Abstracts of Posters

MAGNESIUM CONCENTRATION TRENDS IN POTATO TUBERS DURING THE GROWING SEASON

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Potato became in the last 50 years one of the most important table food crop grown worldwide. It is considered mainly as a source of energy. At the same time, the food currently produced contains less and less minerals, including magnesium. [1] The aim of the conducted research was to determine the trends of magnesium concentration in fractions of potato tubers during the growth period. The presented study based on data obtained from field trials with potato (*Solanum tuberosum* L.), which were carried out in 2007–2008 in the Brody Experimental Farm (52°44'N; 16°28'E). With respect to precipitation in June and July, 2007 can be treated as wet (152 mm) and the second, 2008 as dry (87 mm). The fertilized groups were: absolute control (AC, no fertilizers added), NPK-MOP (K as muriate of potash), NPKMgS-Patentkali (NPK-PAT). The rates of applied nutrients were: N – 130, P – 38.7, K – 166, Mg – 39.1, S – 110.7 kg ha^{-1}. The Corona variety of potato was planted in the second half of April and harvested in the end of September over an area of 19.5 m^2. Tubers were sampled in 10-day intervals since the beginning of the tuber growth (three bushes) and divided into three fractions: small (S, < 2,5 cm), medium (M, 2,5–5,5 cm), large (L, > 5,5 cm). The harvested plant sample was dried at 65°C and then mineralized at 600°C. Magnesium concentration was determined by AAS-flame type.

The tuber yield on the AC plot ranged from 27.8 in 2008 to 40.1 t ha^{-1} in 2007. It indicates a high natural productivity of soil under potato. The impact of tested fertilizing treatments depended on the course of weather, in particular, years of study. In 2007, plants fertilized with NPK-MOP or NPK-PAT produced 63 t ha^{-1} of tubers. In 2008, the yield was, on average, 20 t ha^{-1} lower. The type of weather significantly affected the pattern of the tuber yield increase, especially on the AC plot. On the fertilized plots, the yield pattern followed the linear model.

The Mg concentration in potato tubers during the growing season was significantly dependent on its fraction and the applied fertilizers. Irrespectively of the growing season and fertilizing treatment, the Mg_{max} concentration was the attribute of the smallest tubers. In 2007, it was achieved in 129 DAP, but 23 days later in 2008. The respective Mg_{max} concentration was 0.66 and 0.62 g kg^{-1}. For tuber fertilized with NPK-PAT the Mg_{max} was achieved in 147 DAP in 2007, and 3 days later in 2008. The respective Mg concentration was 0.84 and 0.79 g kg^{-1}. For the medium size tubers almost the same trends in Mg concentration were recorded. In 2007, tubers reached the Mg_{max} at the same time, i.e. 122 DAP. The Mg_{max} was 0.58 and 0.7 g kg^{-1} for the AC and NPK-PAT, respectively. In 2008, the optimum DAP for the Mg_{max} of 0.48 and 0.55 for the AC, and NPK-PAT, was achieved in 109 DAP. The pattern of Mg concentration was different for large-size tubers. In both years, it followed the quadrate model for the AC plot (2007 – 137 DAP; 0.49 g kg^{-1} Mg; 2008 – 142; 0.31 g kg^{-1} Mg), and linear for the NPK-PAT.

One of the most interesting characteristics of potato tubers is the relationship between the yield and nutrient concentration. [2] The Mg concentration, shown in Fig. 1, significantly depended on the tuber fraction and the total yield. Its increase for the small tubers was recorded up to the yield of 43 t ha^{-1}, but for the medium ones up to 41.7 t ha^{-1}. In the dry 2008, the same trend was observed, but the Mg concentration increase was recorded for the yield

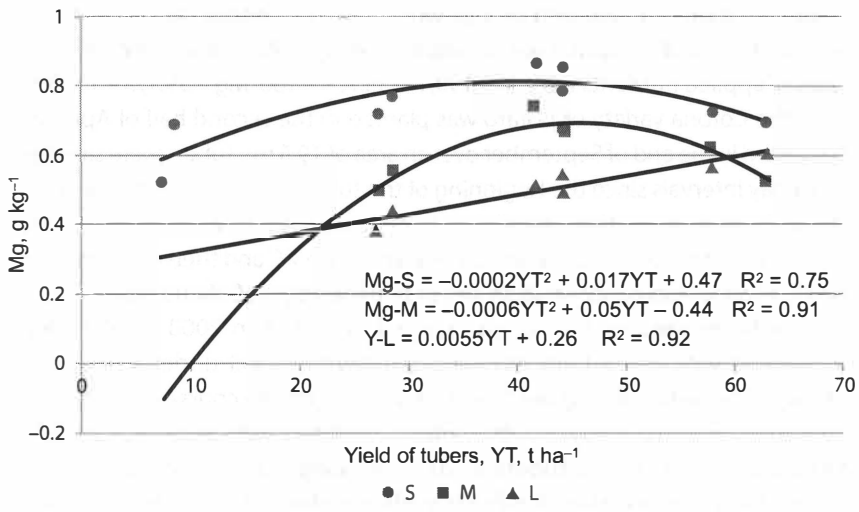

Fig. 1. Magnesium concentration in potato tuber fraction as a function of the tuber yield.

of 29.5 and 24.2 t ha^{-1} for small and medium tuber fractions, respectively. The concentration of Mg in the large tubers was, on average, the smallest, but it showed a progressive increase over the yield.

