



MINERAL COMPOSITION OF *ALLIUM CEPA* L. LEAVES OF SOUTHERN SUBSPECIES

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ABSTRACT

The mineral composition of *Allium cepa* L. leaves was measured by using the scanning electron microscope of Japanese company JEOL, model JSM600LA with EDS system. 11 collection samples of FRC “All-Russian Institute of Plants Genetic Resources named after N. I. Vavilov” and 4 samples of FSBSI “Research Institute of Agriculture of the Crimea” were studied. 12 main elements (in mass., %) contained in onion leaves were evaluated. The samples with the maximum macro- and micronutrient elements accumulation in the leaves used for the southern subspecies breeds and hybrids selection were revealed. These samples can be used to prevent the elements deficiency in the human body. The following samples number with a high accumulation of the elements in the leaves was revealed: K – nine (from 20.0 to 3.3 max %: B12132B, trimontzium, Rouge pale, Red Wetherstfield, Blood red flat, Valensiya, Tavricheskiy, Yaltinskiy lux, Yaltinskiy rubin), P – five (from 1.8 to 2.8 mass., %: B12132B, Mestniy, Valensiya, Yaltinskiy lux, Yaltinskiy rubin), Mg – one (2.23 mass., %: Rouge pale), Ca – nine (from 5.4 to 8.3 mass., %: Mestniy, Rouge pale, Mestniy, Red Wetherstfield, Blood red flat, Valensiya, Brown Beauty, Yaltinskiy lux and Yaltinskiy rubin), Fe – two (from 0.5 to 0.8 mass., %: B12132B, Tavricheskiy), S – seven (from 2.2 to 2.5 mass., %: B12132B, Mestniy, Red Wetherstfield, Tavricheskiy, Yaltinskiy lux, Yaltinskiy rubin, Yaltinskiy model No. 3), Na – two (from 1.3 to 1.5 mass., %: B12132B, Mestniy), Cl – five (from 4.0 to 7.0 mass., %: Mestniy, B12132B, Trimontzium, Red Wetherstfield, Yaltinskiy model No. 3), Cu – one (1.9 mass., %: Yaltinskiy model No. 5), Mo – eight (from 5.2 to 7.0 mass., %: Tavricheskiy, Yaltinskiy lux, Yaltinskiy rubin, Yaltinskiy model No. 3, Mestniy, Trimontzium, Red Wetherstfield, and B12132B), Zn – seven (from 0.5 to 4.97 mass., %: Yaltinskii model No. 3, Mestniy, B12132B, Rouge pale, Blood red flat, Brown Beauty, Yaltinskiy rubin) and Si – one (0.5 mass., %: Yaltinskiy lux). The order of the elements accumulation variation in the onion samples was distributed as follows: Zn > Fe > Si > Na > P > Cl > Mo > Mg > S > Ca > Cu > K.

Keywords: *Allium cepa* L.; leaves; analytical scanning electron microscopy; energy dispersion X-ray analysis; ash elements

INTRODUCTION

The plants natural feature is their ability to extract and assimilate mineral elements from the soil and water solutions. The following macro nutrient elements are necessary for plants growth and development: N, P, S, K, Ca, Mg, Fe and micro-nutrient elements Cu, Mo, Zn, Mn, B. However, in addition to these elements such useful elements as Na, Cl, Si were also included. They are used in the metabolic processes, with their absence in the environment the plant cannot go through the whole development cycle. The onion green leaves are a source of mineral elements that get into the human body in the form of ions in balanced concentrations. The soil and other multifactorial conditions that accompany the onions growth affect the onions mineral composition (Golubkina, Agafonov and Dudchenko, 2009; Golubkina et al., 2015).

Onions - the main vegetable crop, it is actively used in the food and canning industry, modern medicine. Onions are

consumed in the fresh, fried, boiled form, used for salads, minced meat, in the vegetables canning, in the meat and fish industry (Borisenkova, 1993; Vodyanova and Alpysbaeva, 2004). Green onions and garlic are recommended for eating during flu epidemics, at atherosclerosis and heart disease, especially if the basis of nutrition is foods high in fat and low in fiber. Onions in this case suppress the cholesterol synthesis, reduce the level of fibrinogen (complex protein, blood plasma glycoprotein, the most important blood clotting ability component) (Galkin et al., 2000). Onions are potential sources of prostaglandins, substances that regulate blood pressure (Platonova, 2000; Agafonov et al., 2005). An important component of the onion chemical composition is quercetine, used in combination with vitamin C as a vasodilator (Danikov, 1998; Ulyanova, 1998; Platonova, 2000).

