ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. XXIII, N 3, 15 SECTIO DDD 2010

Chair and Department of Food and Nutrition, Medical University of Lublin, Poland

JADWIGA BŁONIARZ, STANISŁAW ZARĘBA

Evaluation of some macroelement levels in selected dietary supplements supporting the immune system of the human organism

Ocena zawartości niektórych makroelementów w wybranych suplementach diety wspomagających system odpornościowy organizmu ludzkiego

INTRODUCTION

Dietary supplements enjoy great popularity with consumers worldwide, also in Poland. The assortment of these preparations is on a constant increase; every year many new supplements are registered. Taking preparations of this type is a comfortable way of supplementing the everyday diet with deficit substances necessary for correct functioning of the body. It is possible to apply supplements prophylactically or as supplements in therapy of different disease entities [6, 12]. Preparations taken, aimed at increasing the body's resistance, constitutean important group of supplements stimulating the immunological system [7, 11, 15]. Powdered herbalist's raw materials and dry extracts from medicinal plants are frequently included among dietary supplements; therefore, these preparations can frequently contain plenty of mineral substances [4].

Mineral elements constitute about 4% body weight of an adult man. They fulfill different functions in the body. Calcium and magnesium constitute the main building material of the bone and teeth, in which over 99% of calcium and 50%–60% of the total amount of magnesium is stored up. The remaining 1% calcium is found in tissues and extracellular liquids, in which this element fulfills other (rather than building) functions. In case of magnesium, 40%–45% of this element is stored up in cells of tissues, mainly in the muscles. Extracellular liquids contain 1% total content of magnesium [18].

The main raw plant materials used for the production of the studied dietary supplements (in the form of capsules and tablets), are: maca root and the root, bark and leaves of vilcacora and the root of Korean and American ginseng [5, 7, 11, 15].

Maca (*Lepidium meyenii* Walpers, *Lepidium peruvianum* Chacon*)* is a plant possessing nutritional and adaptogenic properties supplying the organism with natural amino acids, phytohormones, minerals and vitamins. It is strongly recommended for persons with active lifestyle, whose organism is exposed to intensive mental and physical effort. Preparations from the root find application in

states of weakness, emaciation and undernourishment of organism, during convalescence and in the Hadolescent stage, in fatigue syndromes, increasing the psychophysical activity, they are valuable immunostimulants, energizing and revitalizing the body [5].

Preparations from the root, bark or leaves of vilcacora/ cat's claw (*Uncaria tomentosa*), apart from numerous healing properties, also demonstrate strengthening action exerted on the human organism (tonicum). Thanks to the presence of pentacyclic oxoindole alkaloids which increase the activity of phagocytes, a modulating impact on immunological processes of the organism is exerted. *In vivo* and *in vitro* studies pointed in antiproliferative properties of preparations obtained from the discussed raw material in relation to the line of leukaemic cells, not-hindering the growth of the good cells [5, 15].

Ginseng (*Ginseng radix*) – called the "root of life" – is also obtained from the *Panax kind of ginseng* C.A. Meyer (proper ginseng) and *Panax quinquefolium* L. *American ginseng (*five-leaf ginseng*).*

In the 30 last years, results of over 50 clinical trials, conducted on patients and healthy volunteers, have been published. Results of those studies showed that in 13 cases (of 1572 examined persons) preparations of ginseng resulted in the improvement of physical and mental state, in 17 cases (846 patients) improvement in the physical fitness, improvement was also stated in various parameters of the metabolism in 10 more further studies. The studies on the impact of extracts from ginseng on cell metabolism, CNS, the cardiovascular system and the immunological system confirm the ability of the raw material to increase the body's resistance in the period of intensified action to factors, as free radicals, peroxides of lipids, cytotoxic and carcinogenic compounds. Preparations from this raw material demonstrate the immune system stimulating action and strengthening action. The influence of preparations from ginseng on the immunological system is connected, among others, with the presence of saponins. Saponins of ginseng have anti-oxidative and immunostimulant action, they stimulate the production of antiviral antibodies. As a result of this type of influences, an increase in the body's resistance to bacterial and viral infections and regeneration of the immunological system after experienced problematic illness occurs [7, 11].

Due to the scarcity of academic publications connected with the mineral composition of this type of preparations from non–vitamin – mineral groups and without the addition of minerals, and due to the high popularity in pharmaceutical market and frequent application exercised by members of the public, studying calcium and magnesium levels of the micronutrients important for the human body [14, 16, 17], appeared to be substantiated.

MATERIAL AND METHODS

The subject of the study were dietary supplements in the form of capsules and tablets and in liquid form (juices, their mixtures, liquid extracts from medicinal plants) supplementing the immunological system of the human body. Names and composition of these preparations are given in tables 1 and 2. 4–6 samples of each preparation were analyzed in two parallel runs. Each sample came from separate series of the production.

