	11:1
Bolle	4.48	2.90	2:1
Dobrowianka	65.77	21.50	3:1
Evian	79.27	21.66	4:1
Fonta de Medici	96.54	15.81	6:1
Kropla Beskidu	47.58	12.61	4:1
Neptunas	45.42	5.96	8:1
Salinger	60.58	3.75	17:1
Vilsa	59.53	3.46	17:1
<b>Medium-mineralized natural mineral waters</b>			
Augustowianka	66.37	26.16	2:1
Cisowianka	136.48	21.29	6:1
Everest	23.93	8.40	3:1
Food & Joy Natural Mineral Water	166.69	17.24	10:1
Grodziska Tesco	96.54	30.01	3:1
Jurajska	78.31	37.63	2:1
Kinga Pienińska	98.49	12.59	8:1
Krystynka	171.53	50.13	3:1
Magnesja	43.47	114.52	1:3
Należczowianka	103.55	24.51	4:1
Naturalna Woda Mineralna Sudety (Carrefour)	129.15	14.37	9:1
Naturalna woda mineralna Kaufland	117.80	29.69	4:1
Perrier	185.71	4.84	38:1
Polanica Tesco	121.83	12.47	10:1
Polaris	110.19	15.59	7:1
San Pellegrino	216.03	41.39	5:1
Ustronianka	100.30	16.81	6:1
Veroni Mineral	88.27	9.55	9:1
Wielka Pieniawa	214.23	23.81	9:1
Wielka Wieniecka	104.87	26.50	4:1
Zdroje Piwniczna	123.70	47.85	3:1
<b>High-mineralized natural mineral waters</b>			
Borjomi	43.48		1:1
Darida	50.02		2:1
Krynica	314.36		5:1
Muszyna Skarb Życia	227.57		4:1
Muszyna Tesco Cechini	288.05		5:1
Muszynianka	198.40		2:1
Naturalna Woda Miner. Piotr i Paweł	216.42		3:1
Staropolanka	230.56		5:1
Wysowianka	110.49		3:1
Źródła Muszyny	138.29		2:1



N - low-mineralized natural mineral water  
 S - medium-mineralized natural mineral water  
 W- high-mineralized natural mineral water

Figure 1a. Calcium content in natural mineral water



N - low-mineralized natural mineral water  
 S - medium-mineralized natural mineral water  
 W- high-mineralized natural mineral water

Figure 1b. Magnesium content in natural mineral water

content of minerals from 500 to 1500 mg per litre. Low-mineralised and high mineralized products were in the minority of all the analysed natural mineral waters and constituted 23% and 25%, respectively (Table 1).

When analysing product composition with regard to the degree of their mineralisation, it is clear that none of the products representing the low-mineralised natural mineral water group features a significant calcium or magnesium level (above 150 mg/L or 50 mg/L), respectively (Table 1). However, at the same time, this group of products is represented by waters in which the contents of determined minerals are higher in comparison with the values obtained for medium-mineralised or even high-mineralised natural mineral waters (Figure 1 a, b). Examples of this include: Artic and Fonta de Medici, in which the content of calcium is over twice higher than in some waters of higher degree of mineralisation (e.g. Magnesia, Borjomi). From among medium-mineralised natural mineral waters present on the market, only about 24% contain a significant content of calcium and only 14% contain a significant content of magnesium (Table 1). However, high-mineralised waters are mostly products with a significantly high content of calcium and magnesium (Table 1).

It should be underlined that the total content of all mineral compounds constitutes the general degree of mineralisation of a given bottled water, both cations and anions. Therefore, a higher degree of water mineralisation is not directly connected with a higher content of calcium or magnesium compounds which are essential for the human body. In some natural high-mineralised bottled waters available on the market, a high degree of mineralisation results from a particularly high content of sodium with a lower content of calcium and magnesium (based on the manufacturer's data). Such

mineral composition is characteristic of Borjomi and Darida bottled waters. From a nutritional point of view, the calcium-magnesium ratio is essential for optimal utilisation of minerals in the body. The optimum value of this ratio should be 2:1 (Ca:Mg) [28]. From among natural mineral waters available on the market, only a few feature the optimum calcium-magnesium proportion (Table 1).