[1] W. Grzebisz, *W. J. Elem.*, **2011**, *16(2)*, 299–323.
[2] P.J. White, J.E. Bradshaw, M. Finlay, B. Dale, G. Ramsay, J.P. Hammond, M.R. Broadley, *HortScience*, **2009**, *44*, 6–11.

EFFECT OF SOIL AMENDMENTS ON CONTENT OF MACROELEMENTS IN GRAIN OF OAT ON SOIL CONTAMINATED WITH COBALT

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Cobalt is one of the metals composing the Earth's crust. Beyond the borders of our country, there are sites where the content of this metal in soil significantly exceeds its permissible levels. It is therefore essential to search for optimal methods to limit cobalt uptake by plants, for example through application of different substances to soil and by using phytoremediation abilities of plants. [1]

Considering the above, a study was undertaken with the purpose to determine the effect of various substances (manure, clay, charcoal, zeolite and calcium oxide) on limiting the influence of high cobalt doses on the content of macroelements in grain of oat.

The research was based on a pot experiment conducted in a greenhouse at the University of Warmia and Mazury in Olsztyn (north-eastern Poland). Polyethylene pots, each holding 9 kg of soil, were used to set up the trials. The soil was polluted with increasing doses of cobalt: 0, 20, 40, 80, 160, 320 mg kg^{-1} of soil (cobalt chloride) and mixed with substances such as: granulated bovine manure, clay, charcoal, zeolite (in an amount equal 2% of soil mass per pot) and calcium oxide (in a dose corresponding to 1 hydrolytic acidity). Oat was harvested after 78 days, at full ripeness stage.

The doses of cobalt applied in this experiment, as well as soil amendments such as manure, clay, charcoal, zeolite and calcium oxide had a significant effect on the content of the analysed macronutrients in grain of oat. In the series without neutralising substances, the soil contamination with cobalt caused an increase in the content of nitrogen, phosphorus, sodium, calcium and, partly, potassium, in grain of oat. Among the neutralising substances tested, the most

unambiguous effect was produced by manure, which raised the content of all macronutrients (except calcium and magnesium) in oat grain. The influence of the other substances on the content of macronutrients in oat grain was less equivocal. However, all of them, especially calcium oxide, tended to induce a decrease in the content of most macronutrients in grain of oat.

[1] W. Pszczółkowski, Z. Romanowska-Duda, A. Pszczółkowska, M. Grzesik, Z. Wysokińska, *Comp. Econ. Res.*, **2012**, *15(3)*, 37–55.

SODIUM AND CHLORINE CONTENT IN THE MAIN AND BY-PRODUCT YIELD OF THE SPRING FORMS OF RAPE AND WHEAT DEPENDING ON THE FERTILIZATION WITH SULFUR, MAGNESIUM AND DIFFERENTIATED RATIO OF N:P:K

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Due to the fact that sodium and chlorine may be elements limiting normal plant growth, and in excess they may be toxic, it is important to monitor their content in soil and to assess the effect of other minerals on their uptake and accumulation in plants.

The aim of the study was the assess the effect of sulfur and magnesium fertilization on the content of chlorine and sodium in seeds, grains and straw of spring oilseed rape (L.) cv. Mozart and spring wheat (L.) cv. Opatka. The experiment was based on a complete randomisation method and included three variable factors (sulfur dose, magnesium dose and N:P:K ratio) applied on three levels. The soil was characterized by a slightly acid reaction and an average content of phosphorus, potassium and magnesium.

Analysis of the obtained results shows that the content of sodium in spring rape seeds fluctuated in the range from 0.165 to 0.235 g kg^{-1} d.m., in straw from 0.521 to 1.411 g kg^{-1} d.m. In spring wheat these contents were lower and shaped on the level 0.023–0.052 g kg^{-1} d.m. (grain) and 0.160–1.216 g kg^{-1} d.m. (straw). In the case of chlorine, the content for rape was fluctuated in the range from 2.500 to 4.606 g kg^{-1} d.m. (seeds) and 4.474–29.807 g kg^{-1} d.m. (straw). In spring wheat these contents were ranged in grain from 1.461 to 1.823 g kg^{-1} d.m. and in straw 5.662–1.802 g kg^{-1} d.m. The test results clearly indicate that the applied experimental factors visibly affected the sodium and chlorine content in the test plants. In the straw of both rape and wheat, the highest levels were found in plants fertilized with the highest dose of sulfur.

An analogous situation was recorded in the grain of spring wheat. In the straw of spring rape, the addition of sulfur to the environment was associated with a decrease in the chlorine content. Similarly, in wheat, higher contents of the analyzed element were recorded in objects S1 in relation to S2. In our own research, both fertilization with magnesium and the narrowing of the N:P:K ratio resulted in a change in the content of both analyzed elements, however, this impact was not clearly targeted.

