Discrimination of Hungarian Paprika Growing Regions Using Multi-Element Profiling Combined with Chemometric Techniques

My Ban Thi[1*], Géza Hitka[2], Alwani Naji[2], , Quang D. Nguyen[1]

[1]*Department of Bioengineering and Alcoholic Drink Technology, Institute of Food Science and Technology, Hungarian University of Agriculture and Life Sciences*

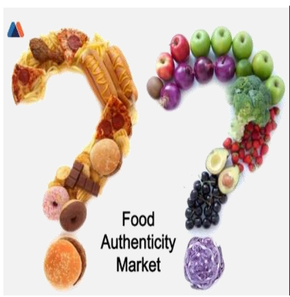
[2]*Department of Postharvest, Supply Chain, Commerce and Sensory Science, Institute of Food Science and Technology, Hungarian University of Agriculture and Life Sciences*

Corresponding author: banthimy@gmail.com

SUMMARY

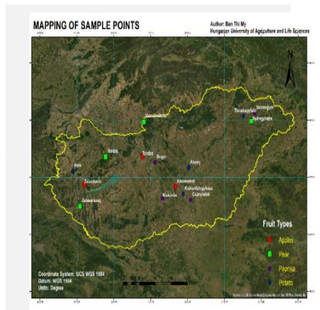
Paprika is one of popular spices used around the world. The quality of paprika is strongly influenced by cultivation area. This study investigates the mineral composition of paprika fruits from four major growing regions of Hungary. The concentrations of many macro-, micro-, and toxic trace elements in three main parts of paprika fruits (peel, pith and seeds) were determined by ICP-MS and ICP-OES techniques. The results indicated that the pith contained the highest levels of the element, followed by the peel, and lowest in the seeds. Although certain toxic elements were detected in some areas, their concentrations remained below the licit. The PCA and LDA techniques were used to classify samples by geographical origin based on their elemental profiles. The results demonstrated that PCA effectively distinguished growing regions of paprika, accounting for 89.9% of the total variance. LDA provided an even clearer separation with the first two discriminant functions accounting for 99.8% of the variance among the growing regions. Notably, the classification performance of LDA model reached 91.7%. The results demonstrated that this analytical approach was effective for the geographic classification of paprika from different regions of Hungary and could be a valuable tool for supporting fair trade in the market.

METHODS



STEP 1 – LITERATURE REVIEW:

According to literature, geographical origin of foods can be traced by geochemical methods. In Hungary, food authentication is gaining interest, but requires adjustment to apply the same methods or approaches.



STEP 2–SAMPLING STRATEGY:

Samples were collected at 4 locations over Hungary, complying with the FOREGS Geochemical Baseline Program sampling protocol.

STEP 3 –SAMPLING:

For each sampling point, three soil subsamples were taken, equidistant from each other and from 2 depth levels: top soil (0-10 cm) and bottom soil (root zone: 40-50 cm). A composite paprika sample consisted of 5 samples taken from the same farm.

STEP 4 – PRE-TREATMENT:

The samples were prepared in the laboratories of the MATE.

STEP 5 – LAB ANALYSIS:

The chemical composition of the soil and paprika samples was measured by ICP-OES and ICP-MS techniques according to MSZ EN 16943: 2017, MSZ EN 15763: 2010 and EPA Method. 6020A: 2007 standards.

STEP 6 – DATA ANALYSIS:

Data was structured into a GIS database. Different analysis tools (exploratory data mining, correlation analysis, PCA, LDA) were applied on the chemical composition data, by QGIS and R to classify samples by geographical origin.

