ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

# Identification And Quantitative Content Determination Of Macro- And Microelements In Spinach Leaves, Seeds And Roots Of "Krasen' Polissia" And "Fantasy" Cultivars.

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**ABSTRACT**

Spinach (*Spinaciaoleracea*L.) is a representative of the amaranth family(Amaranthaceae), originates from Iran and is now cultivated all over the world. According to the literature data spinach has a reach chemical composition and contains various macro- and microelements in sufficient quantity. Spinach leaves, seeds and roots of "Krasen' Polissia" and "Fantasy" cultivars were chosen as the objects of the research. Determination of macro- and microelements' content was carried out using atomic-emission spectroscopy method with photographic registration. As a result of the research 19 macro- and microelements were identified, 5 of which were found in minor quantities. Potassium was present in the highest quantity in all the types of plant material studied. In the spinach plant material of "Fantasy" cultivar the content of macro- and microelements prevailed with insignificant difference. The obtained experimental data will be used for planning further research on spinach leaves, seeds and roots of "Krasen' Polissia" and "Fantasy" cultivars, as well as plant material standardization and development of medicines on the basis of the studied plant.
**Keywords**: Spinaciaoleracea, Spinach, micro- and macro-elements, atomic-emissionspectroscopy

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ISSN: 0975-8585

## INTRODUCTION

Spinach (*Spinaciaoleracea*L.)– is an annual, more rarely perennial, plant which used to be a representative of Chenopodioideae family, and now it belongs to the amaranth family(*Amaranthaceae*). First references to spinach cultivation were found at the territory of modern Iran and date back to year 400 AD. In 1100 this representative of leafy vegetables was brought to Spain, and in 1400 it was already popular all over Europe [20].Nowadays spinach is widely cultivated all over the world and is used in cooking and medicine. Spinach possesses anti-oxidant, anti-inflammatory, hepatoprotective and hypolipidemic activity [6, 7, 13, 15]. Such wide spectrum of pharmacological activity is, first of all, associated with the content of various biologically active compounds. In particular, these are phenolic compounds, flavonoids, vitamins (A, E, K, C), folic acid, carotenoids [8, 19].Besides, according to the literature data, spinach contains large amount of such minerals as potassium, calcium, magnesium, sodium, iron, phosphorus and zinc [1, 11, 17].

Micro- and macroelements play in important role in human body. Sodium maintains osmotic balance in the cells, blood pH level within normal, takes part in amino acids and glucose transport to the body cells. In addition, it is responsible for the conduction of nerve impulses, and heart muscle contraction [12, 18]. Potassium maintains the heart rate and regulates blood pressure, thus, it is of great importance in hypertension. In human body it plays an essential role in various physiological reactions, and its deficiency or excess may affect human health [5]. Calcium takes part in activation of such enzymes as pancreatic lipase and in the synthesis of a neurotransmitter acetylcholine [9]. Magnesium is responsible for enzymatic reactions in human body, metabolism of nutrients, conduction of nerve impulses, body temperature maintenance and detoxification [10].For the nervous system maintenance and anemia prevention human body needs iron. This is an essential element which is a part of myoglobin, hemoglobin and a series of enzymes that play an important role in oxidation of erythrocytes [14]. Zinc is a component of various enzymes: RNA-polymerase, alcohol dehydrogenase, carbonic anhydrase, and alkene phosphate. Deficiency of this element can be the reason of delayed puberty, hair loss, wound healing impairment and emotional distress [12].Phosphorus is a component of more than 240 enzymes. Its deficiency in the body is accompanied with multi-system dysfunction. In addition, phosphorus is responsible for the development of fetus, sperm production and relevant function of immune response [3].

Proceeding from the abovementioned information, the objective of our study was the identification and quantitative determination of macro- and microelements in spinach leaves, seeds and roots of “Krasen’ Polissia” and “Fantasy” cultivars.