The 4–5 gram analytical samples for mineralization, from dietary supplements in the form of tablets, were made after prior averaging of the studied material (fragmenting tablets in the mortar). Dietary supplements in the form of gelatin capsules were weighed in one piece. In case of liquid supplements the measuring was done with pipette of 50–100 ml of liquid into quartz evaporating basins and they were evaporated to dry on a portable electric cooker (on the asbestos net). The

content of quartz melting pots (with analytical samples of tablets, capsules and liquid supplements after evaporating) was burnt initially in the flame of the burner, and then they were put to the furnace.

The samples were mineralized "dry" in the muffle furnace at the temperature of 450ºC. The process of mineralization was hastened using water solution of the nitric acid (V) of 20% concentration (HNO_3 Suprapur, Merck). Ashes were dissolved „ hot" in 15% aqueous solution of the hydrochloric acid (HCl Suprapur, Merck). Next, mineralizates were filtered through paper filters and supplemented with deionized water to the determined volume.

Calcium and magnesium levels were determined by FAAS method (flame atomic absorption spectrometry) in M5 SOLAAR ThermoElemental, spectrometer, applying the parameters of analysis adequate for the specific element. The optimum parameters for determination of calcium [13]: wavelength – 422.7 nm; bandpass – 0.5 nm; lamp current (best sensitivity) – 75%; operating current – 5 mA; flame type – air/acetylene; flame chemistry – stoichiometric; fuel flow rate – 0.9-1.2 $l \cdot min.^{-1}$. The optimum parameters for determination of magnesium [13]: wavelength – 285.2 nm; bandpass – 0.5 nm; lamp current (best sensitivity) – 75%; operating current – 5 mA; flame type – air/acetylene; flame chemistry – stoichiometric; fuel flow rate – 0.9 – 1.2 $l \cdot min.^{-1}$.

In the same conditions, the analysis of referential material was conducted – a blend of Polish herbs „Mixed Polish Herbs" (INST-MPH-2) [3] – determining the calcium and magnesium levels in it. The declared amounts of the analyzed elements were: of calcium 1.08 ± 0.07% and of magnesium 0.292 ± 0.018%, and the determined amounts were as follows: of calcium 0.99 ± 0.03% and of magnesium 0.277 ± 0.009 %.

RESUALTS AND DISCUSSION

Liquid preparations contained the smallest amounts of calcium and magnesium: of calcium from 0.81 $\mu g \cdot ml^{-1}$ (*Ginsenol*) and 1.36 $\mu g \cdot ml^{-1}$ (*Aloe Activ*) to 250.9 $\mu g \cdot ml^{-1}$ (*Aloe vera* drinking gel) and of magnesium from 2.27 $\mu g \cdot ml^{-1}$ (*Aloe Activ*) to 155.8 $\mu g \cdot ml^{-1}$ (*Noni-vita).* In supplements in the form of capsules and tablets, the following levels were stated: of calcium from 45.92 $\mu g \cdot g^{-1}$ (*Acerola Plus)* to 25501 µg/g in *Maca 50 Plus* and 25037 $\mu g \cdot g^{-1}$ in *Maca* preparation and of magnesium : from 513.2 $\mu g \cdot g^{-1}$ in *Maca* preparation and 517.4 $\mu g \cdot g^{-1}$ in *Maca 50 Plus* to 4044 $\mu g \cdot g^{-1}$ (*Żeń-szeń* - vita-complex).

The average intake of calcium with the maximum twenty-four hour dose of the studied supplements in the form of capsules and tablets can reach: from 42.24 µg (*Acerola Plus*) to 61284 µg applying *Cat's Claw* preparation, and from liquid supplements from 4 µg (*Ginsenol*) to 12546 µg when applying gel of bitter aloes (*Aloe vera* drinking gel). Applying dietary supplements in the form of capsules or tablets, by taking the maximum twenty-four hour dose of these preparations, one can absorb on average the amount of magnesium, from 607.5 µg (*Żeń-szeń,* KRKA) to 11952 µg (*Spirulina Pacyfica),* and from liquid preparations: from 83.1 µg (*Ginsenging 400*) to 6231 µg (*Noni-vita* – juice of noni fruit).

The assimilation of calcium from the diet amounts to from 10% to 40%, depending on solubility of the chemical form and composition of the applied diet. Topical norms of calcium for the population of Poland were established on the level corresponding to the sufficient consumption (AI – Adequate Intake) for women from 1000 up to 1300 mg per day (depending on the age and the physiological state) and for men from 1000 up to 1300 mg for twenty-four hours (depending on the age) [6].