The biochemical composition of both bulbs and green leaves varies in different development stages depending on

the breed, environmental and agro-technical conditions of the plant growing (Ananyina, and Glukhova, 1988; Dudchenko, 2009; Kielak et al., 2006; Nemtinov et al., 2019).

The following onions nutritional value is given by Skurikhin and Tutelyan (2007), mg per 100 g product: K – 175, Ca – 31, Mg – 14, Na – 4, S – 65, P – 58, Cl – 25, Fe – 0.8, Cu – 0.09, Zn – 0.85 mg and other trace elements. The elements content of K – 259, Ca – 100, Mg – 18, Fe – 1.0 (mg.100g⁻¹) in green onions significantly exceeds the analogue parameters of onion bulbs, but the lower level of Zn – 0.39 mg.100g⁻¹. The development of the latest technologies in physiological and medical research confirms the important role of micro nutrient elements in metabolic reactions and submolecular processes the activity of which depends on the presence of certain macro- and micro nutrient elements in the daily human diet (Avtsyn et al., 1991; Kavita and Puneet, 2017; Motyleva et al., 2017). The purpose of our work is to study the peculiarities of mineral elements accumulation in 15 samples of *Allium cepa* L., including 11 collection ones, originating from 9 countries of the world and 4 ones selected by FSBSI "RIA of the Crimea".

Scientific hypothesis

There are no comparative data on the mineral composition of the different samples of *Allium cepa* L. onion leaves, originating from 9 countries of the world, grown in the conditions of the Crimea. We evaluated differences in macro- and micronutrient content in the range of consumer properties of hub varieties.

MATERIAL AND METHODOLOGY

The objects under study were *Allium cepa* L. collection samples. The onions collectable and commercial material was grown in FSBSI "RIA of the Crimea" fields. The green onions leaves were prepared for the mineralization at the bulbs early formation stage (Table 1).

The content of each element in the onion samples was conventionally divided into the groups: high, medium, low.

The soils of FSBSI "RIA of the Crimea" experimental and production base are represented by the southern carbonate black earth. The onion plants were grown on the pure

(background) soils uncontaminated with high-density metals (within permissible rates accepted in Russia).

The data of the quantitative elemental composition, given in the present paper, are taken in the laboratory of physiology and biochemistry of the Centre of the plants genofond and bioresources of Federal State Budgetary Scientific Institution All-Russian Horticultural Institute for Breeding, Agrotechnology and Nursery, Moscow. The researches are original and are fulfilled with the usage of the modern analytical equipment. The average seeds weighing with the mass of 10 g was mineralized in the muffle furnace Naberterm (Germany) at T = 400 °C. The received ash was dispergated by ultrasound at 18 kHz frequency for 15 minutes. The dispergate even layer was applied on the object table covered with carbonic scotch.

The chemical composition of the basic ash components (Na, P, S, K, Mn, Fe, Mg, Ca, Al, Si, Cl, Zn, Se, Mo) was determined by the method of energy dispersive spectrometry (ESD) on the analytical raster electron microscope JEOL JSM 6090 LA. The microscope resolution is 4 nm at accelerating voltage 20 kV (secondary electrons image), zooming is from x 10 till x 10 000. While performing the elemental analysis the working distance (WD) is 10mm. Energy-dispersive spectrometer allows to carry out the quantitative X-ray microanalysis with the desired analysing area: in a point or a really, and to receive the maps of elements allocation. X-ray microanalysis data are presented in the form of standard protocols which contain the microstructure picture of the sample under study, the table of the data in weighting and atomic correlation, spectra and histograms. The spectrum example is shown in Figure 1.

Statistical analysis

Taking into consideration the spectrum lines intensity the concentration of the desired element can be determined. The fractional accuracy of the chemical analysis is spread in the following way: at the element concentration from 1 till 5% the accuracy is less than 10%; from 5 till 10% the accuracy is less than 5%; at the element concentration more than 10% the accuracy is less than 2%. 100 ash areas of each sample were studied. The local analysis is 3 mm, the scanned area is not less than 12 µm. We used the statistical analysis of the Excel package (Microsoft Excel, v. 2016).

Table 1 *Allium cepa* L. onion samples.