THE EFFECT OF MEAT AND BONE MEAL AND NITROGEN FERTILIZER ON THE MACRONUTRIENT CONTENT OF MAIZE GROWN FOR SILAGE

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Maize (*Zea mays* L.) is the highest-yielding and most promising crop grown in Poland for grain and silage. The nutritional value of maize silage is determined by climate and soil conditions, fertilization, plant maturity and dry matter (DM) content. [1, 2] A viable alternative to mineral nitrogen-phosphorus (NP) fertilizers could be meat and bone meal (MBM) rich in nitrogen (approx. 8%), phosphorus (approx. 5%), calcium (approx. 10%) and organic matter (approx. 70%). [3] Our previous research has shown that nitrogen doses supplied by MBM do not fully meet the nutrient requirements of maize. Therefore, the aim of this field experiment was to determine the effect of increasing doses of MBM, applied alone or in combination with nitrogen fertilizer, on the yield and macronutrient content of maize cv. Pionieer P8488 grown for silage.

The experiment was conducted in the Agricultural Experiment Station in Tomaszkowo (University of Warmia and Mazury in Olsztyn) on brown soil developed from loamy sand. The experiment had a randomized block design with four replications and seven treatments: 1) 0 (without fertilization), 2) NPK (control), 3) 1.0 t ha^{-1} MBM+K, 4) 1.0 t ha^{-1} MBM+K+N, 5) 1.5 t ha^{-1} MBM+K, 6) 1.5 t ha^{-1} MBM+K+N, 7) 2.0 t ha^{-1} MBM+K. MBM was applied alone or in combination with mineral nitrogen at a maximum total rate of 158 kg N ha^{-1}. The effect of MBM was compared with that of mineral fertilization (NPK): N – $158_{(58+50+50)}$, P – 40 and K – 145 kg ha^{-1}. Since MBM had low potassium content, potassium was supplied by mineral fertilizers in each treatment with MBM, at the rate corresponding to potassium fertilizer levels in the control (NPK) treatment. Maize was harvested in the milk-dough stage and green herbage yield was converted

to 30% DM. Mineralized plant samples were assayed for the content of total nitrogen – with the sodium hypochlorite reagent, phosphorus – by the vanadium-molybdenum method, magnesium – by atomic absorption spectrometry (AAS), calcium and potassium – by atomic emission spectroscopy (AES). The results were processed statistically by analysis of variance (ANOVA) using STATISTICA 12 software. The significance of differences between mean values was estimated by Duncan's test at a significance level of $P \geq 0.05$.

The DM content of maize herbage ranged from 315 to 370 g kg^{-1} (Table 1). In comparison with the NPK treatment, maize plants harvested in the treatment with the highest MBM dose (2.0 t ha^{-1} MBM) had a significantly higher DM content. Average green herbage yield was high (61 t ha^{-1}) and comparable in MBM and NPK treatments. Nitrogen fertilizer applied with MBM increased maize yield by 6 to 9% relative to MBM treatments without nitrogen fertilization. The highest maize yield (69.4 t ha^{-1}) was achieved when MBM was applied with mineral nitrogen (1.5 t ha^{-1} MBM+40 kg N). This indicates that, as expected, the addition of nitrogen to MBM had a yield-promoting effect. [4, 5] In comparison with the NPK treatment, maize fertilized with MBM had a similar content of N and K, and a higher content of P, Ca and Mg. The addition of nitrogen to MBM had no influence on the concentrations of the analyzed macronutrients in maize biomass.

Table 1. Green herbage yield (30% DM) and macronutrient content of maize grown for silage

Treatment	Dry matter	Yield	N	P	K	Ca	Mg
	g kg^{-1}	t ha^{-1}	g kg^{-1} DM				
0 (without fertilization)	357.7^{bc}	49.3^{a}	10.1^{a}	1.96^{ab}	9.45^{ab}	0.95^{a}	0.99^{a}
NPK (control)	334.2^{ab}	61.2^{bcd}	11.2^{ab}	2.01^{ab}	11.13^{b}	1.14^{a}	1.04^{ab}
1.0 t MBM+K	347.1^{bc}	59.4^{bc}	12.9^{b}	1.79^{a}	10.89^{b}	1.10^{a}	1.13^{bc}
1.0 t MBM+K+79 kg N	314.6^{a}	64.9^{cd}	11.2^{ab}	2.43^{c}	10.61^{b}	1.26^{ab}	1.10^{ab}
1.5 t MBM+K	323.2^{a}	65.4^{cd}	11.0^{ab}	2.10^{abc}	10.03^{b}	1.23^{ab}	1.14^{bc}
1.5 t MBM+K+40 kg N	335.9^{ab}	69.4^{d}	12.2^{ab}	2.06^{abc}	9.05^{ab}	1.26^{ab}	1.13^{bc}
2.0 t MBM+K	370.3^{c}	57.5^{b}	12.9^{b}	2.33^{bc}	7.81^{a}	1.51^{b}	1.22^{c}

a,b – $P \leq 0.05$

Maize yield and the content of the analyzed macronutrients (N, P, K, Ca and Mg) in maize biomass were slightly modified by increasing doses of MBM. Supplemental mineral nitrogen fertilizer contributed to an 8% increase in green herbage yield, but it did not induce changes in the mineral content of maize.