RESULTS

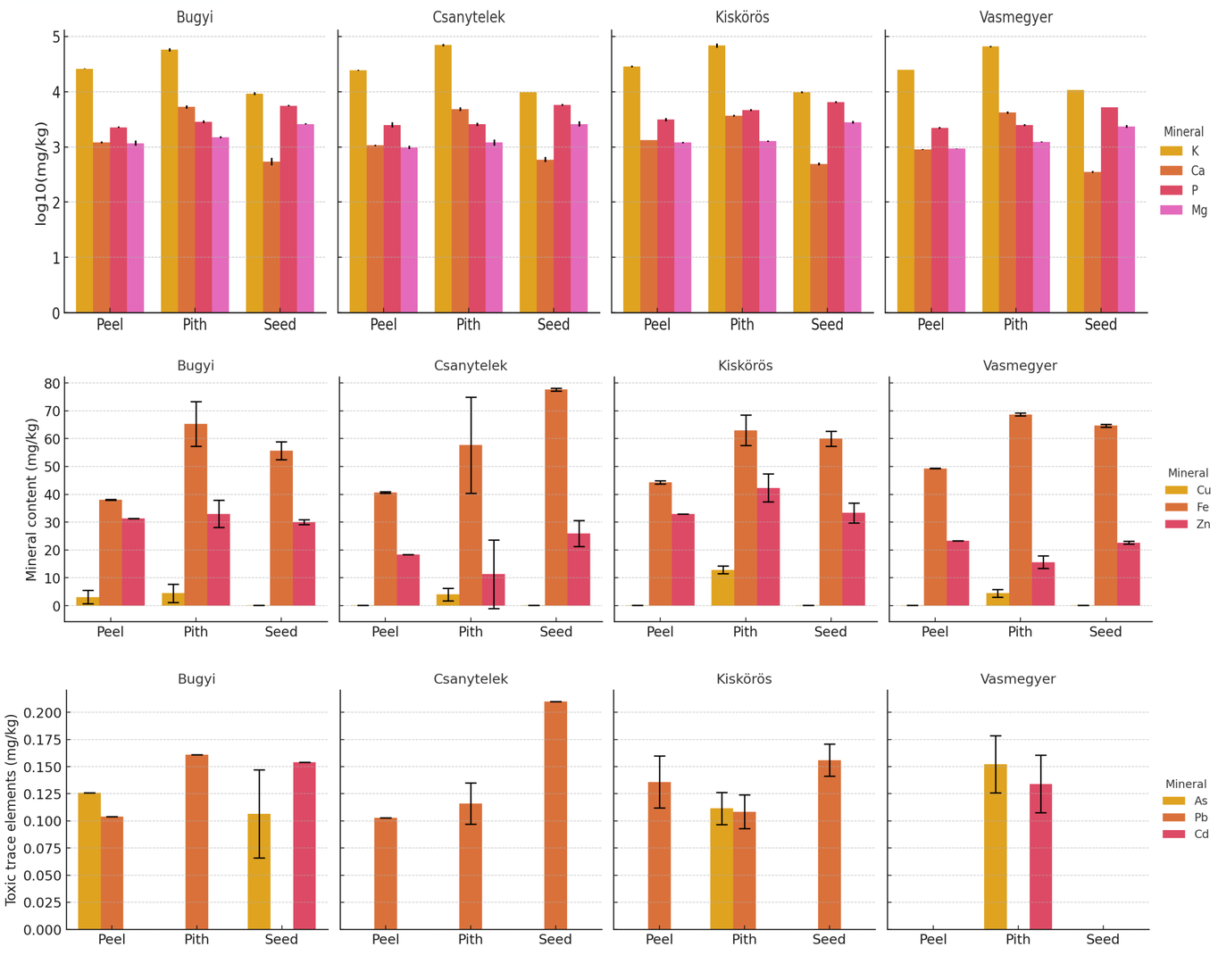


Figure 1. Mineral content of paprika in 4 major growing regions (dry weight)

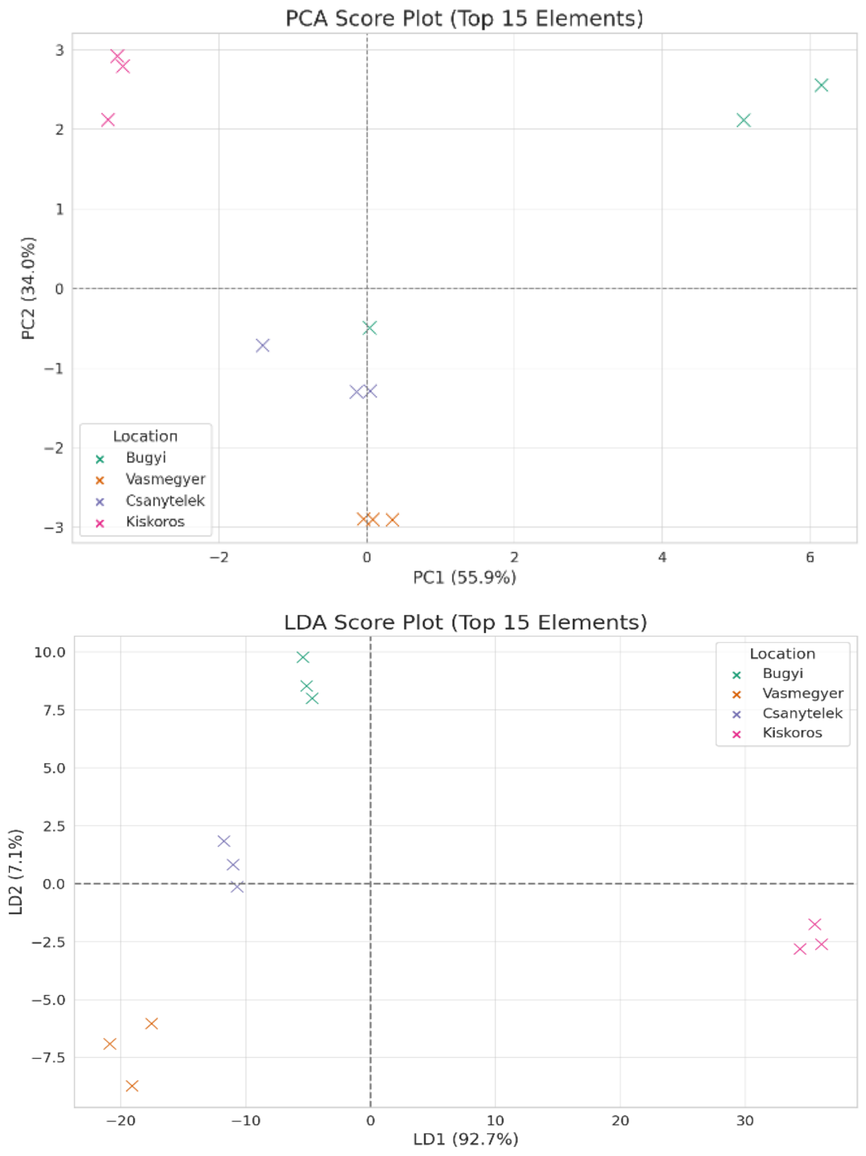


Figure 2. Score plots from PCA and LDA based on top 15 elements for discrimination of Hungarian paprika growing regions

CONCLUSION

- **A comprehensive elemental profile of Hungarian paprika was established for peel, pith and seed.**
- **All paprika growing regions showed safe levels of toxic elements.**
- **The LDA model demonstrated strong potential for traceability of paprika origin in Hungary based on elemental composition.**

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