CONCENTRATION OF CALCIUM AND MAGNESIUM IN MATURE POTATO TUBERS (*Solanum tuberosum* L.)

KONCENTRÁCIA VÁPNIKA A HORČÍKA V ZRELÝCH ZEMIAKOCH (*Solanum tuberosum* L.)

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Súhrn
Bola stanovená koncentrácia vápnika a horčíka vo fyziologicky zrelých ošúpaných zemiakových hľuzách (*Solanum tuberosum* L.) vypestovaných na východnom Slovensku. Priemerná koncentrácia vápnika bola 25,7 mg.kg^{-1} a horčíka 234,1 mg.kg^{-1} zrelých, čerstvo ošúpaných zemiakov. V jednotlivých analyzovaných vzorkách bola pozorovaná veľká rôznorodosť hladín Ca a Mg. Zemiaky v priemere obsahujú asi 9 krát viac horčíka ako vápnika.
Kľúčové slová: zemiaky, *Solanum tuberosum* L., vápnik, horčík, plameňová AAS

INTRODUCTION

Potatoes are a traditional food a they have an important role in the nutrition of the Slovak people.The production of potatoes have some tradition long ago, in the Slovakia. One of the richest sources of some elements in the human diet is potato tubers (*Solanum tuberosum* L.). The quality and the chemical composition of potatoes are influenced by many factors, such as: the production area, cultivars, soil and climate, agricultural practice, storage and commercialization conditions (Burton, van Es, & Hartmans, 1992, Storey & Davies, 1992 published in Ricardo Casañas Rivero et al., 2003). It is recognized that the mineral and trace metal composition of fruits and vegetables are distored reflections of the trace mineral composition of the soil and environment in which the plants grow. Therefore, they can be used to distinguish the geographic origin of potatoes (Anderson et al., 1999). But heterogeneity of results require complicated matematical and statistical analysis such as: t–test, ANOVA–test, cluster analysis etc. (Ricardo Casañas Rivero et al., 2003, Peňa et al. 2001). The alkaline earth metal Ca and Mg have important role in health an quality of harvested potatoes. It is now widely accepted that calcium deficiency is linked to potato tuber disorders such as Brown Center (BC), Internal Brown Spot (IBS) or Internal heat necrosis (IHN) and improved tuber health is expected through increased Ca availability (Arvin et al., 2005, Sterrett et al., 2006). Calcium plays important roles in plants including maintenance of stability and wall structure and influenced tuberization *in vitro* (Marschner, 1995; Palta, 1996; Arvin et al., 2005).Magnesium has unique roles in plant physiology, including a key role as the central atom in the chlorophyll molecule. Consequently magnesium affects plant chlorophyll content and the production and use of carbohydrates. Mg is also important in the activity of a large number of enzyme systems that are particularly important in the metabolism of carbohydrates. Deficit of Mg can results in plants interveinal chlorosis and sometimes accumulation of raddish pigments at the leaf margins (Hoyum, 2000). The calcium and magnesium are very important for human body and its health. They are present in bones, teeth, muscles and some enzymes (LENNTECH Calcium – Ca published in Internet).

Aim of this paper was detected concentrations Ca and Mg in physiologically mature fresh peeled potato tubers (*Solanum tuberosum* L.) harvested in region Eastern Slovakia.

MATERIAL AND METHODS

As experimental material was used samples of physiologically mature potato tubers that supply for other analysis on State Veterinary and Food Institute Košice. The potato samples were randomly selected from specific non deffined climatic and soil conditions and various farmers practics from region of Eastern Slovakia. The various cultivars of potato were availabled for consumers in market chains. The 32 various samples of potatoes harvested in region of Eastern Slovakia were analyzed. Peeled tubers were analyzed as described in the Food codex Slovak Republic. Before analysis samples of potatoes were minaralised in nitric acid by microwave digestion. Weight of sample was 2 grams of peeled potato tubers. The concentration of sample was 2 g/25 ml 0,1 mol.dm^{-3} nitric acid. The best quality chemicals were used on the analysis. Spectrometer was calibrated by metal standard solutions from MERCK (Germany). The content of elements was determined spectrometrically on UNICAM 939 AA FLAME spectrometer Solar from firm ATI UNICAM by official methods used on State Veterinary and Food Institute in Košice CH-1.6. The certified reference materials were used for control of analysis.

