CONTENT OF MACRO- AND MICROELEMENTS AS A TOOL TO ASSESS THE BOTANICAL ORIGIN AND CULTIVATION SYSTEMS OF POTATO

__Aleksandra M. Dramićanin__[1], Filip Lj. Andrić[1], Jelena J. Mutić[1], Vesna D. Stanković[2], Dobrivoj Ž. Poštić[3], Nebojša M. Momirović[4], Dušanka M. Milojković-Opsenica[1]*

[1]University of Belgrade - Faculty of Chemistry, Studentski trg 12-16, 11158 Belgrade, Serbia
[2]Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Njegoševa 12, Belgrade, 11000, Serbia
[3]Institute for Plant Protection and Environment, Teodora Drajzera 9, 11040 Belgrade, Serbia
[4]University of Belgrade - Faculty of Agriculture, Nemanjina 6, 11080 Belgrade - Zemun, Serbia

Introduction

Minerals are micronutrients necessary for the growth and proper functioning of the human body. Humans require at least 22 mineral elements for their wellbeing, and potato (*Solanum tuberosum L.*) is their excellent source. The mineral content of potato crops is influenced by several factors, including soil type, climatic conditions, production systems, and variety choices. There is currently little data relating to the metal content of potato tubers with various agricultural systems in which they are grown. Comparative studies rarely control for these factors and they do not repeat the experiments over several growing seasons. On the other hand, available experiments show contradictory results, often due to the limited number of samples analyzed, varieties of potato, short time between the experiments and/or geographical/ecological variability. Therefore, the main objective of this work was to identify specific chemical markers that can serve as indicators of the type of production, botanical origin, and ripening time. The effects of organic versus integral and conventional crop management on bioavailability, distribution, and content of major and trace elements in different varieties of potato were investigated in a three years field trial.

Experimental part

This paper compares the content of 16 macro- and microelements of a statistically significant number of samples - 48 bulk and 48 peel - of four varieties of potatoes (two middle early red varieties - Red Fantasy (F), and Laura (L), one early yellow variety - Marabel (M), and one late yellow variety - Jelly (J), from three years and three types of production (conventional, integral and organic).

- For the determination of major (macro) elements (Ca, Fe, K, Mg, and Na) Inductively Coupled Atomic Emission Spectrometer, ICP-OES (Thermo Fisher Scientific, Waltham, USA), model 6500 Duo, equipped with a CID86 chip detector was used.
- Concentrations of trace (micro) elements (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Se, and Zn) were determined with inductively coupled plasma quadrupole mass spectrometry (ICP-QMS - iCAP Q, Thermo Scientific X series 2, UK).

Multivariate analysis

In order to estimate the effects of cultivation systems, differences between varieties, harvesting time, and sample types, on the overall variability in the content of macro- and microelements, a multivariate analysis of variance (MANOVA) was performed. MANOVA was carried out using the general linear module, a part of the Statistica software (Statistica v.10, Statsoft Inc. Tulsa, Oklahoma, USA). Concentrations of elements were used as dependent variables. The type of production, varieties and the part of potato were used as categorical variables.