Assimilating magnesium from an average diet reaches the average of about 50%. Topical norms for magnesium for adults were stated on the level of the average demand (EAR – Estimated Average

Requirement) and of recommended consumption (RDA – Recommended Dietary Allowances). For women, depending on the age, EAR is varies from 255 to 265 mg/day, and for men from 330 to 350 mg/day, however RDA – from 310 to 320 mg/day – for women and from 400 to 420 mg/day – for men, depending on the age [6].

The main source of mineral elements for men (including calcium and magnesium) are: food and beverages, and supplementing – dietary supplements with minerals or preparations of vitamin-mineral character [6, 10, 18].

Table 1. Name, producer and composition of dietary supplements (in the form of capsules and tablets) supplementing the immunological system of the human organism

No	Preparation name	Main components
1	*Acerola Plus* (tabl.); Puritan's Pride Inc., USA	Powdered acerola fruit, powdered grains of the buckwheat, buds of the wild rose (*Rosa canina*), citrus biflavonoids, extract from the green pepper, extract from the blackcurrant, rutin, hesperidine
2	*Cat's Claw* (caps.); Now Foods, USA	Powdered cat's claw (*Uncaria tomentosa)*
3	*Maca* (caps.); A-Z Medica, Sp. z o.o., Poland	Powdered maca root (*Lepidium meyenii* Walp.)
4	*Maca 50 Plus*(caps.); A-Z Medica, Sp. z o. o., Poland	Powdered maca root (*Lepidium meyenii* Walp.), antioxidative prefix: beta-carotene, vitamins – E, C; shark's cartilage
5	*Spirulina* (tabl.); Walmark, Sp. z o. o., Czech Rep.	Sea algae (*Spirulina platensis*), Vitamins: B_1, B_2, B_6
6	*Spirulina Hawajska* (caps.); Organic by Nature Inc., USA	Sea algae (*Spirulina platensis*) 100%
7	*Spirulina Pacyfica* (tabl.); Cyanotech Corp., USA	Sea algae (*Spirulina platensis*)
8	*Vilcacora* (caps.); Andean Medicine Centre Ltd., United Kingdom	Vilcacora (*Uncaria tomentosa*)
9	*Żeń-szeń* (caps.); Herbapol Kraków, Poland	Powdered ginseng root (*Ginseng radix*), iron oxides as capsule components
10	*Żeń-szeń Ginseng*, (caps.); KRKA, Slovenia	Dry extract from ginseng root (*Panax ginseng radicis extractym siccum*), iron oxides as capsule components
11	*Żeń-szeń Ginseng* (tabl.); Naturell AB, Sweden	Standardized extract from white Korean ginseng root (*Panax ginseng* C.A. Meyer)
12	*Żeń-szeń koreański*(caps.); Walmark, Sp. z o. o., Czech Rep.	Extract from white Korean ginseng root, vitamin E (D-alpha tocopherol)
13	*Żeń-szeń, vita-complex* (caps.); Olimp Lab., Sp. z o. o., Poland	Korean ginseng (Korean *Panax ginseng extract.*), American ginseng (*Panax quinquefolium extract*}

Table 2. Name, producer and composition of liquid dietary supplements supplementing the immunological system of the human organism

No	Preparation name	Main components
1	*Aloe vera – aloe juice*; Laboratoria Natury, Alter Medica, Olfam, Sp.z o. o., Poland	Aloe juice (*Aloe vera*)
2	*Aloe vera drinking gel juice with pulp pieces* – gel; Laborat. Natury, Sp. z o.o., Bio Medica, Poland	Aloe juice with pulp pieces (*Aloe vera*)
3	*Aloes Activ – aloe juice with extract of ginseng*; Alter Medica, Poland	Aloe juice (*Aloe barbadensis*), ginseng extract (*Acanthopanax senticosus* Maxim)
4	*Aloes Young + żurawina* – aloe juice and cranberry juice with acerola fruit; Alter Medica, Poland	Aloe juice (*Aloe barbadensis* - 70%), cranberry juice (*Oxycoccus palustris* Hill syn. *Vaccinum oxycoccus* – 25%), acerola powdered fruit (*Malpighia gabra* – 5%)
5	*Bodymax Tonik*; Axellus A/S, Denamrk	Standardized extract from ginseng GGE (*Panax ginseng* C.A. Meyer), Standardized extract from Japanese gingko (*Ginkgo biloba*), vitamins: B_1, B_2, B_6, PP, pantothenic acid
6	*Ginsenging 400* – extract from ginseng with honey; MEHECO No18, Guangiming Zhong Jie, China	*Ginseng radix extractum spissum* 3:1 – 400 mg, royal jelly 300 mg in 1 ampoule –10 ml
7	*Ginsenol*; Krakowskie Zakłady Zielarskie „Herbapol”, Kraków, Poland	Ginseng root tincture 1:5 (*Ginseng radix*)
8	*Noni – noni fruit juice*; Alter Medica, Poland	Noni fruit juice (*Morinda citrifolia*)
9	Noni-vita - noni fruit juice; Laboratoria Natury, Sp. z o.o., Poland	100% Noni fruit juice (*Morinda citrifolia*)
10	*Noni Plus – juice of noni and cranberry fruits*; Alter Medica, Poland	Noni fruit juice (*Morinda citrifolia*), cranberry juice (*Oxycoccus palustris*)