RESULTS

The results are expressed in mg.kg^{-1} mature freshly peeled potato tubers (FM). The Table 1 shows the average concentrations and standard deviations of analyzed elements for the 32 different samples of potatoes harvested in region Eastern Slovakia. From the data it follows that peeled physiologically mature potato tubers contained lower concentration of calcium and higher concentration of magnesium. It was also observed high heterogeneity of concentrations studied elements in individual analyzed samples (Fig. 1 and 2). On the basis of different concentrations Ca and Mg we can distribute potato samples as follows: 31,25 % samples contains to 20 mg.kg^{-1} Ca (FM), 37,5 % samples contains from 20 to 30 mg.kg^{-1} Ca (FM) and 31,5 % samples contains higher concentration of Ca than 30 mg.kg^{-1} (FM). Likewise 37,5 % samples contains to 200 mg.kg^{-1} Mg (FM), 37,5 % samples contains 200-300 mg.kg^{-1} Mg (FM) and 25 % samples contains higher concentration of Mg that 300 mg.kg^{-1} (FM).

Table 1 Average concentrations of Ca and Mg in mature freshly peeled potato tubers (*Solanum tuberosum* L.)

Samples	Region		Ca (mg.kg^{-1})	Mg (mg.kg^{-1})
Potato tubers	Eastern Slovakia	Average	25,7	234,1
		STDEV	15,52	80,63
		Minimum	6,088	98,62
		Maximum	76,49	388,6
		n	32	32

Fig. 1 and 2 show concentrations of calcium and magnesium in individually analyzed samples lined up by increased concentrations of elements, respectively.

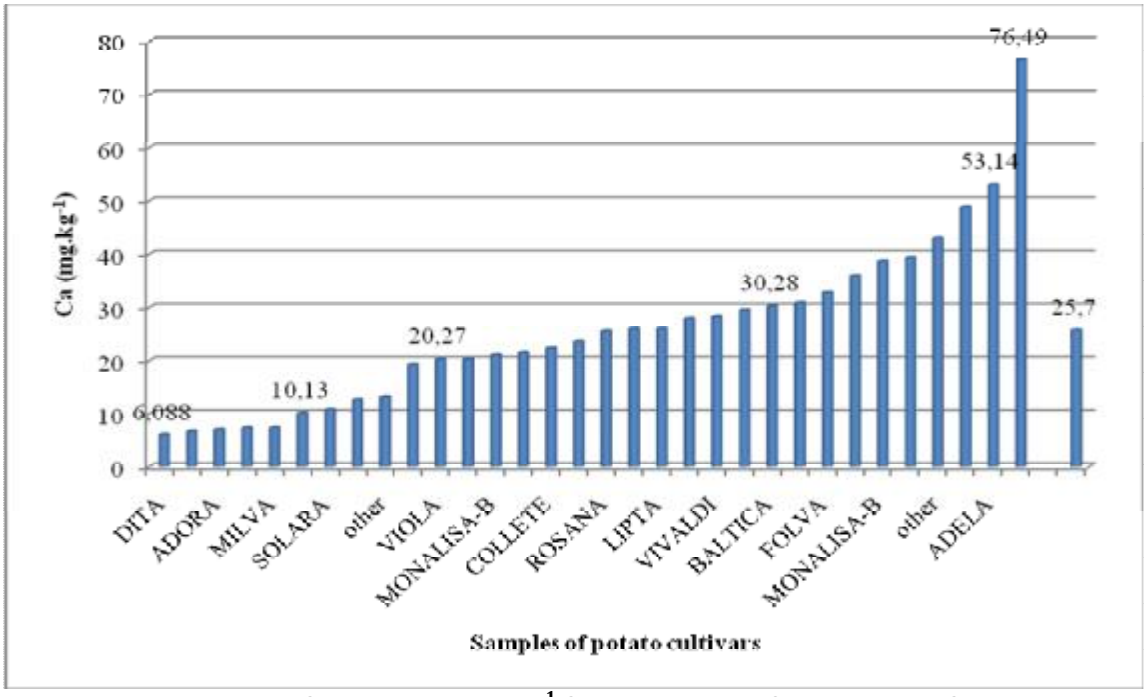

Fig. 1 Concentrations of calcium in mg.kg^{-1} fresh material of individually freshly peeled potato tubers (*Solanum tuberosum* L.*)*.