#### *Calcium and magnesium intake with natural mineral water in comparison with the RDA in different age group of consumers*

An adequate supply of calcium and magnesium is essential in every age. However, particularly high growth in the demand for these components occurs up to the age of 12-13 [28]. The determination of calcium and magnesium content in waters and the assumption of a daily consumption of the product at a volume of 1 litre allows for the estimation of a given water percentage in the RDA of a given mineral.

Among natural low-mineralised waters available on the market, all products provide calcium in an amount of below 20% of the amount recommended for children aged 1-3 years (Table 2). In older children and other population age groups, these products supply even lower levels of the Recommended Dietary Allowance of this component. In the group of medium mineralised waters, only 28% (six products) provide calcium at 20% or more in reference to the Recommended Dietary Allowance for the youngest group of children in 1 litre of consumed product (Table 3). However, only two products (San Pellegino, Wielka Pieniawa) can be regarded as an equally good source of this component in the nutrition of older children aged 10 years old. In case of a higher demand for calcium (persons above 10 years of age), the



Table 2. The percentage of the Recommended Dietary Allowances (RDA) for calcium at the assumed consumption of 1 litre of low- mineralized natural mineral water

Trade name of product	Children			Girls			Boys			Woman			Men		
	Age (years)														
	1-3	4-6	7-9	10-12	13-15	16-18	10-12	13-15	16-18	19-30	31-50	51-65	19-30	31-50	51-65
Artic	12.94	9.06	9.06	6.97	6.97	6.97	6.97	6.97	6.97	9.06	9.06	7.55	9.06	9.06	9.06
Bolle	0.64	0.44	0.44	0.34	0.34	0.34	0.34	0.34	0.34	0.44	0.44	0.37	0.44	0.44	0.44
Dobrowianka	9.50	6.58	6.58	5.06	5.06	5.06	5.06	5.06	5.06	6.58	6.58	5.48	6.58	6.58	6.58
Evian	11.32	7.93	7.93	6.10	6.10	6.10	6.10	6.10	6.10	7.93	7.93	6.61	7.93	7.93	7.93
Fonta de Medici	13.79	9.65	9.65	7.43	7.43	7.43	7.43	7.43	7.43	9.65	9.65	8.05	9.65	9.65	9.65
Kropla Beskidu	6.80	4.76	4.76	3.66	3.66	3.66	3.66	3.66	3.66	4.76	4.76	3.97	4.76	4.76	4.76
Neptunas	6.48	4.54	4.54	3.49	3.49	3.49	3.49	3.49	3.49	4.54	4.54	3.79	4.54	4.54	4.54
Salinger	8.65	6.06	6.06	4.66	4.66	4.66	4.66	4.66	4.66	6.06	6.06	5.05	6.06	6.06	6.06
Vilsa	8.50	5.95	5.95	4.58	4.58	4.58	4.58	4.58	4.58	5.95	5.95	4.96	5.95	5.95	5.95

consumption of 1 litre of medium-mineralized mineral water supplies only about a dozen percent of the RDA of this component to the body (Table 3). In more than 50% of high-mineralised waters, the content of calcium is above 150 mg/L. These waters constitute a significant source of this mineral for children up to 10 years of age, and two of these waters (Krynica, Muszyna Tesco Cechini), can cover even higher demands for this component (1300 mg/day), i.e. they provide at least 20% of the reference amount of this component when consumed at 1 litre per day (Table 4).