Table 3. Calcium content in supplements of diet supporting the immune system of the organism, $\mu g \cdot g^{-1}$ and µg/caps.(tabl.) and intake of calcium with maximal daily dose (µg)

No	Preparation	Calcium (Ca) content ($\mu g \cdot g^{-1}$)	Calcium (Ca) content (µg/caps. (tabl.)	Intake of calcium with maximal of daily dose (µg of Ca)
		Arithmetic mean. standard deviation and content (min.- max.)		
1	*Acerola Plus* (tabl.). n *)= 4, m *) = 0.92	45.92 ± 12.94 35.92 – 65.91	42.24 ± 11.91 32.72 – 60.64	42.24 ± 11.91 32.72 – 60.64
2	*Cat's Claw* (caps.). n = 4, m = 0.60 g	17024 ± 2131 14607 - 18835	10214 ± 1279 8764 - 11301	61284 ± 7674 52584 - 67806
3	*Maca* (caps.). n = 4, m = 0.40 g	25037 ± 92 24948 - 25163	10015 ± 37 9979 - 10065	30045 ± 111 29937 - 30195
4	*Maca 50 Plus* (caps.). n = 4, m = 0.60 g	25501 ± 462 24874 - 25892	15300 ± 277 14924 - 15535	30600 ± 554 29848 - 31070
5	*Spirulina* (Walmark) (tabl.). n = 4, m = 0.65 g	436.9 ± 46.0 364.2 – 487.6	284.0 ± 29.9 236.7 – 316.9	1420 ± 149 1184 - 1585
6	*Spirulina Hawaian* (caps.). n = 4, m = 0.60 g	541.4 ± 83.5 463.5 – 617.8	324.8 ± 50.1 278.1 – 370.7	1949 ± 301 1669 - 2224
7	*Spirulina Pacyfica* (tabl.). n = 4, m = 0.50 g	283.1 ± 32.7 250.3 – 325.2	141.6 ± 16.3 125.2 – 162.6	849.6 ± 98 751.2 – 975.6
8	*Vilcacora* (caps.). n = 4, m = 0.56 g	7139 ± 890 6272 - 7966	3998 ± 50 3512 - 4461	23988 ± 300 21072 - 26766
9	*Żeń-szeń* (Herbapol Kraków) (caps.). n = 4, m = 0.30 g	1732 ± 225 1491 - 1939	519.7 ± 67.5 447.3 – 581.7	2079 ± 270 1789 - 2327
10	*Żeń-szeń Ginseng* (KRKA) (caps.). n = 4, m = 0.46 g	157.4 ± 33.9 122.1 – 190.5	72.39 ± 15.61 56.17 – 87.63	72.39 ± 15.61 56.17 – 87.63
11	*Żeń-szeń Ginseng* (Naturell) (tabl.) n = 4. m = 0.40 g	2547 ± 490 2082 - 3075	1019 ± 196 832 - 1230	2038 ± 392 1666 - 2460
12	*Żeń-szeń koreański* (Walmark) (caps.). n = 4, m = 0.50 g	1577 ± 159 1363 - 1806	788.6 ± 79.7 681.5 – 903.0	788.6 ± 79.7 681.5 – 903.0
13	*Żeń-szeń vita-complex* (Olimp) (caps.). n = 4, m = 0.78 g	3256 ± 470 2853 - 3847	2539 ± 367 2225 - 3001	2539 ± 367 2225 - 3001

n *) number of examined series of production. m *) mean mass of capsule or tablet

Table 4. The magnesium content in supplements of diet supporting immune system organism. $\mu g \cdot g^{-1}$ and µg/caps.(tabl.) and intake of magnesium with maximal of daily dose (µg)