[1] L. Johnson, J.H. Harrison, C. Hunt, K. Shinners, C.G. Doggett, D. Sapienza, *J. Dairy Sci.*, **1999**, *82*, 2813–2825.
[2] A. Łozicki, *Probl. Inż. Roln.*, **2008**, *3*, 59–67. (in Polish)
[3] A.S. Jeng, T.K. Haraldsen, A. Grønlund, P.A. Pedersen, *Nutr. Cyc. Agroecosys.*, **2006**, *76*, 183–191.
[4] A. Nogalska, J. Czapla, Z. Nogalski, M. Skwierawska, M. Kaszuba, *Agric. Food Sci.*, **2012**, *21*, 325–331.
[5] A. Nogalska, L. Chen, S. Sienkiewicz, Z. Nogalski, *Agric. Food Sci.*, **2014**, *23(1)*, 19–27.

EVALUATION OF THE INFLUENCE OF SULFUR AND MAGNESIUM FERTILIZATION AT A DIFFERENT RATIO OF N:P:K ON THE CONTENT OF COPPER AND ZINC IN THE GRAIN AND STRAW OF SPRING FORMS OF RAPE AND WHEAT

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Uptake of heavy metals by plants depends on the form in which these metals occur in the soil as well as on the physicochemical properties of the soil. [1,2] Providing of an appropriate amount of a plant nutrient both macroelements and microelements is one of the main factors determining to obtain a satisfactory yield in terms of quantity and quality. [3]

The object of this study was to evaluate the content of copper and zinc in the yield of the main and side spring oilseed rape (L.) cv. Mozart and spring wheat (L.) cv. Opatka depending on the sulfur fertilization and magnesium with varying ratio of N:P:K. The basis of the research was a three-factorial vase experiment. The magnesium and sulfur dose and the N:P:K ratio were applied on three levels. The experiment was established on soil taken from the arable layer of brown soil with sand grain granulometric composition.

The copper and zinc content in the main and by-product yield of the crops studied varied demonstrably depending on the experimental factors and crop species. The addition of magnesium for fertilization was associated with a decrease in copper content in the straw of spring rape. In plots with sulfur fertilizer dose a decrease in copper content was noted in straw of spring rape and grain and straw of wheat. A similar relationship was observed in the spring rape straw, with the increasing amount of phosphorus and potassium in fertilization. However, in the grain and straw of spring wheat the highest copper content was recorded at the ratio N:P:K as 1:0.13:0.33. The content of zinc in the spring rape straw increased in the presence of magnesium in fertilization.

A reverse dependence was noted with the addition of sulfur to the spring rapeseed growth environment. The ratio of N:P:K as 1:0.13:0.33 was associated with the highest contents of zinc in both the grain, and wheat straw.

[1] P. Mantovi, G. Bonazzi, E. Maestri, N. Marmiroli, *Plant Soil*, **2003**, *250*, 249–257, doi: 10.1023/A:102284813104.
[2] K. Hange, O.R. Awofolu, *J. Soil Sci. Environ. Manage.* **2017**, *8(6)*, 113–121, doi: 10.5897/JSSEM2017.0630.
[3] Y. Yang, T. Ma, F. Ding, H. Ma, X. Duan, T. Gao, et al., *Environ. Sci. Pollut. Res.*, **2017**, *24*, 395–404, doi: 10.1007/s11356-016-7659-0.

CONCENTRATIONS OF MINERALS IN SELECTED SPECIES OF EDIBLE MUSHROOMS

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Wild-growing mushrooms are valued ingredients of food or special dishes in the tradition of many people around the world. Intake of wild growing edible mushroom in Poland is significant. In addition, mushrooms are able to accumulate many times higher amounts of nutritional and toxic elements than plants, therefore knowledge on their concentration levels is important for human health. The determination of minerals content in the biomass of the following edible mushrooms: *Leccinum scabrum*, *Leccinum rufum*, *Boletus edulis*, *Suillus luteus*, *Cantharellus cibarius*, *Xerocomus pruinatus*, *Boletus badius*, *Xerocomus badius* was the aim of presented paper. The mushrooms analysed were collected in the Lublin region in 2007–2017. Mushrooms were collected to paper bags and transported to the laboratory within 24 hours. The biomass of edible mushrooms was carefully purified by separation of sand and forest litter and dried in the oven at 30–40°C to constant weight and next ground in a laboratory grinder.

Eighteen elements (Ca, Cu, Co, K, Fe, Mg, Mn, Ni, Na, Sr, Zn, Cr, Al, Ba, Cd, Hg, Pb, As) were determined in eight fruiting bodies of edible wild growing mushroom species. The mushrooms examined were collected from selected places located in the Lublin province (south-eastern Poland). The efficiency of element accumulation in mushrooms was analysed by using Spectro Arcos ICP-OES.

