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# Mineral content analysis of *Pastinaca sativa*: implications for nutrition and health

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***Abstract***

*Parsnip sativa* (parsnip), is a biennial, vegetable plant with nutritional and medicinal properties used mostly for the roots. Described as a sweet and starchy root, it contains health-promoting compounds such as carbohydrates, proteins, pectin, cellulose, flavonoids and dietary fibers. It is recommended for the preparation of dishes and as a spice being characterized by high mineral (K, P, Ca, Mg, Na, Fe, Zn, Cu) and vitamins content (A, B1, B2, B9 and C). Parsnip is considered an important vegetable also, due to its medicinal effects and can be part of a strategy to support overall health and immune function of the consumers. The aim of the study is to investigate the mineral composition of parsnip, available on the Romanian market and to identify the implication of consumption for nutrition and health. Compared to other root vegetables, parsnips show high content of minerals which are beneficial to human health. Compared to other root vegetables, the versatile parsnips may not be as widely consumed as some other root vegetables but including a diverse range of vegetables in our diet we ensure a variety of nutrients and flavors.

**Key words**: minerals, heavy metals contamination, parsnip roots.

## 1. Introduction

Vegetables are a crucial part of the human diet and are a major source of biologically active substances, vitamins, minerals and phyto-chemicals. Colorful vegetables they are rich in all these elements and are great sources of antioxidants. An easy way to get a full range of vitamins and minerals is achieved by eating a variety of colorful foods which the human body needs to develop. To increase the daily intake of minerals, vegetables and fruits are added to various products as health ingredients, thus enhancing their nutritional and also technological properties [8,9].

Vegetables have a variety of minerals that are required by the body for growth and also have certain health benefits. Minerals can be divided into two groups, major minerals, macronutrients (calcium, magnesium, potassium) and trace minerals, micronutrients, identified as nutrients with health implications, with benefits, usually with a high prevalence of inadequate intake, include iron, zinc, and selenium [3,4,5].

Parsnip (*Pastinaca sativa* L.) is a root vegetable that belongs to the Apiaceae family [14].

*Parsnip sativa* (parsnip), a plant native to Europe and Asia, is cultivated for its large, fleshy taproot (edible part), prefer deep soils, especially sandy or clayey soils, rich in potassium and calcium. Parsnips produce a tuberous root in the first year of cultivation and in the second growing season produce flowering stems [12]. Parsnip fruits are flattened schizocarps with two achenes. Parsnip seeds mature in the second half of

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July [2, 7, 11]. The root (edible part) is white, gray or yellowish-brown [12]. Research has shown that parsnip has three times the nutritional value of carrots and is a rich source of minerals (potassium, calcium, iron, phosphorus), the root being rich in potassium acts as a vasodilator and reduces blood pressure and stress on the heart, contains numerous vitamins (C, $B_1$, $B_2$, E, PP) and carotene, being recommended for people suffering from obesity and atherosclerosis. All parts of the parsnip plant contain aromatic essential oils, and parsnip can be consumed alone or in combination with various food products. This vegetable also has a high-water content of 79.5%. Studies show that when you consume more water-rich foods, this can be associated with decreased calorie intake and weight loss. Its sweet taste, with subtle notes of nutmeg and vanilla, makes it a versatile and appreciated ingredient in traditional cuisine [1, 6, 8, 17]. Although parsnips are often overlooked in favor of other more popular vegetables, this humble root hides a veritable treasure trove of health benefits [16].

The leaves tend to have higher levels of calcium and iron, while parsnip flowers, contain lower concentrations of minerals. Parsnip leaves, less commonly consumed than the root, can be used in salads or as a garnish or can be sautéed or cooked similarly to other leafy greens, or in soups or stews for additional flavor and nutrition. Due to the content of certain compounds, such as furanocoumarins, it's recommended to cook parsnip leaves before consuming them to mitigate any potential adverse effects. The flowers are edible, but small and delicate, which makes them more suited for ornamental purposes rather than culinary use [3].

As people age, their body functions decline and their nutrient needs increase. Thus, increasing access to nutritious foods is one way to positively improve the quality of life, especially for the elderly. Therefore, root vegetables are excellent nutritional foods because they contain various bioactive materials, making the root vegetable market of great importance to human health [10,13].

## 2. Material and methods

The parsnip used for determining water and mineral content was purchased from supermarkets (P1, P2, P4), as well as from the local market (P3). The parsnip roots were washed, cut and dried, then finely ground using a laboratory mill, than packed in sterile airtight bags, labeled and stored for further analysis and use.

### XRF mineral analysis

For XRF (X-ray fluorescence) analyses of samples powder were used Hitachi X-MET8000 portable spectrometer. Each mineral detected in the analyzed material produces a set of characteristic fluorescent X-rays (“a fingerprint”) that is unique for that specific element [15]. All analyses were performed in triplicate and the results were reported in ppm.