Results

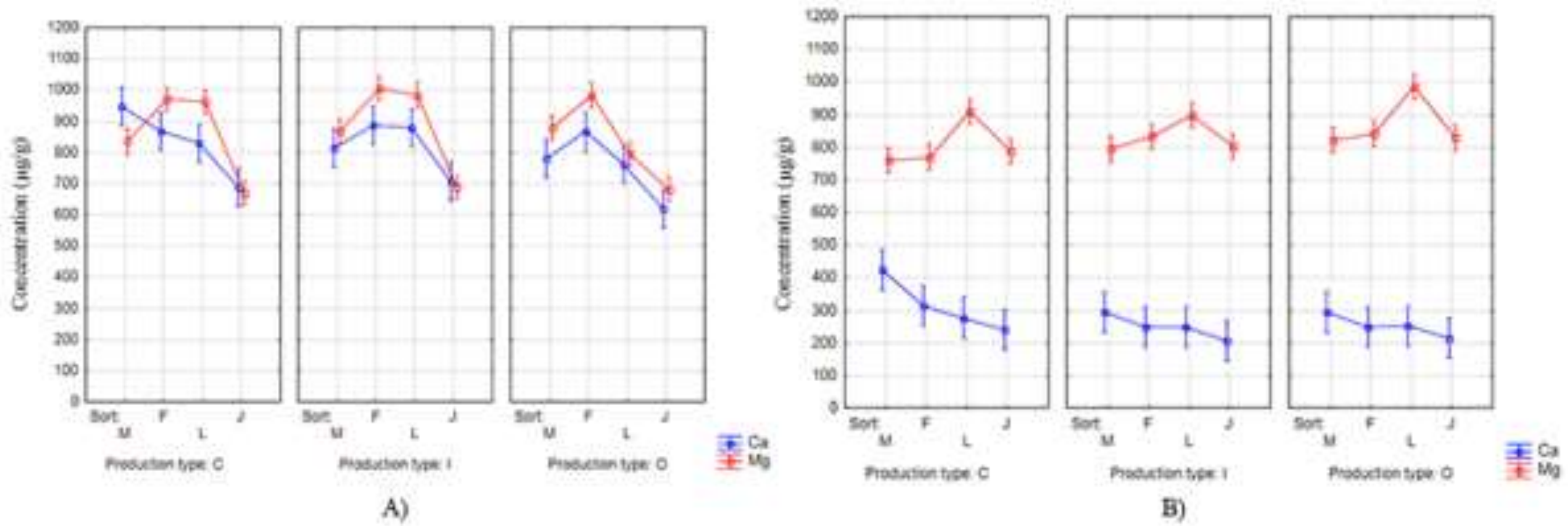

Figure 1. MANOVA factor effects for macro elements: calcium and magnesium in potato peel (A) and bulk (B) for a three-year production period. The concentrations (µg/g) of elements Ca and Mg were plotted on the y-axis; the potato varieties (F – Red Fantasy, L – Laura, M –Marabel, J – Jelly) and the cultivation systems (C - conventional, I - integral, O - organic) were plotted on the x-axis. Vertical bars denote 0.95 confidence intervals.

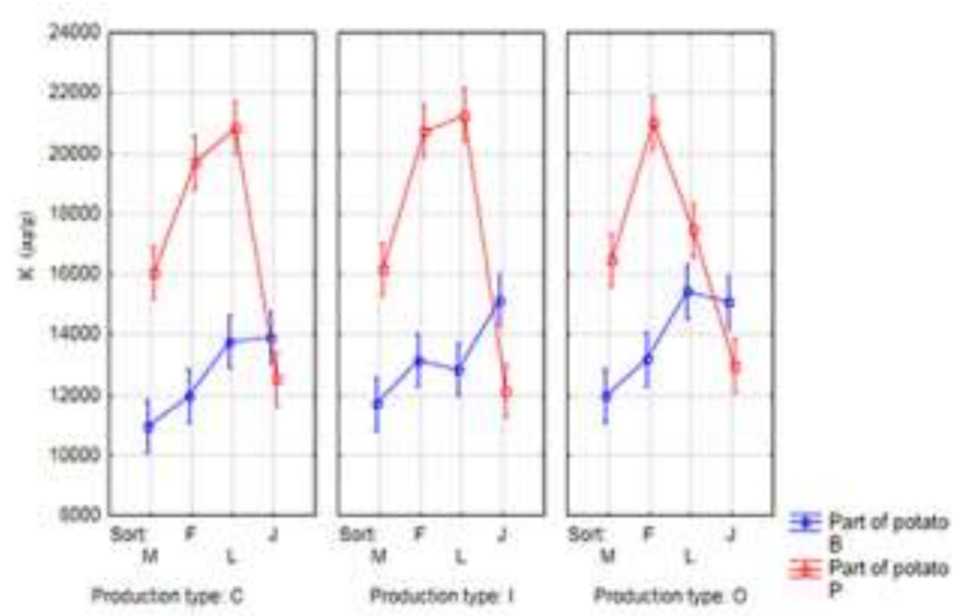

Figure 2. MANOVA factor effects for macro element potassium in potato peel and bulk for a three-year production period. The concentrations of K (µg/g) was plotted on the y-axis; the potato varieties (F – Red Fantasy, L – Laura, M –Marabel, J – Jelly) and the cultivation systems (C - conventional, I - integral, O - organic) were plotted on the x-axis. Vertical bars denote 0.95 confidence intervals.