No	Preparation	Magnesium (Mg) content ($\mu g \cdot g^{-1}$)	Magnesium (Mg) content µg/caps. (tabl.)	Intake of magnesium with maximal daily dose (µg of Mg)
		Arithmetic mean. standard deviation and content (min. –max.)		
1	*Acerola Plus* (tabl.). n *)= 4, m *)= 0.92	661.5 ± 161.5 505.0 – 842.1	608.6 ± 148.6 464.6 – 774.7	608.6 ± 148.6 464.6 – 774.7
2	*Cat's Claw* (caps.). n = 4, m = 0.60 g	1101 ± 238 924 - 1431	660.3 ± 142.6 554.4 – 858.6	3962 ± 855.6 3326 - 5152
3	*Maca* (caps.). n = 4, m = 0.40 g	513.2 ± 118.4 400.0 – 642.2	205.3 ± 47.4 160.0 – 256.9	615.9 ± 142.2 480.0 – 770.7
4	*Maca 50 Plus* (caps.). n = 4, m = 0.60 g	517.4 ± 118.6 403.7 – 628.6	310.5 ± 71.2 242.2 – 377.2	621.0 ± 142.4 484.4 – 754.4
5	*Spirulina* (Walmark) (tabl.). n = 4, m = 0.65 g	2237 ± 187 2000 - 2511	2237 ± 187 2000 - 2511	11185 ± 935 10000 - 12555
6	*Spirulina Hawaian* (caps.). n = 4, m = 0.60 g	2743 ± 503 2212 - 3341	1646 ± 302 1327 - 2005	9876 ± 1812 7962 - 12030
7	*Spirulina Pacyfica* (tabl.). n = 4. m = 0.50 g	3983 ± 285 3750 - 4399	1992 ± 143 1875 - 2200	11952 ± 858 11250 - 13200
8	*Vilcacora* (caps.). n = 4, m = 0.56 g	507.5 ± 39.4 469.1 – 561.2	284.2 ± 22.1 262.7 – 314.3	1705 ± 132.6 1576 - 1886
9	*Żeń-szeń* (Herbapol Kraków) (caps.). n = 4, m = 0.30 g	1357 ± 128 1217 - 1473	407.1 ± 38.3 365.1 – 441.9	1628 ± 153.2 1460 - 1768
10	*Żeń-szeń Ginseng* (KRKA) (caps.). n = 4, m = 0.46 g	1321 ± 151 1190 - 1536	607.5 ± 69.4 547.4 – 706.6	607.5 ± 69.4 547.4 – 706.6
11	*Żeń-szeń Ginseng* (Naturell) (tabl.). n = 4, m = 0.40 g	1590 ± 271 1189 - 1768	636.1 ± 108.4 475.6 – 707.2	1272 ± 216.8 951.2 - 1414
12	*Żeń-szeń koreański* (Walmark) (caps.). n = 4, m = 0.50 g	3748 ± 660 3142 - 4931	1874 ± 330 1571 - 2466	1874 ± 330 1571 - 2466
13	*Żeń-szeń - vita-complex* (Olimp) (caps.). n = 4, m = 0.78 g	4044 ± 582 3473 - 5004	3154 ± 454 2709 - 3903	3154 ± 454 2709 - 3903

n *) number of examined series of production. m *) mean mass of capsule or tablet

Table 5. Calcium and magnesium content in supplements of diet supporting the immune system of the human organism. $\mu g \cdot ml^{-1}$; intake of calcium and magnesium with maximal daily dose (μg)

No	Preparation	Calcium (Ca) content ($\mu g \cdot ml^{-1}$)	Intake of calcium with maximal of daily dose (μg of Ca)	Magnesium (Mg) content ($\mu g \cdot ml^{-1}$)	Intake of magnesium with maximal daily dose (μg of Mg)
		Arithmetic mean (M). standard deviation (SD) and content (min.–max.)			
1	*Aloe vera – aloe juice.* n*) = 4, v*) = 50 ml	43.10 ± 3.07 40.50 – 46.50	2155 ± 153 2055 - 2325	30.73 ± 3.96 25.15 – 33.48	1537 ± 198 1258 - 1680
2	*Aloes - aloe juice with pulp pieces* –gel. n = 4, v= 50 ml	250.9 ± 17.7 240.0 – 282.0	12546 ± 883 12000 - 14100	69.83 ± 6.19 58.79 – 73.22	3492 ± 309 2940 - 3661
3	*Aloes Activ – aloe juice with extract of ginseng.* n = 4, v = 50 ml	1.36 ± 0.41 0.98 – 1.72	68.0 ± 20.5 49.0 – 86.0	2.27 ± 0.38 1.89 – 2.80	113.3 ±19.2 94.5 – 140.0
4	*Aloes Young – aloe juice with cranberry.* n = 4, v = 60 ml	6.11 ± 1.07 5.03 – 7.46	367 ± 64.1 301.8 – 447.6	7.56 ± 0.60 6.68 – 8.04	453.5 ± 36.1 400.8 – 482.4
5	*Bodymax Tonik*. n = 4, v = 50 ml	4.71 ± 1.21 3.54 – 5.89	235.5 ± 60.6 177.0 – 294.5	8.85 ± 0.79 7.78 – 9.56	442.3 ± 39.4 389.0 – 478.0
6	*Ginsenging 400 - extract of ginseng with honey*. n = 3, v = 10 ml	6.40 ± 1.18 5.38 – 8.08	49.0 ± 33.1 53.8 – 80.8	8.31 ± 1.37 7.06 – 10.26	83.1 ± 13.7 70.6 – 102.6
7	*Ginsenol*. n = 2, v = 5 ml	0.81 ± 0.11 0.71 – 0.94	4.0 ± 0.6 3.6 – 4.7	43.22 ± 2.30 40.50 – 45.20	216.1 ± 11.49 202.5 – 226.0
8	*Noni - juice of noni fruits*. n = 5, v = 40 ml	16.00 ± 3.94 13.54 – 22.91	640.2 ± 157.5 541.6 – 910.4	105.8 ± 12.1 90.3 – 124.1	4232 ± 481.8 3612 - 4964
9	Noni-vita - juice of noni fruits. n=4, v = 40 ml	96.70 ± 9.35 84.87 – 107.2	3868 ± 374 3395 - 4388	155.8 ± 20.4 141.1 – 185.8	6231 ± 816.6 5676 - 7432
10	*Noni Plus - juice of noni and cranberry fruits*. n = 3, v = 40 ml	6.67 ± 0.90 5.94 – 7.85	266.7 ± 35.9 237.6 – 314.0	68.80 ± 3.78 63.89 – 72.65	2752 ± 151.3 2556 - 2906