### Statistical Analysis

The analysis of data was performed using MVSP statistical program. Principal Component Analysis (PCA) has the role to reduce the complexity of multiple variables (mineral concentrations) while retaining the most significant patterns. It is enabling the visualization of high-dimensional data allowing the observation of clusters and the separation of samples based on the metal profiles.

## 3. Results and Discussion

The results obtained using XRF analysis are presented in table 1.

In order to identify potential fingerprints or patterns specific to the parsnip samples minerals contentration data we have performed PCA (Table 2) and for better visualities we have constructed a jointplot graphic (Figure 1).

The joint plot of the first two principal components shows clustering and separation of samples based on their origin of acquisition (supermarket: samples P1, P2 and P4, respectively local market P3).

**Table 1.** Nutritional values of parsnips

| Nutritional compounds | Parsnip 1 [ppm] | Parsnip 2 [ppm] | Parsnip 3 [ppm] | Parsnip 4 [ppm] |
|---|---|---|---|---|
| Potassium (K) | 71400 ± 184 | 70640 ± 86 | 92824 ± 519 | 67266 ± 158 |
| Calcium (Ca) | 9073 ± 10 | 10664 ± 139 | 9091 ± 38 | 9935 ± 123 |
| Cooper (Cu) | 32 ± 3 | 52 | 21 ± 6 | 28 ± 5 |
| Manganese (Mn) | 157±38 | 144±7 | 105 | 131 ± 3 |
| Molybdenum (Mo) | 12 ± 4 | 9 ± 4 | 12 ± 2 | 9 ± 1 |
| Zinc (Zn) | 71 | 55 | 45 ± 1 | 46 ± 9 |
| Nickel (Ni) | ND | 18 | 25 | ND |
| Barium (Ba) | 165 ± 24 | 111 ± 1 | 133 | ND |
| Strontium (Sr) | 66 ± 1 | 66 ± 1 | 59 ± 1 | 66 ± 9 |
| Rubidium (Rb) | 42 ± 2 | 46 | 13 ± 1 | 25 ±4 |
| Tin (Sn) | ND | 39 ± 3 | 36 | ND |
| Tantalum (Ta) | 18 ± 2 | 24 ± 2 | 23 ± 3 | 23 |
| Lead (Pb) | 3 | 6 | 3 | ND |
| Thorium (Th) | 5 | 7 | 5 | 5 |
| Antimony (Sb) | ND | 13 | ND | 19 |
| Cadmium (Cd) | 11 | 14 | 17 | ND |
| Uranium (U) | 6 | 5 | 5 ± 1 | ND |
| Titanium (Ti) | 5 | 5 | 5 ± 2 | ND |
| Selenium (Se) | 3 | 3 | ND | ND |
| Thallium (Tl) | 5 | 5 | 5 | ND |

**Table 2.** Principal Components Analysis of XRF data

| | | | |
|---|---|---|---|
| Analyzing 4 variables x 21 cases | | | |
| Data standardized and square-root transformed are transposed before analysis | | | |
| Tolerance of eigen analysis set at 1E-007 | | | |
| Eigenvalues | | | |
| | Axis 1 | Axis 2 | Axis 3 |
| Eigenvalues | 8.571 | 6.76 | 5.668 |
| Percentage | 40.817 | 32.191 | 26.993 |
| Cum. Percentage | 40.817 | 73.007 | 100 |
| PCA variable loadings | | | |
| | Axis 1 | Axis 2 | Axis 3 |
| K/1000 | 0.209 | -0.284 | -0.119 |
| Ca/1000 | -0.127 | 0.261 | -0.266 |
| Mn/100 | -0.019 | 0.326 | 0.222 |
| Ba/10 | 0.336 | 0.051 | 0.05 |
| Cu | 0.02 | 0.368 | -0.12 |
| Mo | 0.238 | -0.195 | 0.214 |
| Zn | 0.134 | 0.224 | 0.299 |
| Ni | 0.199 | -0.062 | -0.335 |
| Sr | -0.161 | 0.315 | 0.137 |
| Rb | 0.018 | 0.373 | 0.099 |
| Sn | 0.191 | -0.009 | -0.348 |
| Ta | -0.094 | -0.033 | -0.402 |
| Pb | 0.3 | 0.157 | -0.103 |
| Th | 0.061 | 0.292 | -0.262 |
| Sb | -0.268 | 0.164 | -0.189 |
| Cd | 0.336 | 0.025 | -0.072 |
| U | 0.335 | 0.073 | 0.02 |
| Ti | 0.336 | 0.067 | -0.016 |
| Se | 0.151 | 0.331 | 0.105 |
| Tl | 0.336 | 0.067 | -0.016 |
| PCA case scores | | | |
| | Axis 1 | Axis 2 | Axis 3 |
| P1 | 0.84 | 0.528 | 1.884 |
| P2 | 0.456 | 1.71 | -1.289 |
| P3 | 1.198 | -1.844 | -0.672 |
| P4 | -2.494 | -0.395 | 0.076 |