## EXPERIMENTAL

Dried and crushed spinach leaves, seeds and roots of “Krasen’ Polissia” and “Fantasy” cultivars were chosen as the objects of the research. The plant material was grown at experimental grounds of the Institute of Horticulture and Melon-growing of the National Academy of Agrarian Sciences of Ukraine in 2016-2017. Leaves were collected in the phase of maximal vegetative development, seeds – during the fruiting stage, and roots – in autumn, at the end of the stage of aerial part dying-off.

The element composition of spinach leaves, roots and seeds of “Krasen’Polissia” and “Fantasy” cultivars was studied using atomic emission spectrography with photographic registration [2, 4, 16].

Before analysis the crude samples pretreated with diluted sulfuric acid were carbonized in a muffle furnace (temperature max. 500$^{o}$C). Samples were evaporated from graphite electrode craters in AC arc discharge at 16 A current and 60 sec exposure. Spectra were obtained and registered at DFS-8 spectrograph with diffraction grating of 600 grooves/mm and three-lens slit illumination system. Specter photography terms: AC arc current 16A, ignition phase 60$^{o}$C, ignition pulse frequency 100 discharges per second, analytical gap 2 mm; spectrograph slit width 0,015 mm; exposure 60 s. Spectres were photographed at 230-330 nm range. Photo plates were developed, dried, then the following lines (in nm) were photo measured in spectra of samples and graduated specimens as well as their background. For each element we calculated from photometry results differences in blackening of lines and background (S=Sl+b – Sb) for spectra of samples (Se) and of calibration specimens (Scs). For each element we calculated from photometry results the differences in blackening of lines and background (S=Sl+b – Sb) for spectra of samples (Se) and of calibration specimens (Scs).

ISSN: 0975-8585

Then we built the calibration plot in such coordinates: mean value of lines and background blackening difference (Scs) – calibration specimens element content logarithm (lg C), where C is expressed in per cent relative to base. From this plot we found an element content in ash (a, %). The element content in plant material (x, %) we found by formula: $X = \frac{a \times m}{M}$,

where m – ash mass, g;
M – crude material mass, g;
a – element content in ash, %.

In analysis we considered the lower limits of impurities content which were for Cu – $1 \cdot 10^{-4}$; Co, Mo, Mn, – $2 \cdot 10^{-4}$; Ni, Pb– $5 \cdot 10^{-4}$; Sr, Zn – $1 \cdot 10^{-4}$ %

## RESULTS AND DISCUSSIONS

As a result of the experiment carried out, 19 micro- and macroelements, 5 of which were found in minor quantity, were detected in spinach plant material of "Krasen' Polissia" and "Fantasy" cultivars. The content of heavy metals did not exceed the limits of maximum allowable concentrations.

The obtained numerical data are given in the Table I.

**Table I: Element composition of spinach plant material of "Krasen'Polissia" and "Fantasy" cultivars**

| Element name | Element content, mg/100 g | | | | | |
|---|---|---|---|---|---|---|
| | Spinach of "Krasen' Polissia" cultivar | | | Spinach of "Fantasy" cultivar | | |
| | Leaves | Roots | Seeds | Leaves | Roots | Seeds |
| Fe | 31.50 | 42.90 | 12.60 | 2.10 | 22.50 | 8.80 |
| Si | 385.00 | 545.00 | 315.00 | 210.00 | 470.00 | 40.00 |
| P | 260.00 | 270.00 | 155.00 | 340.00 | 375.00 | 160.00 |
| Al | 52.50 | 78.60 | 20.20 | 50.20 | 41.30 | 20.00 |
| Mn | 4.20 | 1.80 | 6.70 | 3.90 | 0.70 | 16.00 |
| Mg | 525.00 | 430.00 | 145.00 | 790.00 | 375.00 | 180.00 |
| Ni | 0.14 | 0.12 | 0.05 | 0.21 | 0.09 | 0.04 |
| Mo | 0.14 | 0.04 | 0.07 | 0.21 | 0.09 | 0.03 |
| Ca | 875.00 | 430.00 | 315.00 | 1315.00 | 660.00 | 360.00 |
| Cu | 1.10 | 0.86 | 0.31 | 2.00 | 1.40 | 0.36 |
| Zn | 9.60 | 9.30 | 4.50 | 10.50 | 16.90 | 4.80 |
| Na | 700.00 | 560.00 | 45.00 | 1050.00 | 565.00 | 20.00 |
| K | 5250.00 | 4290.00 | 1260.00 | 7900.00 | 5450.00 | 1200.00 |
| Sr | 1.10 | 1.10 | 1.10 | 1.60 | 0.90 | 3.40 |
| Σ | 8094.98 | 6659.72 | 2280.53 | 11675.72 | 7978.88 | 2013.43 |