n *) number of examined series of production; v*) maximal of daily dose of supplement. ml

In the studies conducted earlier on dietary supplements without the planned addition of mineral compounds it was stated that the mentioned macroelements also appeared in every kind of these preparations, only in different amounts [1, 2]. In the study [1], in which the level of calcium and magnesium in dietary supplements supplementing slimming was studied, the content of these elements ranged as follows: – for calcium from 2.69 ± 0.26 $\mu g \cdot g^{-1}$ (*Zielona herbata – Green tea* – extract) up to 39612 ± 1136 $\mu g \cdot g^{-1}$ (*Aplefit*), and for magnesium – from 44.58 ± 7.85 $\mu g \cdot g^{-1}$ (*Adipobon mono)* to 1233 ± 64 $\mu g \cdot g^{-1}$ *(Chitobon*), on average. In preparations containing antioxidants [2] calcium contents ranged in the scope of , on average, from 6.98 ± 125 $\mu g \cdot g^{-1}$ (*Aronia z luteiną*) to 2137 ± 166 $\mu g \cdot g^{-1}$ (*Vision Maxi*) and to 5299 ± 951 $\mu g \cdot g^{-1}$ in preparation of *Czosnek z pietruszką*. The preparation containing

the smallest amounts of magnesium was: *Aronia z luteiną*, on average 3.34 ± 0.50 $\mu g \cdot g^{-1}$ however, the bulk of this element was determined in *Czosnek z pietruszką* supplement: on average – 2997.8 ± 439 $\mu g \cdot g^{-1}$. Leśniewicz et al. [9] in different healing preparations studied also determined, apart from microelements, calcium content and magnesium. Amounts of calcium were in the range from 3740 $\mu g \cdot g^{-1}$ *(Alax*) to 11320 µg of calcium in 1 g of *Tonic tablets*. The content of magnesium were in the range from 1130 $\mu g \cdot g^{-1}$ (*Urogram)* to 5170 $\mu g \cdot g^{-1}$ (*Alax*). Calcium and magnesium levels were also determined in multivitamin preparations by Krejčová et al. [8] of the Czech Republic. The amounts were also in wide ranges: Ca – from 31.3 mg/tabl. to 136 mg/tabl. and Mg – from 10.5 mg/tabl. to 76.8 mg/tablet. Results of the analysis of these elements using ICP-OES after microwave digestion and ICP-OES slurry technique were compared with the amount declared by the producer.

CONCLUSIONS

Calcium and magnesium levels in the studied dietary supplements were diversified – they depended on pharmaceutical form of preparation and composition.

Indicated quantities of the studied macroelements can fill up the daily demand of the organism for calcium and magnesium in the course of the application.

It was stated that the average intake of calcium with the maximum twenty-four hour dose as for the studied capsules and tablets could be for adults from about 4.7% AI*) to 6% AI (*Cat's Claw*), and from liquid supplements – about 1% AI (*Aloe* gel), taking magnesium – from 2.9% RDA (men) to 3.8% RDA**) (women) with the maximum twenty-four hour dose of *Spirulina Pacyfic* preparation and from 1.4% RDA to 1.9% RDA from *Noni-vita*.