Sample name	Origin
Collectable samples	
Mestniy	Russia
B12132B	Australia
Southport red	the USA
Trimontzium	Bulgaria
Tavricheskiy	Russia
Rouge pale	Algeria
Mestniy	Azerbaijan
Red Wetherstfield	Bolivia
Blood red flat	the Netherlands
Valensiya	Portugal
Brown Beauty	the USA
Samples selected by FSBSI "RIA of the Crimea"	
Yaltinskiy model No. 3	Russia
Yaltinskiy model No. 5	Russia
Yaltinskiy lux	Russia
Yaltinskiy rubin	Russia

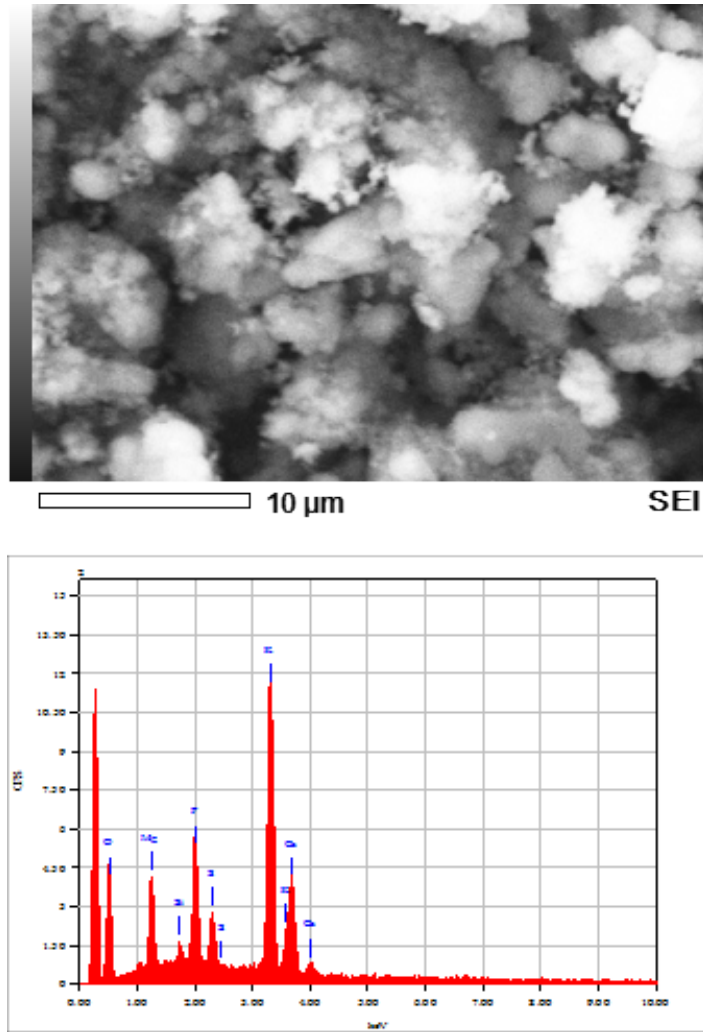


Figure 1 The microstructure picture of the sample under study (1) and the general view of the X-ray spectrum lines that show the elements presence in the analyzing area (2).