When analysing the low-mineralised natural waters available on the market as a source of magnesium, three products can be distinguished which contain higher magnesium contents (Dąbrowianka, Evian, Fonta de Medici). The consumption of 1 litre daily of these waters provides about 20% of the Recommended Dietary Allowance only in children aged 1-3 years (Table 5). The remaining products at the same mineralisation level consumed in such a quantity can supply magnesium in only several to a dozen percent of the RDA. Among the medium-mineralized waters available on the market, the

Table 3. The percentage of the Recommended Dietary Allowances (RDA) for calcium at the assumed consumption of 1 litre of medium- mineralized natural mineral water

Trade name of product	Children			Girls			Boys			Woman			Men		
	Age (years)														
	1-3	4-6	7-9	10-12	13-15	16-18	10-12	13-15	16-18	19-30	31-50	51-65	19-30	31-50	51-65
Augustowianka	9.48	6.64	6.64	5.11	5.11	5.11	5.11	5.11	5.11	6.64	6.64	5.53	6.64	6.64	6.64
Cisowianka	<b>19.50</b>	13.65	13.65	10.50	10.50	10.50	10.50	10.50	10.50	13.65	13.65	11.37	13.65	13.65	13.65
Everest	3.42	2.39	2.39	1.84	1.84	1.84	1.84	1.84	1.84	2.39	2.39	1.99	2.39	2.39	2.39
Food&Joy Natural Mineral Water	<b>23.81</b>	16.67	16.67	12.82	12.82	12.82	12.82	12.82	12.82	16.67	16.67	13.89	16.67	16.67	16.67
Grodziska Tesco	13.79	9.65	9.65	7.43	7.43	7.43	7.43	7.43	7.43	9.65	9.65	8.05	9.65	9.65	9.65
Jurajska	11.19	7.83	7.83	6.02	6.02	6.02	6.02	6.02	6.02	7.83	7.83	6.53	7.83	7.83	7.83
Kinga Pienińska	14.07	9.85	9.85	7.58	7.58	7.58	7.58	7.58	7.58	9.85	9.85	8.21	9.85	9.85	9.85
Krystynka	<b>24.50</b>	17.15	17.15	13.19	13.19	13.19	13.19	13.19	13.19	17.15	17.15	14.29	17.15	17.15	17.15
Magnesja	6.21	4.35	4.35	3.34	3.34	3.34	3.34	3.34	3.34	4.35	4.35	3.62	4.35	4.35	4.35
Nałęczowianka	14.79	10.36	10.36	7.97	7.97	7.97	7.97	7.97	7.97	10.36	10.36	8.63	10.36	10.36	10.36
Naturalna Woda Mineralna Sudety (Carrefour)	18.45	12.92	12.92	9.93	9.93	9.93	9.93	9.93	9.93	12.92	12.92	10.76	12.92	12.92	12.92
Naturalna Woda Mineral. Kaufland	16.83	11.78	11.78	9.06	9.06	9.06	9.06	9.06	9.06	11.78	11.78	9.82	11.78	11.78	11.78
Perrier	<b>26.43</b>	18.57	18.57	14.29	14.29	14.29	14.29	14.29	14.29	18.57	18.57	15.48	18.57	18.57	18.57
Polanica Tesco	17.40	12.18	12.18	9.37	9.37	9.37	9.37	9.37	9.37	12.18	12.18	10.15	12.18	12.18	12.18
Polaris	15.74	11.02	11.02	8.46	8.46	8.46	8.46	8.46	8.46	11.02	11.02	9.18	11.02	11.02	11.02
San Pellegrino	<b>30.86</b>	<b>21.60</b>	<b>21.60</b>	16.62	16.62	16.62	16.62	16.62	16.62	21.60	21.60	18.00	21.60	21.60	21.60
Ustronianka	14.33	10.03	10.03	7.72	7.72	7.72	7.72	7.72	7.72	10.03	10.03	8.36	10.03	10.03	10.03
Veroni Mineral	12.61	8.83	8.83	6.79	6.79	6.79	6.79	6.79	6.79	8.83	8.83	7.36	8.83	8.83	8.83
Wielka Pieniawa	<b>30.60</b>	<b>21.42</b>	<b>21.42</b>	16.48	16.48	16.48	16.48	16.48	16.48	21.42	21.42	17.85	21.42	21.42	21.42
Wielka Wieniecka	14.98	10.49	10.49	8.07	8.07	8.07	8.07	8.07	8.07	10.49	10.49	8.74	10.49	10.49	10.49
Zdroje Piwniczna	17.67	12.37	12.37	9.52	9.52	9.52	9.52	9.52	9.52	12.37	12.37	10.31	12.37	12.37	12.37