AI*) – (Adequate Intake) – level of sufficient consumption

RDA** – (Recommended Dietary Allowances) – recommended consumption

REFERENCES

1. Błoniarz J., Zaręba S., Rahnama M.: The levels of calcium and magnesium In dietary supplements. W: red. K. Pasternak Pierwiastki, środowisko i życie człowieka, Wydawnictwo „System-Graf", Lublin 2009.
2. Błoniarz J., Zaręba S., Rahnama M.: The study of calcium and magnesium levels in dietary supplements containing antioxidants available in the Polish market. Annales UMCS, sect. DDD, 22, 171, 2009.
3. Dybczyński R. et al.: Preparation and Certification of the Polish Reference Material „Mixed Polish Herbs" (INST-MPH-2) for inorganic Trace Analysis, Raporty IChTJ, Seria A nr 4/2002, Institute of Nuclear Chemistry and Technology, Warszawa 2002.
4. Elless M.P. et al.: Plants as a natural source of concentrated mineral nutritional supplements. Food Chem., 71, 181, 2000.
5. Gonzales G.F., Valerio L.G.: Medical plants from Peru: A review of plants as potential agents against cancer. Anti-Cancer Med. Chem., 6, 429, 2006.
6. Jarosz M., Bułhak – Jachymczyk B.: Normy żywienia człowieka. PZWL, Warszawa 2008.
7. Kim M.-H. et al.: Immunomodulatory activity of *Ginsan*, a polysaccharide of *Panax ginseng*, on dendritic cells. Korean J. Physiol. Pharmacol., 13, 169, 2009.

8. Krejčová A. et al.: Determination of macro and trace element in multivitamins preparations by inductively coupled plasma optical emission spectrometry with slurry sample introduction. Food Chem., 98, 171, 2006.
9. Leśniewicz A., Jaworska K., Żyrnicki W.: Macro- and micro-nutrients and their bioavailability in polish herbal medicaments. Food Chem., 2006, 99, 670-679.
10. Moyad M.A.: The potential benefits of dietary and/or supplemental calcium and vitamin D. Urologic Oncology, 21, 384, 2003.
11. Park J.D., Rhee D.K., Lee Y.H.: Biological activities and chemistry of saponins from *Panax ginseng* C.A. Meyer. Phytochem. Rev., 4, 159, 2005.
12. Pietruszka B., Brzozowska A.: Witamin and mineral supplement use among adults in central and eastern Poland. Nutr. Res., 1999, 19, 817-823.
13. Pinta M.: Absorpcyjna spektrometria atomowa. Zastosowanie w analizie chemicznej. PWN, Warszawa 1977.
14. Power M. L. et al.: The role of calcium in health and disease. Am. J. Obstet. Gynecol., 181, 1560, 1999.
15. Reiss R.I.N. et al.: Immunomodulating and antiviral activities of *Uncaria tomentosa* on human monocytes infected with dengue virus-2. *International Immunopharmacology*, 8, 468, 2008.
16. Swaminathan R.: Magnesium metabolizm and its disorders. Clin. Biochem.Rev., 24, 47, 2003.
17. Vormann J.: Magnesium: nutrition and metabolizm. Molecular Aspect Med., 24, 27, 2003.
18. Ziemlański Ś.: Normy żywienia człowieka. Fizjologiczne podstawy. PZWL, Warszawa 2001.

SUMMARY

Dietary supplements enjoy great popularity among consumers in Poland it is possible to apply them prophylactically or as supplements in therapy of different disease entities. Preparations taken with an aim of increasing the body's resistance constitute an important group of supplements. Plant raw materials included in the studied supplements contain active substances which biologically reveal general strengthening action, restore physical fitness and intellectually stimulate the organism and improve properties of the immunological system. Powdered herbalist's raw materials composing these preparations can frequently abound in significant amounts of mineral substances. Due to the scarcity of academic publications connected with mineral composition of this type of preparations and their frequent application, examining calcium content and of magnesium (of the micronutrients important for the human body) appeared to be substantiated. The subject of the research were the supplements in the form of capsules and tablets (*Acerola Plus, Cat's Claw, Maca, Maca 50 Plus, Spirulina, Spirulina Hawajska, Spirulina Pacifica, Vilcacora, Żeń-szeń* from „Herbapol" Herbal Plant in Krakow, *Żeń-szeń – Ginseng* <KRKA>, *Żeń-szeń* <Naturell>, *Żeń-szeń koreański* <Walmark>, *Żeń-szeń* vita-complex) and fluid preparations (*Aloes–aloe juice*;, *Aloe vera drinking gel*, *Aloes–aloe juice with pulp pieces*, *Aloes Activ, Aloes Young, Bodymax Tonik, Ginsengin 400, Ginsenol, Noni, Noni-vita*, *Noni Plus*). Samples of supplements were mineralized "dry" at the temperature of 450˚C. Calcium and magnesium contents were determined in the atomic absorption spectrometer SOLAAR M 5 (Thermo Elemental).The smallest levels of calcium and magnesium were noted in the l iquid preparations: of calcium from 0.81 $\mu g \cdot ml^{-1}$ (*Ginsenol*) and 1.36 $\mu g \cdot ml^{-1}$ (*Activ Aloe*) to 250.9 $\mu g \cdot ml^{-1}$ (*Aloe Vera drinking gel*) and of magnesium from 2.27 $\mu g \cdot ml^{-1}$ (*Aloe Activ)* to 153.7 $\mu g \cdot ml^{-1}$ (*Noni-vita*). In supplements in the form of capsules and tablets, calcium content ranged from 45.92 $\mu g \cdot g^{-1}$ (*Acerola*