Note: Inthesamples: Co<0.03; Pb<0.03; Cd<0.01; As<0.01; Hg<0.01.

On carrying out comparative analysis of both spinach cultivars it should be mentioned that the content of micro- and macroelements is not of much difference. Though, the plant material of "Fantasy" cultivar appeared to be richer by the content of potassium, calcium and sodium. In addition, it should be noticed, that the content of micro- and macroelements prevailed in spinach leaves among other types of plant material. Spinach leaves of "Fantasy" cultivar were found to contain in large quantity, except for the abovementioned elements, magnesium (790.00 mg/100g), phosphorus (340.00 mg/100g) and silicon (210.00 mg/100g). Their total content comprised 1340.00 mg/100g. Aluminum and zinc were accumulated in way smaller quantities with values of 50.20 mg/100gand 10.50 mg/100g respectively. Besides that, the content of manganese (3.90 mg/100g), iron (2.10 mg/100g), copper (2.00 mg/100g) and strontium (1.60 mg/100g) was determined in spinach leaves of "Fantasy" cultivar. The plant material was found to accumulate nickel and molybdenum in the quantity of 0.21 mg/100g for each of the elements.

In spinach roots of "Fantasy" cultivar the prevalence of potassium, calcium and sodium was detected. Their total content comprised 6675.00 mg/100g which was the fifth part of the total micro- and macroelements' content in the plant material studied. The content of silicon was 470.00 mg/100g. Phosphorus and magnesium were accumulated in the equal quantity – 375.00 mg/100g each. The content of aluminum, iron and zinc in the quantities of 41.30 mg/100g, 22.50 mg/100g and 16.90 mg/100g respectively should also be mentioned in spinach roots of "Fantasy" cultivar. The content of strontium comprised 0.90 mg/100g, which was 18 times less than the content of zinc. Manganese was accumulated with insignificant difference and comprised 0.70 mg/100g. Nickel and molybdenum in the roots, as well as in spinach leaves of "Fantasy" cultivar, were found in equal quantity, which was 0.09 mg/100g for each of the elements.

The micro- and macroelements' content in spinach seeds of "Fantasy" cultivar differed from their content in the leaves and roots of the same cultivar. The prevailing elements were potassium, calcium and magnesium with the values in mg/100g – 1200.00, 360.00 and 180.00 respectively. Phosphorus accumulated in the quantity of 160 mg/100g. Among other studied elements the content of silicon – 40.00 mg/100g, aluminum – 20.00 mg/100g, sodium and manganese in the quantity 20.00 mg/100g each could be noted in spinach seeds of "Fantasy" cultivar. The accumulation of manganese in the quantity 16.00 mg/100g, 8.80 mg/100g of iron, 4.80 mg/100g of zinc and 3.40 mg/100gof strontium was detected in this type of the plant material. This was the highest strontium value among all the studied parts of spinach of both cultivars.

Prevailing elements in spinach leaves of "Krasen'Polissia"cultivar, as well as in the leaves of "Fantasy" cultivar, were potassium, calcium and sodium, the total content of which was 6825.00 mg/100g. Magnesium was accumulated in rather smaller quantity – 525.00 mg/100g. The content of silicon and phosphorus with the values 385.00 mg/100g and 260.00 mg/100g respectively was determined. The total content of aluminum and iron comprised 84.00 mg/100g. Zinc was found in the quantity 9.60 mg/100g, and manganese – in the quantity 4.20 mg/100g. In the smallest quantity among the studied elements, in mg per 100g, were accumulated: copper and strontium – 1.10 each, and nickel and molybdenum – 0.14 each.