Table 4. The percentage of the Recommended Dietary Allowances (RDA) for calcium at the assumed consumption of 1 litre of high- mineralized natural mineral water

Trade name of product	Children			Girls			Boys			Woman			Men		
	Age (years)														
	1-3	4-6	7-9	10-12	13-15	16-18	10-12	13-15	16-18	19-30	31-50	51-65	19-30	31-50	51-65
Borjomi	6.21	4.35	4.35	3.34	3.34	3.34	3.34	3.34	3.34	4.35	4.35	3.62	4.35	4.35	4.35
Darida	7.15	5.00	5.00	3.85	3.85	3.85	3.85	3.85	3.85	5.00	5.00	4.17	5.00	5.00	5.00
Krynica	<b>44.91</b>	<b>31.44</b>	<b>31.44</b>	<b>24.18</b>	<b>24.18</b>	<b>24.18</b>	<b>24.18</b>	<b>24.18</b>	<b>24.18</b>	<b>31.44</b>	<b>31.44</b>	<b>26.20</b>	<b>31.44</b>	<b>31.44</b>	<b>31.44</b>
Muszyna Skarb Życia	<b>32.51</b>	<b>22.76</b>	<b>22.76</b>	<b>17.51</b>	17.51	17.51	17.51	17.51	17.51	22.76	22.76	18.96	22.76	22.76	22.76
Muszyna Tesco Cechini	<b>41.15</b>	<b>28.81</b>	<b>28.81</b>	<b>22.16</b>	<b>22.16</b>	<b>22.16</b>	<b>22.16</b>	<b>22.16</b>	<b>22.16</b>	<b>28.81</b>	<b>28.81</b>	<b>24.00</b>	<b>28.81</b>	<b>28.81</b>	<b>28.81</b>
Muszynianka	<b>28.34</b>	<b>19.84</b>	<b>19.84</b>	15.26	15.26	15.26	15.26	15.26	15.26	19.84	19.84	16.53	19.84	19.84	19.84
Naturalna Woda Mineralna Piotr i Paweł	<b>30.92</b>	<b>21.64</b>	<b>21.64</b>	16.65	16.65	16.65	16.65	16.65	16.65	21.64	21.64	18.04	21.64	21.64	21.64
Staropolanka	<b>32.94</b>	<b>23.06</b>	<b>23.06</b>	17.74	17.74	17.74	17.74	17.74	17.74	23.06	23.06	19.21	23.06	23.06	23.06
Wysowianka	15.78	11.05	11.05	8.50	8.50	8.50	8.50	8.50	8.50	11.05	11.05	9.21	11.05	11.05	11.05
Źródła Muszyny	19.76	13.83	13.83	10.64	10.64	10.64	10.64	10.64	10.64	13.83	13.83	11.52	13.83	13.83	13.83

Table 5. The percentage of the Recommended Dietary Allowances (RDA) for magnesium at the assumed consumption of 1 litre of low- mineralized natural mineral water