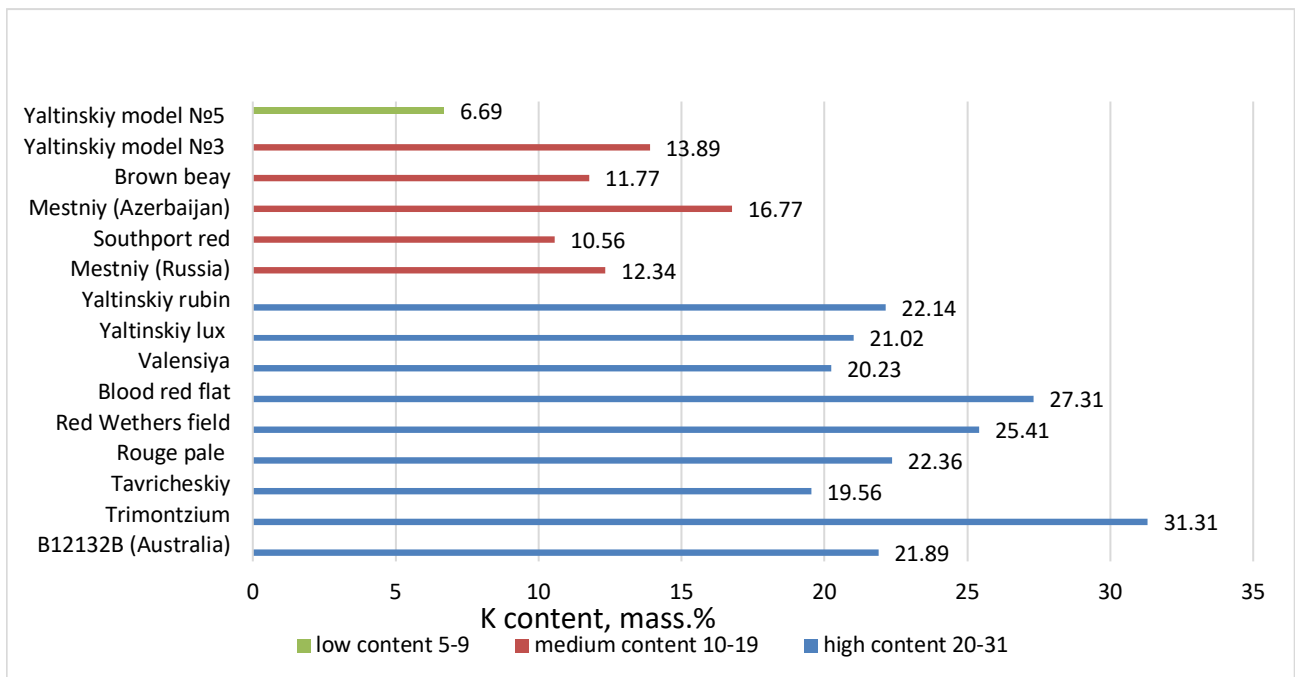


Figure 2 The cultivar differences at K accumulation in *Allium cepa* L. leaves.

RESULTS AND DISCUSSION

Onions or young leaves are used for eating in onion crops. Green leaves have less dry solids and soluble carbohydrates than bulbs, but contain a significant amount of nitrogen compounds, minerals and vitamins. While having hepatic and bile ducts diseases, traditional medicine recommends eating 100 grams of green onion daily, as it contains a significant amount of trace elements the daily dose of which for a person is 200 mg. However, the role of micro-nutrient elements is not yet fully investigated, new data that constantly appear contradict the previous ones. In this regard, we analysed 12 most significant macro and micro-nutrient elements found in green onion leaves. 17 trace elements were found in the onion's ash. Micro-nutrient elements – Cu, Zn, Co, Mo are parts of enzymes and participate in their activation, improve the plants growth and development.

K is necessary for the muscle contractions, the heart muscle normalization, the nerve cells activity, the blood osmotic concentration, the acid-alkaline and water balance. It controls the transmembrane potential of osmotic pressure, the cathode-anion balance, the pH of cell hemostasis. In ion form K increases the concentration of other ions and is found in all the human body organs (Meathnis et al., 1997).

The highest value of K from 20 to 31 mass., % was accumulated in 9 samples of *Allium cepa* L. onion leaves originating from 7 countries: B12132B (Australia), Trimontzium (Bulgaria), Tavricheskiy (Russia), Rouge Pale (Algeria), Red Wetherstfield (Bolivia), Blood red flat (the Netherlands), Valensiya (Portugal), 2 breeds selected by FSBSI "RIA of the Crimea" - Yaltinskiy lux and Yaltinskiy rubin (Figure 2). The other 5 samples from different places of origin contained a medium amount of K in the leaves - from 10.6 to 16.8 mass., % and the sample Yaltinskiy model No. 3 (Russia) accumulated only 6.7 mass., % of K.

In the paired correlation ratios of K the medium connection was revealed with Mg, Cl, S, Cu at $r = 0.4 - 0.6$ and the high correlation with Mo at $r = 0.7$ and the low one with Na, Ca and Zn at $r = 0.16 - 0.24$. The connection with Fe was practically absent ($r = 0.02$) (Figure 3).

P (phosphorus) is a part of humans and animals skeleton, more than 50% of it is represented in tissues in the form of inorganic compounds. It is an integral part of DNA, RNA, phospholipids, ATF, ADP, where it performs a structural function. Its role in cellular energy is great.

Its greatest value in the onion leaves ash is noted in 6 samples: Blood red flat (the Netherlands), B12132B (Australia), Mestniy (Azerbaijan), Valensiya (Portugal), Yaltinskiy lux and Yaltinskiy rubin (Russia). The medium rates (1.2 – 1.4 mass., %) are found in 3 samples: Trimontzium (Bulgaria), Yaltinskiy model No. 3 (the Crimea) and Rouge pale (Algeria). The low level of P content (0.4 – 0.7 mass., %) is marked in 5 samples: Mestniy (Krasnodar, Russia), Southport red (the USA), Red Wethers field (Bolivia), Brown beauty (the USA), Yaltinskiy model No. 5 (Russia). And a very low value (0.22 mass., %) is identified in Tavricheskiy (Russia).