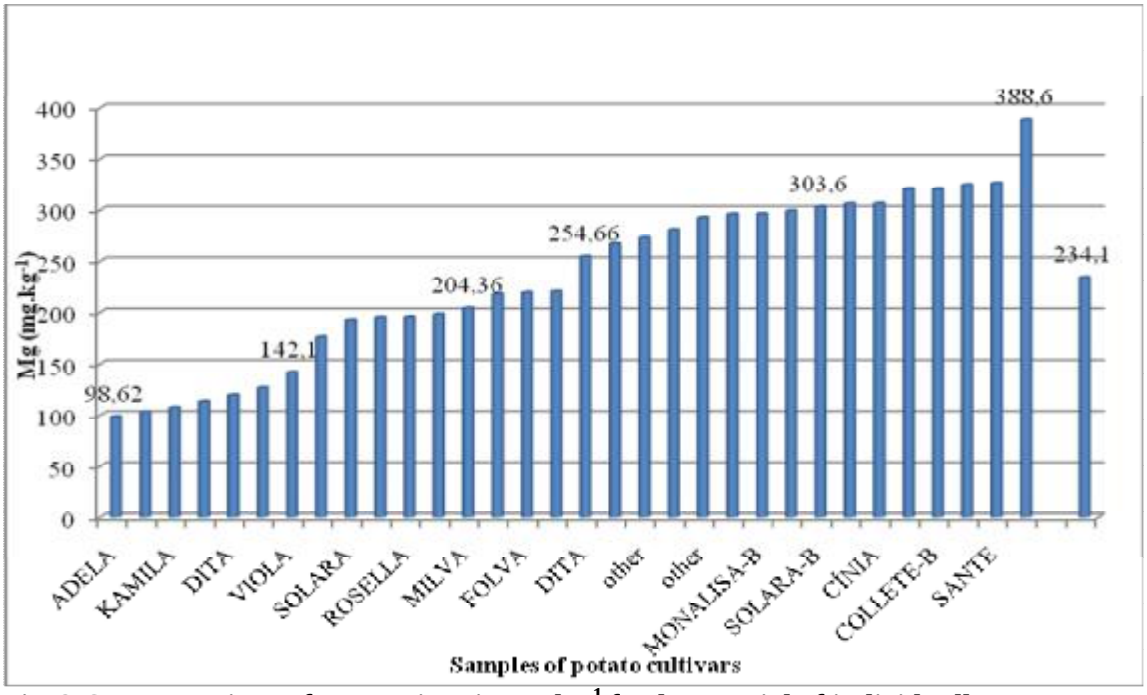

Fig. 2 Concentrations of magnesium in mg.kg^{-1} fresh material of individually mature freshly peeled potato tubers (*Solanum tuberosum* L.). (Samples marked as „other“ were potatoes of undefined variety.)

Table 2 Ratio concentrations of calcium to magnesium, line up by names of cultivars.

No	Cultivar	Ratio Ca:Mg
1	*ADELA*	1:2
2	***AGRIA-B***	1:13
3	*AGRIA*	1:9
4	*ADORA*	1:18
5	***BALTICA***	1:11
6	***CÍNIA***	1:9
7	***COLLETE-B***	1:12
8	***COLLETE***	1:12
9	*DITA*	1:20
10	*DITA*	1:38
11	***FOLVA***	1:7
12	***LAURA-B***	1:10
13	***LIPTA***	1:10
14	*KAMILA*	1:11
15	*MILVA*	1:28
16	***MONALISA-B***	1:15
17	***MONALISA-B***	1:8
18	***MONALISA-B***	1:5
19	***ROSANA***	1:11
20	***ROSELLA***	1:8
21	***SANTE***	1:16
22	***SOLARA-B***	1:8
23	*SOLARA*	1:18
24	*SPUNTA*	1:27
25	***VINETA***	1:4
26	***VIOLA***	1:7
27	***VITARA-B***	1:12
28	**VIVALDI**	1:11
29	*other*	1:17
30	*other*	1:3
31	*other*	1:6
32	*other*	1:14
Average	*Potato tuber*	1:9
Minimum		1:38
Maximum		1:2

Table 3 Ratio concentrations of calcium to magnesium, line up by decreased ratio Ca:Mg.