Trade name of product	Children			Girls			Boys			Woman			Men		
	Age (years)														
	1-3	4-6	7-9	10-12	13-15	16-18	10-12	13-15	16-18	19-30	31-50	51-65	19-30	31-50	51-65
Artic	10.29	6.33	6.33	3.43	2.29	2.29	3.43	2.00	2.00	2.65	2.57	2.57	2.06	1.96	1.96
Bolle	3.63	2.23	2.23	1.21	0.81	0.81	1.21	0.71	0.71	0.94	0.91	0.91	0.73	0.69	0.69
Dobrowianka	<b>26.88</b>	16.54	16.54	8.96	5.97	5.97	8.96	5.24	5.24	6.94	6.72	6.72	5.38	5.12	5.12
Evian	<b>27.08</b>	16.66	16.66	9.03	6.02	6.02	9.03	5.28	5.28	6.99	6.77	6.77	5.42	5.16	5.16
Fonta de Medici	<b>19.76</b>	12.16	12.16	6.59	4.39	4.39	6.59	3.86	3.86	5.10	4.94	4.94	3.95	3.76	3.76
Kropla Beskidu	15.76	9.70	9.70	5.25	3.50	3.50	5.25	3.08	3.08	4.07	3.94	3.94	3.15	3.00	3.00
Neptunas	7.45	4.58	4.58	2.48	1.65	1.65	2.48	1.45	1.45	1.92	1.86	1.86	1.49	1.41	1.41
Salinger	4.69	2.88	2.88	1.56	1.04	1.04	1.56	0.91	0.91	1.21	1.17	1.17	0.94	0.89	0.89
Vilsa	4.33	2.66	2.66	1.44	0.96	0.96	1.44	0.84	0.84	1.12	1.08	1.08	0.87	0.82	0.82

Table 6. The percentage of the Recommended Dietary Allowances (RDA) for magnesium at the assumed consumption of 1 litre of medium- mineralized natural mineral water

Trade name of product	Children			Girls			Boys			Woman			Men		
	Age (years)														
	1-3	4-6	7-9	10-12	13-15	16-18	10-12	13-15	16-18	19-30	31-50	51-65	19-30	31-50	51-65
Augustowianka	<b>32.70</b>	<b>20.12</b>	<b>20.12</b>	10.90	7.27	7.27	10.90	6.38	6.38	8.44	8.18	8.18	6.54	6.23	6.23
Cisowianka	<b>26.61</b>	16.38	16.38	8.87	5.91	5.91	8.87	5.19	5.19	6.87	6.65	6.65	5.32	5.07	5.07
Everest	10.50	6.46	6.46	3.50	2.33	2.33	3.50	2.05	2.05	2.71	2.63	2.63	2.10	2.00	2.00
Food&Joy Natural Mineral Water	<b>21.55</b>	13.26	13.26	7.18	4.79	4.79	7.18	4.20	4.20	5.56	5.39	5.39	4.31	4.10	4.10
Grodziska Tesco	<b>37.57</b>	<b>23.08</b>	<b>23.08</b>	12.50	8.34	8.34	12.50	7.32	7.32	9.68	9.38	9.38	7.50	7.15	7.15
Jurajska	<b>47.04</b>	<b>28.95</b>	<b>28.95</b>	15.68	10.45	10.45	15.68	9.18	9.18	12.14	11.76	11.76	9.41	8.96	8.96
Kinga Pienińska	15.74	9.68	9.68	5.25	3.50	3.50	5.25	3.07	3.07	4.06	3.93	3.93	3.15	3.00	3.00
Krystynka	<b>62.66</b>	<b>38.56</b>	<b>38.56</b>	<b>20.89</b>	13.93	13.93	<b>20.89</b>	12.23	12.23	16.17	15.66	15.66	12.53	11.94	11.94
Magnesja	<b>143.15</b>	<b>88.09</b>	<b>88.09</b>	<b>47.72</b>	<b>31.81</b>	<b>31.81</b>	<b>47.72</b>	<b>27.93</b>	<b>27.93</b>	<b>36.94</b>	<b>35.79</b>	<b>35.79</b>	<b>28.63</b>	<b>27.27</b>	<b>27.27</b>
Nałęczowianka	<b>30.64</b>	<b>18.85</b>	<b>18.85</b>	10.21	6.81	6.81	10.21	5.98	5.98	7.91	7.66	7.66	6.13	5.84	5.84
Naturalna woda mineralna Sudety (Carrefour)	17.96	11.05	11.05	5.99	3.99	3.99	5.99	3.50	3.50	4.64	4.49	4.49	3.59	3.42	3.42
Naturalna woda mineral. Kauffland	<b>37.11</b>	<b>22.84</b>	<b>22.84</b>	12.37	8.25	8.25	12.37	7.24	7.24	9.58	9.29	9.29	7.42	7.07	7.07
Perrier	6.05	3.72	3.72	2.10	1.34	1.34	2.10	1.18	1.18	1.56	1.51	1.51	1.21	1.15	1.15
Polanica Tesco	15.59	9.59	9.59	5.20	3.46	3.46	5.20	3.04	3.04	4.02	3.90	3.90	3.12	2.97	2.97
Polaris	<b>19.49</b>	11.99	11.99	6.78	4.33	4.33	6.78	3.80	3.80	5.03	4.87	4.87	3.90	3.71	3.71
San Pellegrino	<b>51.74</b>	<b>31.84</b>	<b>31.84</b>	17.25	11.50	11.50	17.25	10.09	10.09	13.35	12.93	12.93	10.45	9.85	9.85
Ustronianka	<b>21.01</b>	12.93	12.93	7.00	4.70	4.70	7.00	4.10	4.10	5.42	5.25	5.25	4.20	4.00	4.00
Veroni Mineral	11.94	7.35	7.35	3.98	2.65	2.65	3.98	2.33	2.33	3.08	2.98	2.98	2.39	2.27	2.27
Wielka Pieniawa	<b>29.76</b>	<b>18.32</b>	<b>18.32</b>	9.92	6.61	6.61	9.92	5.81	5.81	7.68	7.44	7.44	5.95	5.67	5.67
Wielka Wieniecka	<b>33.13</b>	<b>20.38</b>	<b>20.38</b>	11.04	7.36	7.36	11.04	6.46	6.46	8.55	8.28	8.28	6.63	6.31	6.31
Zdroje Piwniczna	<b>59.81</b>	<b>36.81</b>	<b>36.81</b>	<b>19.94</b>	13.29	13.29	<b>19.94</b>	11.67	11.67	15.44	14.95	14.95	11.96	11.39	11.39