In the paired correlation ratios of P a medium connection was revealed with S, K, Fe and Mo at $r = 0.3 - 0.6$ and an insignificant correlation with Ca at $r = 0.2$ and a very low one with Cl, Cu and Zn at $r = 0.01 - 0.02$ (Figure 3).

Mg (magnesium) is necessary for Ca absorption, the metabolism of glucose, amino acids, fats, the nutrients transportation, is involved in the process of protein synthesis, the nerve signals transmission. It is necessary for the cells, tissues and organs regeneration processes. It activates a large number of enzymes that are involved in CO₂ and N consumption process. It is necessary for keeping the cathode-anion and pH balance.

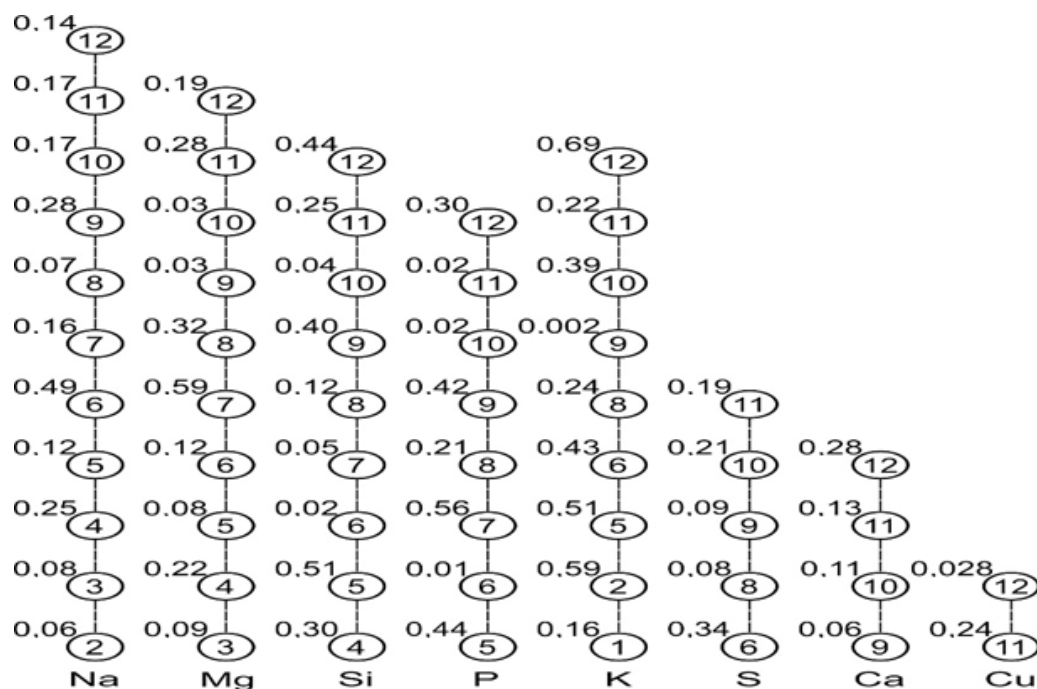


Figure 3 The paired values of the elements content correlation coefficients in *Allium cepa* L. onion leaves: 1 – Na, 2 – Mg, 3 – Si, 4 – P, 5 – S, 6 – Cl, 7 – K, 8 – Ca, 9 – Fe, 10 – Cu, 11 – Zn, 12 – Mo.

Its highest value was found only in one onion leaves sample (2.23 mass.,%): Rouge pale (Algeria), in the other 6 samples the medium rates are marked: 1.1 – 1.5 mass.,%: B12132B (Australia), Southport red (the USA), Trimontzium (Bulgaria), Red Wetherstfield (Bolivia), Valensiya (Portugal).

Mg low value (0.4 – 1.0) was presented in 9 samples: Mestniy (Russia), Tavrisheskiy (Russia), Mestniy (Azerbaijan), Blood red flat (the Netherlands), Brown Beauty (the USA) and 4 samples selected by FSBSI "RIA of the Crimea": Yaltinskiy model No. 3, Yaltinskiy model No. 5, Yaltinskiy lux and Yaltinskiy rubin.

In the paired correlation ratios of Mg the medium connection was revealed with K, Ca and Zn at $r = 0.3 - 0.6$, an insignificant correlation with Si, P, S, Cl, Fe and Cu at $r = 0.08 - 0.22$ (Figure 3).

Ca (calcium). The major part of the human skeleton and teeth consists of Ca. Its ions are involved in blood clotting processes, as well as in providing constant osmotic pressure. It is involved in the cell growth and development processes, is a part of enzymes, affects the metabolism and immunity (Gusev, 1998; Gins and Gins, 2011).