Preaviling elements in spinach roots of "Krasen'Polissia" cultivar were potassium, sodium and silicon. Their content was 4290.00 mg/100g, 560.00 mg/100g and 545.00 mg/100g respectively. In addition, the accumulation in equal quantities of magnesium and calcium – 430.00 mg/100g each – was determined. The content of phosphorus was almost 1,5 times less than of the abovementioned elements, and comprised 270.00 mg/100g. The accumulation of aluminum and iron in the spinach roots in total comprised 121.50 mg/100g. Zinc was found in the quantity 9.30 mg/100g, and manganese – 1.80 mg/100g. The content of strontium was equal for all the plant material types of spinach of "Krasen'Polissia" cultivar and comprised 1.10 mg/100g. Copper was accumulated in smaller amount – 0.86 mg/100g. The content of nickel and molybdenum comprised 0.12 mg/100g and 0.04 mg/100g respectively.

In spinach seeds of Krasen'Polissia" cultivar, as well as the previous types of the plant material, the content of potassium prevailed, the value of which was 1260.00 mg/100g. The content of silicon and calcium was equal, and comprised 315.00 mg/100g, while the content of phosphorus and magnesium was almost twice lower – 155.00 mg/100g and 145.00 mg/100g respectively. Unlike the leaves and roots, the content of sodium in spinach seeds of Krasen'Polissia" cultivar was substantially lower, and comprised 45.00 mg/100g. In addition, the content of manganese among the studied elements should be mentioned – 6.70 mg/100g. Other 7 elements in spinach seeds of Krasen'Polissia" cultivar was accumulated in smaller quantities, than in the leaves and roots of the same cultivar.

## CONCLUSION

The study of the content of micro- and macro elements was carried out using atomic-emission spectroscopy method in spinach leaves, seeds and roots of "Krasen' Polissia" and "Fantasy" cultivars. In all the plant material samples 19 elements were found to be accumulated, with5 being present in minor quantities. The dominating element was potassium, the content of which comprised 55-68% from the total content of micro- and macroelements in both spinach cultivars. In the spinach plant material of "Fantasy" cultivar the content of macro- and microelements prevailed with insignificant difference. The obtained experimental data will be used for planning further research on spinach leaves, seeds and roots of "Krasen' Polissia" and "Fantasy" cultivars, as well as plant material standardization and development of medicines on the basis of the studied plant.

ISSN: 0975-8585

## REFERENCES


[1] Barzegar M., Erfani F., Jabbari A., Hassandokht M. Chemicalcompositionof 15 spinach (*Spinaceaoleracea* L.) cultivarsgrowninIran. ItalianJournalofFoodScience, 2007, 19(3):309-318.

[2] Burda N. Ye., Dababneh F Moeen., Klivniak B. M., Zhuravel I. A., Rozhkovsky Y. V. TheElementCompositionStudyofThickExtractfromTribulusterrestris L. Herb. ResearchJournalofPharmaceutical, BiologicalandChemical Sciences.2016; 7(6): 2200-2202.

[3] Dafalla A, Abdalla H. Determination the minerals contents of the roots of four medicinal plants as Asaudianindigenousplantsusingflameatomicabsorptionspectroscopy (FAAS) J ChemPharmRes. 2014;6(11):101–4.

[4] Dovgal E, Dababneh MF, Kyslychenko V, Gurieva I, Zhuravel I. TheElementCompositionStudyofCattailFruits. J. Chem. Pharm. Res., 2016, 8 (9):167-68

[5] Ekinci N., Ekinci R., Polat R., Budak G. Analysisoftraceelementsinmedicinalplantswithenergydispersive X-rayfluorescence. J RadioanalNuclChem., 2004, 260(1):127-131.