Table 7. The percentage of the Recommended Dietary Allowances (RDA) for magnesium at the assumed consumption of 1 litre of high-mineralized natural mineral water

Trade name of product	Children			Girls			Boys			Woman			Men		
	Age (years)														
	1-3	4-6	7-9	10-12	13-15	16-18	10-12	13-15	16-18	19-30	31-50	51-65	19-30	31-50	51-65
Borjomi	<b>38.06</b>	<b>23.42</b>	<b>23.42</b>	12.69	8.46	8.46	12.69	7.43	7.43	9.82	9.52	9.52	7.61	7.25	7.25
Darida	<b>31.86</b>	<b>19.61</b>	<b>19.61</b>	10.62	7.08	7.08	10.62	6.22	6.22	8.22	7.97	7.97	6.37	6.07	6.07
Krynica	<b>81.40</b>	<b>50.09</b>	<b>50.09</b>	<b>27.13</b>	18.09	18.09	<b>27.13</b>	15.88	15.88	<b>21.01</b>	<b>20.35</b>	<b>20.35</b>	16.28	15.50	15.50
Muszyna Skarb Życia	<b>68.54</b>	<b>68.54</b>	<b>68.54</b>	<b>22.85</b>	15.23	15.23	<b>22.85</b>	13.37	13.37	17.69	17.13	17.13	13.71	13.05	13.05
Muszyna Tesco Cechini	<b>75.71</b>	<b>46.59</b>	<b>46.59</b>	<b>25.24</b>	16.83	16.83	<b>25.24</b>	14.77	14.77	19.54	18.93	18.93	15.14	14.42	14.42
Muszynianka	<b>147.78</b>	<b>90.94</b>	<b>90.94</b>	<b>49.26</b>	<b>32.84</b>	<b>32.84</b>	<b>49.26</b>	<b>28.83</b>	<b>28.83</b>	<b>38.14</b>	<b>36.94</b>	<b>36.94</b>	<b>29.56</b>	<b>28.15</b>	<b>28.15</b>
Naturalna Woda Mineralna Piotr i Paweł	<b>87.96</b>	<b>54.13</b>	<b>54.13</b>	<b>29.32</b>	<b>19.55</b>	<b>19.55</b>	<b>29.32</b>	17.16	17.16	<b>22.70</b>	<b>21.99</b>	<b>21.99</b>	17.59	16.75	16.75
Staropolanka	<b>58.59</b>	<b>36.05</b>	<b>36.05</b>	<b>19.53</b>	13.02	13.02	<b>19.53</b>	11.43	11.43	15.12	14.65	14.65	11.72	11.16	11.16
Wysowianka	<b>44.05</b>	<b>27.11</b>	<b>27.11</b>	14.68	9.79	9.79	14.68	8.59	8.59	11.37	11.01	11.01	8.81	8.39	8.39
Źródła Muszyny	<b>69.94</b>	<b>43.04</b>	<b>43.04</b>	<b>23.31</b>	15.54	15.54	23.31	13.65	13.65	18.05	17.48	17.48	13.99	13.32	13.32