In the onion leaves ash Ca is represented at high rates (5.43 – 8.27 mass., %) in 9 samples: Mestniy (Russia), Rouge pale (Algeria), Mestniy (Azerbaijan), Red Wetherstfield (Bolivia), Blood red flat (the Netherlands), Valensiya (Portugal), Brown Beauty (the USA) and 2 breeds selected by FSBSI "RIA of the Crimea" - Yaltinskiy lux and Yaltinskiy rubin.

Five sort samples showed a medium content (3.74 – 4.92 mass., %) – B12132B (Australia), Southport red (USA), Trimontzium (Bulgaria), Tavrisheskiy (Russia), Yaltinskiy model No. 3 (Russia) and a low level one (1.93 mass., %) – Yaltinskiy model No5 (Russia).

In the paired correlation ratios of Ca there was revealed the correlation with Mo at $r = 0.3$, with Fe, Cu and Zn at $r = 0.06 - 0.13$ (Figure 3).

Fe (iron) is the main active element of blood hemoglobin, is a part of other cells enzymes, it catalyzes the breathing processes in them. Organic Fe is an important compound of the body, it is a part of many oxidation-reduction enzymes.

In the onion ash 2 samples had an increased Fe accumulation (0.49 – 0.78 mass., %): B12132B (Australia) and Tavrisheskiy (the Crimea). The other 9 samples had the medium Fe accumulation (0.11 – 0.21 mass., %): Mestniy (Russia), Trimontzium (Bulgaria), Rouge pale (Algeria), Blood red flat (the Netherlands), Red Wetherstfield (Bolivia), Valensiya (Portugal), Brown Beauty (the USA) and 2 breeds from the Crimea - Yaltinskiy lux and Yaltinskiy rubin. The low Fe accumulation (0.06 – 0.08 mass., %) was found in 4 samples: B12132B (Australia), Mestniy (Azerbaijan) and Yaltinskiy model No. 3 and Yaltinskiy model No. 5 (Russia).

In living organisms S (sulfur) regulates the synthesis of the protein quantity and quality, is a part of its composition, has antioxidant activity. It ensures the process of the electrons energy transfer in the cell. It participates in the methyl groups transportation and fixation, in the production of various hydrogen compounds, which allows the transmission of genetic information (Gins et al., 2018).

The highest S accumulation (from 2.16 – 2.5 mass., %) was found in 7 onion samples: B12132B (Australia), Tavrisheskiy (Russia), Mestniy (Azerbaijan), Red

Wetherstfield (Bolivia), Yaltinskiy model No. 3, Yaltinskiy lux and Yaltinskiy rubin (Russia). The medium content (1.34 – 1.69 mass., %) was noted in 4 samples: Trimontzium (Bulgaria), Rouge pale (Algeria), Blood red flat (the Netherlands), Valensiya (Portugal). The other 4 samples were characterized by the low S accumulation (0.6 – 0.8 mass., %) in the onion leaves ash: Mestniy (Russia), Brown Beauty (the USA), Southport red (the USA) and Yaltinskiy model No. 5 (Russia).

In the paired correlation of S the medium connection was marked with Cl at $r = 0.3$, with other macro- and micro nutrient elements (Ca, Fe, Cu and Zn) the low one at $r < 0.3$ (0.08 – 0.21) (Figure 3).

Na (sodium) a part of the plants enchylema that creates high osmotic pressure, is found mainly in intercellular fluid. Na in combination with K is involved in the membrane potential creation, enzymes and muscle contractions, acid-alkaline and water balance activation provides membrane transfer (Avtsyn et al., 1991). A great number of Na salts are found in green onions, garlic, beetroot, parsley, tomatoes and dill.

Na accumulation in the samples of *Allium cepa* L. onion leaves was marked in the following content (mass.,%): high (1.28 – 1.47) Mestniy (Russia), B12132B (Australia); medium (0.5 – 0.9) Trimontzium (Bulgaria), Rouge pale (Algeria), Mestniy (Azerbaijan), Red Wetherstfield (Bolivia), Blood red flat (the Netherlands), Brown Beauty (the USA); the other 7 samples showed low and very low values.

In the paired correlation ratios of Na, the medium connection was revealed with Cl and Fe at $r = 0.49$ and 0.28 , with other elements the connection was low at $r = 0.12 - 0.25$ and very low at $r = 0.06 - 0.08$ (Figure 3).

Cl (chlorine) is one of the biogenic elements, a constant component of plants, human and animals' tissues. Cl-ions together with Na and K atoms are involved in osmotic equilibrium maintenance and acid-alkaline equilibrium regulating. Na chloride plays a major role in chemical composition homeostasis and water-salt exchange maintenance helping to keep water in tissues. Cl is also an integral part of hydrochloric acid found in gastric juice and actively affects digestion.