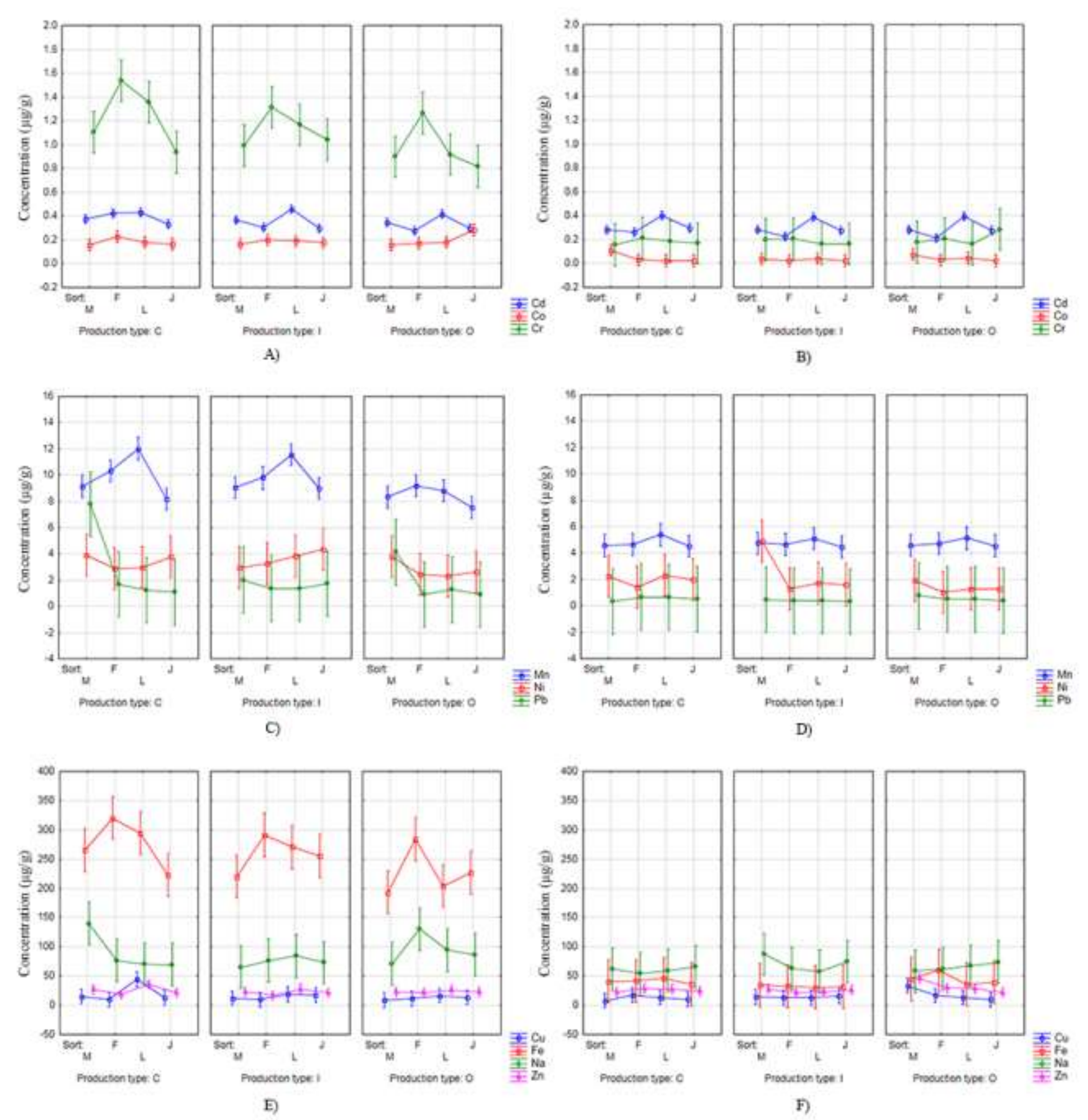

Figure 3. MANOVA factor effects for microelements: Cd, Co and Cr in potato peel (A) and bulk (B), Mn, Ni and Pb in potato peel (C) and bulk (D), and Cu, Fe, Na and Zn in potato peel (E) and bulk (F) for a three-year production period. The concentrations of elements (µg/g) were plotted on the y-axis; the potato varieties (F – Red Fantasy, L – Laura, M –Marabel, J – Jelly) and the cultivation systems (C - conventional, I - integral, O - organic) were plotted on the x-axis. Vertical bars denote 0.95 confidence intervals.

Conclusion

The mineral profile is a parameter of utmost importance for assessing the productive characteristics, the authentication of genotypes of potato, and harvesting time, as well as the protection of geographical origin, and the assessment of its authenticity. The analyses showed that macro components, calcium, magnesium, and potassium, were identified as the most abundant elements in both the bulk and the peel of potato. Regarding the content of Ca, Mg, and K as a promising tool in defining the "profile" of the examined varieties and methods of potato cultivation, it should be known that the physiological balance of crops strongly influences the proper uptake and storage of these elements. Therefore, the fact that additional amounts of potassium, calcium, and magnesium are not used in supplementation is one of the decisive factors which were not equally expressed in all cultivars in this study. Compared with macro components, microcomponents, cadmium, cobalt, chromium, manganese, nickel, lead, copper, zinc, including iron and sodium, were found in traces. In total average, the contents of all these elements are higher in samples of peel than in bulk.

The results indicate that **Ca, Mg,** and **K** may be considered as indicators of the type of production, botanical origin, and ripening time. Additionally, microelements such as **Cd, Co, Cr, Mn, Ni, Pb, Cu, Zn** including **Fe** and **Na** can distinguish between production types and botanical origin of potato.

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