The highest concentrations of Zn, Cu, K, Mg, Na, Fe and significantly lower concentrations of Ba, Cd, Co, Hg, Ni, Pb, As and Sr were observed.

Based on conducted investigations, it was ascertained that examined mushroom species i.e. *Leccinum scabrum*, *Leccinum rufum*, *Boletus edulis*, *Suillus luteus*, *Cantharellus cibarius*, *Xerocomus pruinatus*, *Boletus badius*, *Xerocomus badius* from selected regions of Lublin are safe for consumers' health, since the mean levels of analysed toxic metals did not exceed the acceptable for these elements limits in Poland as well as in European Union.

YIELD AND MINERAL COMPOSITION OF JERUSALEM ARTICHOKE TUBERS (*HELIANTHUS TUBEROSUS* L.) DEPENDING ON THE DOSE OF NITROGEN

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Jerusalem artichoke (*Helianthus tuberosus* L.) comes from North America; it was brought to Europe by Christopher Columbus. It was one of the first sources of food for humans and animals. [1] Originally, the plant was cultivated by Native Americans of the tribe Topinamboure. It has been cultivated in Poland since 1730. [2] The tubers of Jerusalem artichoke typically comprise of around 80% water, 15% carbohydrate (mainly inulin), and 1–2% protein. They contain various minerals, they are especially rich in iron (4 to 37 mg kg^{-1}), calcium (0.14 to 0.37 g kg^{-1}) and potassium (4.20–6.57 g kg^{-1}). [3] High content of inulin makes the tubers tolerate low temperatures and can overwinter in the soil in our climatic conditions.

The aim of the research is to determine the effect of the level of nitrogen fertilization on the yield and content of macroelements in Jerusalem artichoke tubers.

Field experiments were carried out in the Didactic and Experimental Department of the University of Warmia and Mazury in Tomaszkowo near Olsztyn on the specific brown soil, made of clayey sand (class IVb, rye good complex). Three cultivars of topinambour were grown (Albik, Rubik - Polish cultivars and Gute Gelbe – German cultivar, preferred by German organic farms). The pre-sowing plant was used 26.2 kg P and 66.7 kg K ha^{-1}. The study included 3 levels of nitrogen fertilization: 0, 80 and 120 kg N ha^{-1}. Jerusalem

artichoke tubers were planted in the third decade of April and collected in two dates: autumn (beginning of November) and after overwintering in the soil (mid-March).

The tuber crop yield from autumn harvest ranged from 19.10 t ha^{-1} (Albik cv.) to 23.20 t ha^{-1} (Gute Gelbe cv.). In contrast, the yield of tubers harvested in early spring, depending on the variety, was 7.5 to 12.9% higher. The highest yield was achieved with Jerusalem artichoke fertilized with 80 kg N ha^{-1}.

The content of macronutrients in Jerusalem artichoke tubers, depending on the level of nitrogen fertilization, variety and date of harvest, was: N – 10.0–14.5; P – 5.5–7.5; K – 22.3–32.8; Na – 0.3–0.5; Ca – 2.1–2.8 and Mg – 0.5–0.7 g kg^{-1} d.m. The level of N fertilization only slightly modified the content of macroelements in tubers. Increasing the level of N fertilization resulted in a higher content of nitrogen and potassium in tubers. The content of other ingredients was more dependent on the properties of the variety. Jerusalem artichoke tubers wintering in the soil were richer in macronutrients (except Na) than those harvested in late autumn.

[1] M.B. Chekroum, J. Amzile, A. Mokhtari, N.E. El Haloui, J. Prevost, R. Fontanillas, *New Zealand J. Crop Hort. Sci.*, **1996**, *24*, 115–20.
[2] S. Góral, *Hod. Rośl. Nasien.*, **1998**, *2*, 6–11.
[3] L. Kocsis, P. Liebhard, W. Praznik, *Pflanzenbauwissenschaften*, **2008**, *12(1)*, 8–21.
[4] Z. Izsáki, G.N. Kádi, *Am. J. Plant Sci.*, **2013**, *4*, 1629–1640.

CONTENT OF MINERAL ELEMENTS IN THE MILK OF LOCAL BREEDS OF COWS

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Milk and dairy products are an important source of dietary minerals in many European countries, accounting for 10–20% of daily dietary intake. [1] The milk nutritional value, including the content of minerals, depends on many factors, i.a. the cattle breed and animal nutrition system, which is clearly differentiated on traditional and intensive farms.

The aim of the study was to assess the content of mineral elements in the milk of cows locally maintained on low-input farms, using a traditional cow feeding system basing on the pastures.

Research material consisted of 210 samples of milk taken from Polish Red (n = 76), White-backed (n = 62) and Simmental (n = 72) cows. Samples were taken individually from each cow from May to August, when the basis for feeding was pasture forage. Samples taken from the cows with udder inflammation were eliminated. The concentration of macro- and microelements in the milk samples was determined by atomic absorption spectrometry. Potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), iron (Fe) and zinc (Zn) were determined using a Varian AA240FS Fast Sequential Atomic Absorption Spectrometer with an air-acetylene flame atomizer. Manganese (Mn) and iron (Fe) concentrations were determined using a Varian AA240Z spectrometer. Mineralization was performed under increased pressure in a CEM MARS 5 Xpress microwave digester (CEM Corporation, Matthews, NC, USA). Statistica ver. 13 by StatSoft, Inc. [2016] was used for the statistical elaboration of the results obtained.