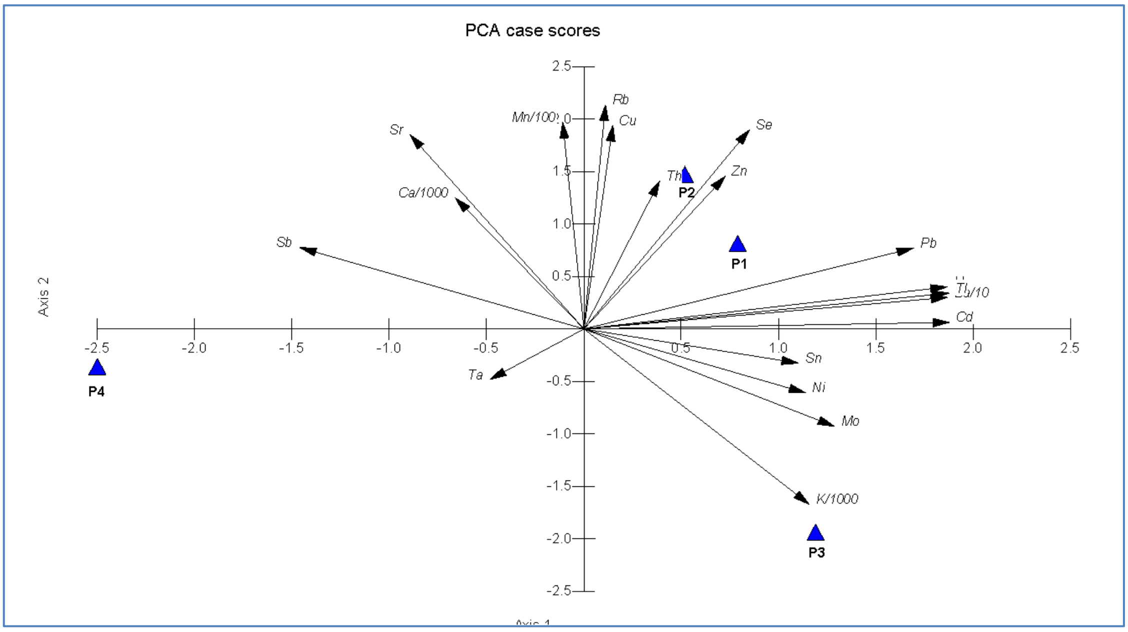


**Figure 1** Graphical representation of data using Principal Component Analysis

P1 sample shows high Zn but moderate contributions from Pb, Rb, and Se. The soil conditions of P1 had higher Zn availability, influencing its nutrient profile.

P2 sample is relatively balanced regarding mineral elements content, with significant contributions from multiple elements like Sn, Zn, etc. The growing environment of P2 reflects moderate soil fertility with potential contamination (e.g., Ni, Sn).

P3 sample is rich in Ni and Cd, both of which are concerning as they are heavy metals. P3 sample was very clearly cultivated in soil with heavy metal contamination, possibly from industrial or polluted sources, which make it less suitable for consumption.

P4's isolation in quarter III, is driven by its unique high Sb, lack of several other elements (Pb, Cd, U), and lower K. The absence of heavy metals is recommending as food but the low content of K (Potassium) can reduce its overall nutritional value compared to other samples. As it looks, it seems that P4 samples were cultivated in soil with Zn and K deficiency but with high antimony content, possibly from natural or anthropogenic sources.

Based on the results we can affirm that: P1 and P2 are more suitable for consumption but require monitoring of specific contaminants (Pb); P3 may be unsuitable due to high Cd and Ni levels and P4 is less nutritious, could be safer, but lacks essential minerals.

Cd Risk: The Maximum Limit (ML) for cadmium in leafy vegetables is 0.2 ppm in the EU. The levels in P1, 2 and 3 exceed this limit by 50-80 times, posing a significant health risk with regular consumption.

Ni Risk: Safe levels for nickel in leafy vegetables are generally under 0.1-1 ppm. Levels in P2 and P3 exceed this significantly, making frequent consumption unsafe.

## 4. Conclusions

To increase the daily intake of minerals, vegetables are added to various products as health ingredients, thus enhancing their nutritional and also technological properties.

Introducing parsnips into the diet not only adds flavor and texture to different dishes, but also provides a wide range of essential nutrients for maintaining of optimal health. This humble root vegetable is proving to be a true superfood, with remarkable benefits for the human body, from supporting optimal functioning of the digestive and cardiovascular systems, to strengthening immunity, this vegetable is a reliable ally for the body's overall well-being.

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## Compliance with Ethics Requirements

Authors declare that they have no conflict of interest and that all procedures involving human / or animal subjects (if exist) respect the specific regulations and standards.

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