Cl accumulation of in the samples of *Allium cepa* L. onion leaves was marked in the following content (mass.,%): high (4.25 – 6.88) Mestniy (Russia), B12132B (Australia), Trimontzium (Bulgaria), Red Wetherstfield (Bolivia) and Yaltinskiy model No. 3 (Russia), medium (3.44 – 3.69) Southport red (the USA), Tavrisheskiy (the Crimea) and Valensiya (Portugal); the other 5 samples contained low rates: low 1.99 – 2.99 and one sample very low 0.79.

Cu (copper) is an important essential micronutrient element in human metabolism, as it is connected with enzymes, hormones and vitamins (Fraga, 2005). According to the U.S. Institute of Medicine and the European Union's Food Science Committee, the daily requirement of an adult is 1 – 1.5 mg. Cu carries out the biological mechanism of enzyme biocatalysis, electron transfer, interaction with Fe. It participates in the generational organ and hemoglobin formation, growth and development processes, is a part of melanin, i.e. together with Fe, Mn, Zn, Cu, Se Cu belongs to the 4th group of Mendeleev Periodic System and is an essential micro nutrient element for humans and mammals (Avtsyn et al., 1991). The importance of onion

Table 2 The cultivar differences at Cu, Mo, Zn, Si accumulation in *Allium cepa* L. leaves.

The sample name, (origin)	Micronutrient elements (mass %, $\pm SD$)			
	Cu	Mo	Zn	Si
Mestniy (Krasnodar, Russia)	1.11 \pm 0.14	1.86 \pm 0.13	0.49 \pm 0.05	0.06 \pm 0.01
B12132B (Australia)	1.09 \pm 0.06	6.14 \pm 0.04	0.58 \pm 0.01	0.24 \pm 0.04
Southport red (the USA)	0.88 \pm 0.07	1.73 \pm 0.03	0.28 \pm 0.01	0.03 \pm 0.01
Trimontzium (Bulgaria)	1.06 \pm 0.11	5.52 \pm 0.44	0.22 \pm 0.01	0.14 \pm 0.02
Tavrisheskiy (the Crimea)	1.23 \pm 0.11	6.83 \pm 0.31	0.11 \pm 0.02	0.07 \pm 0.01
Rouge pale (Algeria)	0.69 \pm 0.01	3.54 \pm 0.22	0.65 \pm 0.02	0.07 \pm 0.01
Mestniy (Azerbaijan)	1.11 \pm 0.11	5.49 \pm 0.24	0.22 \pm 0.02	0.29 \pm 0.02
Red Wetherstfield (Bolivia)	0.12 \pm 0.01	5.59 \pm 0.33	0.2 \pm 0.01	0.12 \pm 0.01
Blood red flat (the Netherlands)	0.88 \pm 0.01	2.68 \pm 0.24	0.47 \pm 0.04	0.08 \pm 0.01
Valensiya (Portugal)	1.41 \pm 0.13	4.01 \pm 0.14	0.07 \pm 0.01	0.13 \pm 0.01
Brown Beauty (the USA)	0.89 \pm 0.02	1.35 \pm 0.11	0.68 \pm 0.01	0.09 \pm 0.02
Yaltinskiy model No. 3 (the Crimea)	0.77 \pm 0.01	5.15 \pm 0.25	4.97 \pm 0.15	0.29 \pm 0.01
Yaltinskiy model No. 5 (the Crimea)	1.93 \pm 0.14	0.44 \pm 0.01	0.33 \pm 0.01	0.15 \pm 0.06
Yaltinskiy lux (the Crimea)	1.15 \pm 0.09	5.88 \pm 0.54	0.31 \pm 0.01	0.51 \pm 0.05
Yaltinskiy rubin (the Crimea)	1.32 \pm 0.10	5.42 \pm 0.45	0.82 \pm 0.03	0.06 \pm 0.02

Note: Means within a column with at least one identical superscript are not significantly different by Student's t-test ($p < 0.05$).

consumption as a source of Fe, Mn and Cu for humans is great (Golubkina et al., 2013; Skalnaya et al., 2004).