The effect of cattle breed on potassium and calcium contents has not been demonstrated. Significantly ($p \leq 0.05$) less sodium (by 85.5 mg/L) and magnesium (by 14 mg/L) contained milk from Simmental cows. However, the milk of White-backed cows was the poorest source of iron (0.34 mg/L), with the highest content of manganese (0.05 mg/L, $p \leq 0.05$).

Litwińczuk et al. [2], analyzing the effect of breed of cows (Simmental, White-backed and Polish Red) kept in the traditional system on the content of macroelements in milk, reported the highest concentrations of Ca, Fe and Zn in milk of Simmental cows (1131.93 mg/L, 0.35 mg/L and 6.01 mg/L, respectively). Results of research conducted also by Litwińczuk et al. [3] confirm that the content of mineral elements in milk depends, among others, on the production system. Authors showed that milk from the traditional system contained the highest level of minerals. The lowest concentration of Ca, Na, Mg, Zn and Fe was characteristic for milk from the organic system. However, Gabryszuk et al. [4], comparing the content of Ca and Mg in milk from cows maintained on the farms with intensive (non-grazing) and extensive (with grazing the pasture) production systems, found a significantly higher level of analysed elements in milk from intensive farms. Authors explained the differences by the use of doses of mineral-vitamin mixtures on high-production farms.

Concluding, it should be stated that milk obtained from cows fed in the traditional system (using pastures) is a valuable raw material for the production of high-nutritional dairy products. Undertaking the activities aimed at promoting products obtained from such milk will allow to provide the consumers with the products that are unique in terms of nutritional value, including content of mineral elements.

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[1] Š. Zamberlin, N. Antunac, J. Havranek, D. Samaržija, *Mljekarstvo,* **2012**, *62*, 111–125.
[2] Z. Litwińczuk, J. Barłowska, W. Chabuz, A. Brodziak, *Ann. Anim. Sci.*, **2012**, *12*, 423–432.
[3] Z. Litwińczuk, N. Koperska, W. Chabuz, M. Kędzierska-Matysek, *Med. Wet.*, **2018**, 309–313.
[4] M. Gabryszuk, T. Sakowski, E. Metera, B. Kuczyńska, E. Rembiałkowska, *Żywn.-Nauk. Technol. Ja.*, **2013**, 16–26.

INVESTIGATION OF SELENIUM SPECIATION IN ANIMAL TISSUES USING MASS SPECTROMETRY METHODS

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The aim of the project is speciation analysis of selenium in various tissue samples (serum, liver, muscle, heart) obtained from lambs fed with the diet enriched with inorganic compounds of Se(VI) and organic selenium (selenium yeast). In the course of the study, it was examined how the presence of inorganic and organic forms of selenium in the lambs' forage affects the expression of selenium-containing compounds in lambs tissues.

The first part of the work includes optimization of the extraction process of selenium compounds from tissues. Next, speciation analysis of selenium in extracts from lamb samples were performed with the use of hyphenated high-performance liquid chromatography and inductively coupled plasma mass spectrometry (HPLC-ICP-MS) method. Matching the retention times of sample compounds with standards allowed the preliminary identification of selenium-containing compounds. Verification of identified selenocompounds and identification of new selenocompounds was achieved using triple-quadrupole mass spectrometer coupled to high-performance liquid chromatography (HPLC-ESI-MS/MS). This allowed for quantitative analysis of selenomethionine and selenomethyloselenocysteine in biological tissues.

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[1] M. Czauderna, M. Białek, K. A. Krajewska, A. Ruszczyńska, E. Bulska, *J. Anim. Feed Sci.*, **2017**, *26*, 192–203.

MASS SPECTROMETRY FOR ELEMENTAL ANALYSIS OF ATHEROSCLEROTIC PLAQUE

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According to statistical reports, vascular diseases remain the first cause of death in Poland, responsible for nearly 46% of deceases. [1] Atherosclerosis is the main factor associated with that kind of decease. [2] The essence of the illness is narrowing the lumen of an artery due to the build-up of plaque. Atherosclerotic plaque is composed of glycolipoprotein part and inorganic part, mainly calcium compounds. [3] Chemical composition of an atherosclerotic plaque may depend on an individual course of illness and also on a plaque location.

The aim of a study was an analytical comparison of chemical composition of plaques obtained from different patients and different vessels. Total content of elements was quantified by using inductively coupled plasma mass spectrometry (ICP-MS). Elemental distribution maps were obtained by using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Moreover, results obtained for the sample taken directly from the patient were compared with those for lyophilized plaque, taking into consideration advantages and drawbacks of different methods of preparing material for the analysis.