No	Cultivar	Ratio Ca:Mg
Maximum		1:2
1	*ADELA*	1:2
30	*other*	1:3
25	***VINETA***	1:4
18	***MONALISA-B***	1:5
31	*other*	1:6
11	***FOLVA***	1:7
26	***VIOLA***	1:7
17	***MONALISA-B***	1:8
20	***ROSELLA***	1:8
22	***SOLARA-B***	1:8
3	*AGRIA*	1:9
6	***CÍNIA***	1:9
Average	*Potato tuber*	1:9
12	***LAURA-B***	1:10
13	***LIPTA***	1:10
5	***BALTICA***	1:11
14	*KAMILA*	1:11
19	***ROSANA***	1:11
28	**VIVALDI**	1:11
7	***COLLETE-B***	1:12
8	***COLLETE***	1:12
27	***VITARA-B***	1:12
2	***AGRIA-B***	1:13
32	*other*	1:14
16	***MONALISA-B***	1:15
21	***SANTE***	1:16
29	*other*	1:17
4	*ADORA*	1:18
23	*SOLARA*	1:18
9	*DITA*	1:20
24	*SPUNTA*	1:27
15	*MILVA*	1:28
10	*DITA*	1:38
Minimum		1:38

(Samples marked as „other“ were potatoes of undefined variety.)

The ratio concentrations of calcium to magnesium decreased from 1:2 to 1:38. More than 53 % samples have ratio from 1:9 to 1:20 and 37,5 % samples have ratio from 1:2 to 1:9. Only three samples have ratio lower than 1:20 (9,4 % of samples).

DISCUSSION

Potatoes are generally recognised as good sources of nutrients such as vitamin C and potassium. Less known are the concentrations of other minerals. Nevertheless, potato is listed as providing 6 percent of the Required Daily Allowance of iron, phosphorus and magnesium and 2 percent of calcium and zinc (Brown et al., 2005). Aim of this paper was to detect concentrations Ca and Mg in different samples of potato tubers (*Solanum tuberosum L.*) harvested in region Eastern Slovakia. The 22 different cultivars and 4 samples without definition of variety were analyzed. Concentration of calcium changed from 6 to 76 $mg.kg^{-1}$ fresh material and concentration of magnesium changed from 99 to 389 $mg.kg^{-1}$ FM (fresh material). It is known that potato tubers have low concentration of calcium compared to the leaves and stems (Spillman, 2003; Pulane Charity Modisane, 2007). Endogenous tuber calcium concentration changed from 0,009 to 0,066 g Ca/100 g dry mater. (Olsen et al., 1996). The periderm tissue of potato tubers contains higher calcium concentration than in the medullary tissue (Locascio et al., 1992). We have investigated physiologically mature freshly peeled potato tubers as (consumable potatoes) form tissues for consumers. The results published in this paper are consistent with it published by other authors (Cieslik and Sikora, 1998; Ilin et al., 2002; Peňa et al., 2001). But some authors published higher concentrations for calcium and magnesium in potato tubers (Dunbar et al., 2003; Arvin et al., 2005). Research by Bamberg et al. (1993) has suggested that here are species differences in the ability to accumulate Ca in the tubers. They evaluated unpeeled tuber Ca accumulation ability among 21 *Solanum* species. We analyzed mature peeled potato tubers of 22 different cultivars. High differences in contents of Ca and Mg of different cultivars were observed. Our results confirmed the observations published by Bamberg et al. (1993). Sterrett et al. (2006) analyzed fourteen variables for example concentrations of P, K, Mg, Ca, S, Na, Zn, Mn, Cu, and Fe. They observed significant heterogeneity among the error variances for all of the variables. Cieslik and Sikora (1998) determined concentrations of Ca and Mg in 16 cultivars of consumable potatoes. Statistical analysis showed significant differences in tuber magnesium and calcium contents depending on cultivar and year of cultivation. In their experiments variability in tuber calcium and magnesium levels was found to be cultivar-dependent. Results published in this paper are consistent with results of cited literature. The ratio Ca:Mg varied in studied cultivars. It is not constant value. Ca:Mg ratio probably reflect contents of Ca and Mg in soil where potato tubers were cultivated. In all analyzed potato samples concentration of calcium was lower than magnesium. In contrast to potato tubers, for example in cashew nut kernel, was observed higher concentrtion of calcium compared with concentration of magnesium (Akinhanmi and Akintokun, 2008).

CONCLUSION

The present study has demonstrated high variability of concentrations Ca and Mg in different potatoes cultivars harvested in region Eastern Slovakia. The results can by used as suplement for definition nutrition quality of various potato species on level of mineral composition physiologically mature peeled potato tubers.

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