Plus) to over 20 000 $\mu g \cdot g^{-1}$ (*Maca, Maca 50 Plus*) and of magnesium from 513 $\mu g \cdot g^{-1}$ (*Maca 50 Plus*) and 517 $\mu g \cdot g^{-1}$ (*Maca*) to 4043 $\mu g \cdot g^{-1}$ (*Żeń-szeń* vita-complex). Calcium and magnesium contents in the studied dietary supplements were diversified depending on the pharmaceutical form of the preparation and the composition. The stated quantities of mentioned macroelements can fill up the daily demand of the organism for calcium and magnesium in the course of their application.

Keywords: dietary supplements, calcium, magnesium, flame atomic absorption spectrometer (FAAS)

STRESZCZENIE

Suplementy diety cieszą się dużą popularnością wśród konsumentów w Polsce, można je stosować profilaktycznie lub pomocniczo w terapii różnych jednostek chorobowych. Ważną grupę suplementów stanowią preparaty stosowane w celu zwiększenia odporności organizmu. Surowce roślinne zawarte w badanych suplementach zawierają substancje czynne biologicznie, wykazujące działanie ogólnie wzmacniające, przywracające sprawność fizyczną i umysłową organizmu oraz właściwości stymulujące system odpornościowy. Sproszkowane surowce zielarskie wchodzące w skład tych preparatów mogą zawierać czasami znaczne ilości substancji mineralnych. W związku z niewielką ilością publikacji naukowych związanych ze składem mineralnym tego typu preparatów i częstym ich stosowaniem przez ludzi celowe było zbadanie zawartość wapnia i magnezu (ważnych dla organizmu człowieka biopierwiastków). Przedmiotem badań były suplementy w postaci kapsułek i tabletek (*Acerola Plus, Cat's Claw, Maca, Maca 50 Plus, Spirulina, Spirulina Hawajska, Spirulina Pacifica, Vilcacora, Żeń-szeń* z Zakładu Zielarskiego „Herbapol" w Krakowie, *Żeń-szeń – Ginseng* <KRKA>, *Żeń-szeń* <Naturell>, *Żeń-szeń koreański* <Walmark>, *Żeń-szeń vita-complex*) i preparaty płynne (*Aloes–sok, Aloe vera drinking gel, Aloes–sok z miąższem, Aloes Activ, Aloes Young, Bodymax Tonik, Ginsengin 400, Ginsenol, Noni, Noni-vita, Noni Plus*). Próbki suplementów mineralizowano „na sucho" w temp. 450˚C. Zawartość wapnia i magnezu oznaczono w spektrometrze absorpcji atomowej SOLAAR M5 (Thermo Elemental). Najmniejszą ilość wapnia i magnezu zawierały preparaty płynne: wapnia od 0.81 $\mu g \cdot ml^{-1}$ (*Ginsenol*) i 1,36 $\mu g \cdot ml^{-1}$ (*Aloes Activ*) do 250,9 $\mu g \cdot ml^{-1}$ (*Aloe vera drinking gel*) i magnezu od 2,27 $\mu g \cdot ml^{-1}$ (*Aloes Activ*) do 153,7 $\mu g \cdot ml^{-1}$ (*Noni-vita*). W suplementach w postaci kapsułek i tabletek stwierdzono zawartość wapnia od 45,92 $\mu g \cdot g^{-1}$ (*Acerola Plus*) do ponad 20 000 $\mu g \cdot g^{-1}$ (*Maca, Maca 50 Plus*) i magnezu od 513 $\mu g \cdot g^{-1}$ (*Maca 50 Plus*) i 517 $\mu g \cdot g^{-1}$ (*Maca*) do 4043 $\mu g \cdot g^{-1}$ (*Żeń-szeń vita-complex*). Zawartości wapnia i magnezu w badanych suplementach diety były zróżnicowane, zależały od postaci farmaceutycznej preparatu oraz składu. Stwierdzone ilości wymienionych makroelementów mogą uzupełniać dzienne zapotrzebowanie organizmu w wapń i magnez w czasie ich stosowania.

Słowa kluczowe: suplementy diety, wapń, magnez, płomieniowa absorpcyjna spektrometria atomowa (FASA)