[6] Giri R K, Kanungo S K, Tripathi N K. HypolipidemicActivityofSpinaciaOleracea L. inAtherogenicDietInducedHyperlipidemicRats. JBPR, 2012, 1 (1): 39-43

[7] Hetta M; Moawad A; Hamed M; Ismail A. InvitroandinvivoHypolipidemicActivityofSpinachRootsandFlowers. IJPR, 2017, 16 (4): 1509-1519

[8] Jiraungkoorskul W. ReviewofNeuro-nutritionUsedasAnti-AlzheimerPlant, Spinach, Spinaciaoleracea. PharmacognRev., 2016, 10(20): 105–108.

[9] Karpiuk UV, Azzam KM, Abudayeh ZH, Kislichenko V, Naddaf A, Cholak I, Yemelianova O. QualitativeandQuantitativeContentDeterminationofMacro-MinorElementsinBryoniaAlba L. RootsusingFlameAtomicAbsorptionSpectroscopyTechnique. AdvPharmBull., 2016, 6(2): 285–291.

[10] Kartika H., Shido J., Nakamoto S.T., Li Q.X., Iwaoka W.T. Nutrientandmineralcompositionofdriedmamakileaves (*Pipturusalbidus*) andinfusions. J FoodCompostAnal, 2011, 24(1): 44-48.

[11] Kavitha V., RamadasSaradha V. Nutritionalcompositionofrawfreshandshadedriedformofspinachleaf (*Spinacholeracea*). JPR: BioMedRx: AnInternationalJournal, 2013,1(8): 767-770

[12] Khan KY, Khan MA, Niamat R, Munir M, Fazal H, Mazari P, Seema N, Bashir T, Kanwal A, Ahmed SN. Elementcontentanalysisofplantsofgenus Ficususingatomicabsorptionspectrometer. Afr. J. Pharm. Pharmacol., 2011, 5(3): 317-321.

[13] Ko SH, Park JH, Kim SY, Lee SW, Chun SS, Park E. AntioxidantEffectsofSpinach (*Spinaciaoleracea* L.) SupplementationinHyperlipidemicRats. PrevNutrFoodSci, 2014, 19 (1): 19–26.

[14] Niamat R, Khan MA, Khan KY, Ahmad M, Ali B, Mazari P. etal. ElementContentofSomeEthnomedicinalZiziphusLinn. SpeciesUsingAtomicAbsorptionSpectroscopyTechnique. J ApplPharmSci., 2012, 2(3):96–100.

[15] Otari K V, Gaikwad P S, Shete R V. SpinaciaoleraceaLinn: a pharmacognosticandpharmacologicaloverview. IJRAP, 2010, 1 (1): 78-84

[16] Popova N.V., Bobritska L.O.,.Arakelian M.A. Theultimatecompositionofimmortelleflowersandflamin. Newsofpharmacy, 2013, 3 (75): 49-51

[17] Sabaghnia N., Asadi-Gharneh H.A., Janmohammadi M. Geneticdiversityofspinach (*Spinaciaoleracea* L.) landracescollectedinIranusingsomemorphologicaltraits. ActaagriculturaeSlovenica, 2014, 103(1): 101-111.

[18] ShahinAziz, KoushikSaha, NasimSultana, HusnaParvinNur, Md. AminulAhsan, ShamimAhmed, Md. KamalHossain. Comparativestudiesofelementalcompositioninleavesandflowersof Catharanthusroseusgrowing inBangladesh. AsianPac J TropBiomed, 2016, 6(1): 50–54.

[19] Shivaranjani V. Leela, Poornima H., Umamaheswari J., LakshmiDevi K. Preliminaryphytochemicalscreeningandquantificationofbioactivecompoundsintheleavesofspinach ( *Spinaceaeoleraceae* L.). JournalofPharmacyResearch, 2014,8(8): 1113-1119

[20] Zvalo V., Respondek A. SpinachvegetablecropsproductionguideforNovaScotia. VegetableProductionGuide – Spinach, AgraPoint, 2008, April: 1-9.