By using ICP-MS, the total content of elements in mineralized samples was firstly estimated by using screening method and then quantified by using standard solution and certified reference materials. Elements such as: Ca, Mg, Fe, K, Al, Mn, Ni, Cu, Co, As, Se, Ag, Cd, Zn, Sr, Ba and Pb were successfully quantified, with the greatest content of typical calcification components: Ca and Mg.

LA-ICP-MS analysis was performed, with no need of sample mineralization and with a possibility of visualizing elemental distribution on a sample surface. Inhomogeneous distribution of several elements was observed, again mainly in case of calcification (Ca, Mg, Sr, P). Moreover, the influence of sample preparation was stated, seeing that lyophilization enhances analytes concentration, but also causes the loss of several elements, such as Pb or S.

[1] Z. Strzelecki, J. Szymborski, *Zachorowalność i umieralność na choroby układu krążenia a sytuacja demograficzna Polski,* Rządowa Rada Ludnościowa, **2015**.
[2] W. Herrington, B. Lacey, P. Sherliker et al., *Circ. Res.*, **2016**, *118*, 353–46.
[3] M.J. Lara, E. Ros, M. Sierra et al., *Ultrastruct. Pathol.*, **2014**, *38*, 167–177.

INVESTIGATION OF SELENIUM-CONTANING PROTEINS IN A SELENIUM-ENRICHED PLANT BY USING SDS-PAGE-LA-ICP-MS

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Selenium is an essential trace micronutrient for human and animals. The existence of crucial selenoproteins such as glutathione peroxidase was announced in human and animals genes, but in case of higher plants it has not been confirmed yet.

The aim of this work was to evaluate SDS-PAGE coupled with LA-ICP-MS to study selenoproteins – bioactive compounds in plants' samples. The plants of chives (*Allium schoenoprasum*) were grown in soil enriched with two different media: selenite and selenate. Then, various extraction procedures were applied to collect respective soluble proteins fractions. SDS-PAGE was then applied to separate proteins in enriched-chive sample extracts. LA-ICP-MS was used for screening the presence of selenium in proteins bands in gel. In order to validate the applied procedure as well as obtained results indicating the distribution of species in Se-fortified chives samples, chromatography separation (HPLC) coupled with ICP-MS was also employed.

By using SDS-PAGE, proteins extracted from the analyzed samples were effectively separated into visible different bands in gel. However, detection of Se in proteins bands by LA-ICP-MS was unsuccessful. This failure could be explained by three hypotheses: 1) selenoprotein exists in the analyzed Se-enriched samples at level below the detection limit; 2) the used pulse width (nanosecond) of the laser ablation is not sensitive enough to detect Se cooperated in protein separated in gel; 3) the extraction method had failed to isolate selenoproteins from the samples.

EFFECTS OF EXHAUSTIVE SWIMMING ON BODY MAGNESIUM REDISTRIBUTION

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Magnesium (Mg) plays a central role in energy production, neuronal activity, cardiac excitability, neuromuscular transmission, muscular contraction, vasomotor tone, and blood pressure, all of which are significantly related to physical performance. Blood Mg levels have been shown to increase during exhaustive swimming exercise. However, Mg redistribution and transporter expression during the exercise remain to be determined.

The male Sprague-Dawley rats (n = 20, 220–250 g) were subjected to 30 min forced swimming exercise until exhaustion. After swimming, inductively coupled plasma-mass spectrometry was applicable to the determination of Mg in serum, red blood cell (RBC), quadriceps muscle, heart, kidney, liver, lung and brain. The levels of glycogen, adenosine triphosphate (ATP), hexokinase (HE), citrate synthase (CS), malondialdehyde (MDA) and superoxide dismutase (SOD) in quadriceps muscle were measured by spectrophotometry. Also, the Transient receptor potential melastatin-7 (TRPM7) channels and solute carrier family 41 member A1 (SLC41A1) gene expressions were measured by real-time PCR.

After exercise, Mg in serum, heart, kidney, liver, lung and brain were increased, while Mg in RBC and quadriceps muscle were decreased. Also, HK, CS, MDA and SOD in quadriceps muscle were increased, but glycogen and ATP in the muscle were decreased. The gene expression levels of TRPM, the Mg influx as the Mg channel, were not changed but the levels of SLC42A1, the Mg efflux as a Na^+/Mg^{2+} exchanger, were upregulated.

These results suggested that the exhaustive swimming exercise could produce Mg redistribution from quadriceps muscle to serum of the circulatory system. The decreased Mg levels in quadriceps muscle were related to the increased metabolic demands and the stimulation of Mg efflux.

THERAPEUTIC MILD HYPOTHERMIA-INDUCED Mg^{2+} HOMEOSTASIS IN HEART

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Severe deep hypothermia (4°C) is widely used in conjunction with cardioplegia to minimize neurologic and cardiac damage during cardiac surgery. However, during the subsequent rewarming and reperfusion many destructive processes result in inevitable post-ischemic myocardial injuries due to Ca^{2+} overload. Therapeutic mild hypothermia (core temperature 30–35°C) or Mg^{2+} has a protective capacity against the reperfusion injuries. Our aim was to investigate Mg^{2+} homeostasis in the heart during mild hypothermia.