According to Cu accumulation the highest value is noted in 1 sample (1.93 mass.%) Yaltinskiy model No. 5 (Russia) (Table 2), medium one was found in 8 samples (1.0 – 1.5 mass. %): Mestniy (Russia), B12132B (Australia), Tavrisheskiy (Russia), Mestniy (Azerbaijan), Valensiya (Portugal) and breeds Yaltinskiy lux and Yaltinskiy rubin (Russia). Low Cu accumulation had 6 samples (0.12 – 0.9 mass. %): Southport red (the USA), Rouge pale (Algeria), Red Wetherstfield (Bolivia), Blood red flat (the Netherlands), Brown Beauty (the USA) and Yaltinskiy model No. 3 (Russia).

In the paired correlation ratios of Cu low connection was revealed with Zn at $r = 0.24$ and a very low correlation with Mo at $r = 0.028$ (Figure 3).

Mo (molybdenus) ensures the enzyme catalysis mechanisms, as well as the electrons transfer, is involved in the aminoacids synthesis, in the vitamins C, E, and B12 exchange Avtsyn et.al. (1991). A human's daily need for Mo is 0.5 mg. Mo accumulates mainly in the liver, the kidneys, the internal secretion glands and the skin.

The high Mo accumulation was found in 8 samples: Yaltinskiy model No. 3, Yaltinskiy rubin (the Crimea), Mestniy (Azerbaijan), Trimontzium (Bulgaria), Red Wetherstfield (Bolivia), Yaltinskiy lux (the Crimea) and B12132B (Australia) (from 5.15 – 6.14 mass. %) with the highest value in Tavrisheskiy (the Crimea) (6.83 mass. %) (Table 2). The medium Mo content was revealed in 3 samples (from 2.68 – 4.01 mass. %): Blood red flat (the Netherlands), Rouge pale (Algeria) and Valensiya (Portugal); the low rates – in 3 samples (from 1.35 – 1.86 mass. %): Southport red (the USA), Brown Beauty (the USA), Mestniy (Russia) and Yaltinskiy model No. 5 (Russia) showed the lowest value (0.44 mass. %).

Zn (zinc) stabilizes the molecules structure, plays an important role in DNA and RNA metabolism, in the protein synthesis and cells division, in the process of signal

transmission inside the cell (Nechaev, Trauberg and Kochetkova, 2007). There are plants-concentrators and even superconcentrators, which accumulate micronutrient elements and can be used for Zn deficiency treatment and prevention measures in the human body.

In our example, *Allium cepa* L. samples accumulated a very high content (4.97 mass.%) in Yaltinskiy model No. 3 (Russia) and the high one in 6 samples (0.47 – 0.82 mass. %): Mestniy (Russia), B12132B (Australia), Rouge pale (Algeria), Blood red flat (the Netherlands), Brown Beauty (the USA), Yaltinskiy rubin (Russia) (Table 2). The other 7 samples accumulated Zn at low values (0.2 – 0.33 mass. %), with the highest rate in Yaltinskiy model No. 5 (Russia). A very low Zn content (0.07 – 0.11 mass. %) corresponded to two breeds - Tavrisheskiy (Russia) and Valensiya (Portugal).

Si (silicon) is an obligatory element for plants (Kolesnikov and Gins, 2001). It is accumulated in large quantities in leaves, especially in the leaves and roots conductive tissues. Si is not only the basis of tissues, but it also controls a number of biological and chemical processes in humans and animals. The skin, tendons, vascular walls elasticity is due mainly to Si contained in them. Si increases the plants specific resistance to abiogenic stresses.

Si accumulation in the samples of *Allium cepa* L. onion leaves was noted in the following rates, mass. %: high (0.5) Yaltinskiy lux (Russia), medium (0.21 – 0.3): B12132B (Australia), Mestniy (Azerbaijan) and Yaltinskiy model No. 3. (Russia), low (0.11 – 0.2): Mestniy (Russia), Trimontzium (Bulgaria), Red Wetherstfield (Bolivia) and Yaltinskiy model No. 3 (Russia) and a very low (0.03 – 0.1): (6 samples) (Table 2).

Cu and Zn content in plant products controlled by sanitary standards, which are 5 mg.kg⁻¹ (Cu) and 10 mg.kg⁻¹ (Zn) (SANPIN 2.3.2 1078-01, 2013). According to our data, the content of Cu and Zn in the studied onion samples does not exceed permissible norms.

CONCLUSION

Allium cepa L. onion samples, the concentrators, with the highest accumulation of macro- and micronutrient elements in the leaves have been studied. The breeds that can be used for the selection purposes and elements deficiency prevention in the human body were revealed. The following number of the samples with high elements accumulation in the leaves were identified: K – nine, P – five, Mg – one, Ca – nine, Fe – two, S – seven, Na – two, Cl – five, Cu – one, Mo – eight, Zn – seven and Si – one.

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