majority of products when consumed at 1 litre daily to a significant degree cover the Recommended Dietary Allowance determined for children aged 1-3 years (Table 6). For higher demands for this component, in children between 4 and 9 years of age, only about 50% of products at medium mineralisation degree consumption of the assumed quantity of water will supply enough calcium to meet at least 20% of RDA. For adults with high demand (420 mg/day/person) for this component, Magnesja, a medium-mineralized water, can constitute a significant amount of magnesium. This product, along with Muszynianka, a high-mineralised water, is a rich source of magnesium, whose consumption covers up to about 30% of the RDA for this age group. Due to the high content of magnesium in both above-mentioned products, their consumption in the assumed amount is not recommended for children aged below 3 years since it would cause an excessive supply of this component. The recommendations of the Institute of Mother and Child concerning the nutrition of 1-3 -year-old children include the use of low-carbonated water to prevent the intake of excessive levels of mineral elements compared to the daily recommended intake. However, the composition of natural mineral water products available on the market is highly varied. The majority of the water products, including those with declared general high-carbonation levels, are characterised by a low content of both calcium and magnesium. Therefore, although eliminating the use of highly-mineralised waters in the nutrition of small children is not excluded, products with contents above of 700 mg Ca/L and 80 mg Mg/L water should be excluded or limited. It is therefore essential to analyse information provided on product packaging and to adjust the consumed amounts to the consumer's age. The consumption of other high-mineralised waters in the assumed amounts covers the Recommended Dietary Allowance for magnesium for about 20% to 70% in children up to 9 years of age (Table 7). Moreover, the majority of these products consumed at 1 litre daily

will also be a significant source of this component – at a level of 20 - 30% RDA particularly for 10-12-year olds.

Based on the results of other investigators, only about 13% of university students drink high-mineralised bottled water, which can provide an particularly essential source of calcium and magnesium [4]. Moreover, the choice of an adequate mineral composition of bottled water is particularly important in diagnosing calcium supply deficiencies in a diet [19].

## CONCLUSIONS

1. The natural mineral waters available on the Polish market can be characterised by a varied content of calcium and magnesium and a high degree of product mineralisation, although they do not always guarantee significant amounts of these components.
2. Considering the mineralisation degree of the studied products, it can be stated that the largest percentage of products with significant contents of calcium and magnesium can be found in the high-mineralised water group.
3. For some natural mineral waters, the consumption of 1 litre daily may ensure the recommended intake levels of calcium and magnesium in some consumer groups to a considerable degree.
4. For 1-3 -year-old children it is recommended to consume less than 1 litre daily of natural mineral waters containing an excess of 700 mg of calcium and 80 mg of magnesium in 1 litre.

### Conflict of interest

*The authors declare no conflict of interest.*

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