Intracellular Mg^{2+} concentration ($[Mg^{2+}]i$), intracellular Na^+ concentration ($[Na^+]i$) and total Mg efflux ([Mg]e) were measured in isolated papillary muscle and perfused heart from guinea-pig by ion-selective microelectrode technique and atomic absorbance spectrophotometry.

In beating papillary muscle of the guinea pig, $[Mg^{2+}]i$ was significantly increased by hypothermia (34°C and 30°C), accompanied by an increase in $[Na^+]i$, a large positive inotropic effect, depolarization of membrane potential and prolongation of action potential duration. In addition, mild hypothermia enhanced the increase in $[Mg^{2+}]i$ induced by high extracellular Mg^{2+} concentration. The rate of [Mg]e in the perfused heart was significantly attenuated by hypothermia.

These results suggested that the therapeutic mild hypothermia could produce an increase in $[Mg^{2+}]i$ in the guinea-pig heart by stimulation of Mg^{2+} influx and attenuation of Mg^{2+} efflux.

[1] K.H. Polderman, *Crit. Care Med.*, **2009**, *37(2)*, S186–202.
[2] T. Miki, G.S. Liu, M.V. Cohen, J.M. Downey, *Basic. Res. Cardiol.*, **1998**, *93(5)*, 372–383.
[3] S.J. Kim, S.J. Lee, J.S. Kim, H.S. Kang, *Exp. Physiol.*, **2008**, *93(12)*, 1223–1232.

LUDWIG II. KING OF BÁVARIA – A MIRROR IMAGE OF MAGNESIUM DEPLETION? EXAMPLE AND REFLECTIONS ON MAGNESIUM DEPLETION IN HISTORIC PERSONALITIES

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Diseases of personalities of historic interest have been sensitive issue of various discussions. Regarding the extraordinary performances of a lot of historical persons who suffered from diseases, it is not reasonable to focus on diseases of such persons presently as stigmatizing hot topic. Magnesium deficiency has not been focused yet as diagnosis of historic personalities because it has been revealed only since middle of 20th century and is still today mostly missed.

Ludwig II (1845-1886), King of Bavaria and subject matter of any myth suffered from symptoms presented by many people under different kind of stress nowadays but had no chance of a "Magnesium-diagnose". Many of such symptoms are still now frequently categorized like Ludwig II: "it is crazy" . Misleading "framing" and "WYSIATI" ("What You See Is All There Is") are frequent and typical error producing circumstances – cognitive biases. [1]. The biography [2] reports the following of Ludwig's long term medical history: "typical symptoms of neurasthenia", "irritability, attacks of dizziness, headache, heart palpitations, exhaustion", "inability for exercise", "brooding, fitful sleep, constipation, hypochondria and depression", "rapid fatigue of arms and legs", "involuntary muscle cramps, muscle twitching". All these symptoms but especially the aggregation of symptoms make the diagnosis of "Magnesium depletion" very likely. Increasing body weight, reported alcohol consumption might as well support the plausibility of the diagnosis.
Material and methods for estimating a contemporary diagnosis in a historic person: It is a similar task as diagnosing in primary care medicine without

technical tools. Thus, we try to give estimations of probability for Magnesium depletion in this well-known historic personality comparing the association of single and aggregated symptoms with laboratory established diagnosis of Magnesium depletion from a cohort of our patients in primary care office of medicine. The thought comes to mind that also the great French humanist, Michel de Montaigne (1533-1592), locking back 426 years after his death evaluating his complains described in his book "Italian voyage" [3] might have also suffered from chronic Mg depletion.

More present case reports of Neil Armstrong, first man on the moon (Apollo 11, 20. July 1969) and James Irwin (Apollo 15) described by Rowe [3] based on NASA medical reports interpret the Lunar-Catecholamine-Syndrome as co-induced by acute Magnesium depletion. The world of history is not assessable by evidence based on medicine and statistics. So, it resembles the situation in everyday medicine of medical doctors as iatros (ιατροσ).

We recognize parallels between the classification of symptoms in historical persons like Ludwig II and "niggles" that we meet today in the history of many patients with later on established Magnesium-depletion who often recover from these "niggles" when treated with Magnesium. Till now patients suffering from not classified – today ignored – Magnesium depletion disease are stigmatized by wide parts of the public. It is time for a change! Prominent Heros of history might help us to provide understanding patients and people beyond "Descartes error" [5] of digital medicine.

[1] D. Kahnemann *Schnelles Denken Langsames Denken*, Siedler **2012**; Original: *Thinking fast and slow*, **2011**.

[2] K. Reichold, T. Endl *Die phantastische Welt des Märchenkönigs Ludwig II Biographie*, Luftschiffer **2017**.

[3] M. de Montaigne *Tagebuch der Reise nach Italien über die Schweiz und Deutschland 1580-81*, Die andere Bibliothek **2013**.

[4] W. Rowe, Int. J. Cardiol. **2017**, *231*, 42-46.

[5] A.R. Damasio, *Descartes Irrtum – Fühlen und Denken und das menschliche Gehirn*, List **1994**.