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The Determination of Mineral and Heavy Metal Contents of Echinacea Species Cultivated in Turkey

S. Ayşe ÇELİK[*1], Yüksel KAN[1]

[1]Selcuk University, Faculty of Agriculture, Department of Medical Plants 42075-Konya.

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Abstract: This study was carried out in the ecological conditions of Konya in 2013 and 2014 at Selcuk University Faculty of Agriculture, The Farm of Medicinal Plants. Mineral compositions (Na, K, Ca, P, Fe, Zn, Cu, Mn Al, Cd, Co, Ni, Cr, Mo and Pb) were examined in five different species of Echinacea. The analyses of mineral compositions in *Echinacea* species were determined using NMKL 161 method and A Perkin-Elmer Optima 2000 inductively coupled plasma–optical emission spectrophotometer (ICP–OES) was used to analyze the elements to determine the mineral substances. The highest B, Ca, K, Na, P and S average contents according to the two-year mean values belonging to the herbs of Echinacea species were *Echinacea purpurea* var. *double decker* 135,029 ppm, *Echinacea purpurea* var. *double decker* 31185,018 ppm, *Echinacea purpurea* var. *baby white swan* 21968,858 ppm, *Echinacea pallida* var. *pallida* 104,742 ppm, *Echinacea purpurea* var. *purpurea* 2490,672 ppm and *Echinacea paradoxa* var. *paradoxa* 1754,594 ppm respectively. The herbs with the highest Al, Cd, Co, Cr, Cu, Fe, Mn, Pb, Mo, Ni and Zn average contents according to the two-year mean values belonging to the herbs of Echinacea species were *Echinacea purpurea* var. *baby white swan* 432.195 ppm, *Echinacea purpurea* var. *purpurea* 0.111 ppm, *Echinacea paradoxa* var. *paradoxa* 0,395 ppm, *Echinacea paradoxa* var. *paradoxa* 2,615 ppm, *Echinacea purpurea* var. *purpurea* 22,535 ppm, *Echinacea purpurea* var. *baby white swan* 451.350 ppm, *Echinacea paradoxa* var. *paradoxa* 46.217 ppm, *Echinacea paradoxa* var. *paradoxa* 21.366 ppm, *Echinacea purpurea* var. *purpurea* 3.364 ppm, *Echinacea paradoxa* var. *paradoxa* 2.936 ppm and *Echinacea paradoxa* var. *paradoxa* 22.218 ppm respectively. The highest B, Ca, K, Na, P and S contents according to the two-year mean values of Echinacea roots were determined as *Echinacea purpurea* var. *double decker* 102,620 ppm, *Echinacea purpurea* var. *purpurea* 38805,7 ppm, *Echinacea paradoxa* var. *paradoxa* 20656,313 ppm, *Echinacea pallida* var. *pallida* 2062,226 ppm, *Echinacea paradoxa* var. *paradoxa* 2262,165 ppm and *Echinacea paradoxa* var. *paradoxa* 2181,838 ppm.

Keywords: Echinacea, Minerals, Heavy metals, Herb, Root.

1. INTRODUCTION

Compositeae (Asteraceae) is the richest family of flowering plants, representing by nearly 1000 genera and close to 20,000 species. About 133 genera and 1156 species belonging to family Asteraceae are grown in our country [1]. Echinacea species are perennial herbaceous plants in the Asteraceae family [2]. The Echinacea genus contains 11 species according to the review by Mc Keown (1999) [4]. The first culture studies of Echinacea plant in our country

[*]Corresponding Author E-mail: sacelik@selcuk.edu.tr

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started in 2005 in the Selcuk University Faculty of Agriculture, The Farm of Medicinal Plants. Echinacea is a plant that can be grown up to 60-80 cm and starts to bloom from the second half of June. Leaf and stem of them are light hairy. The stem is cylindrical and consists of a very large number of side branches (25-30 on average). Approximately 250-300 seeds can be obtained in a mature flower bed. The seeds are about 5 mm long and 1.5 mm wide; it is angular and resembles a funnel. 1000 seed weights are about 5-6 g [5].

Echinacea species were used as wound healing externally and as a headache, gastric pain and cough cutter by the Native Americans [3, 6]. It has proven anti-bacterial, anti-inflammatory, immune system strengthening and wound healing properties [7]. Especially in infectious diseases, it helps the body naturally increase resistance and pain. It is a preventive and therapeutic against colds, chill and influenza. The demand to Echinacea is increasing day by day both in our country and in the world [8]. Echinacea species are imported as drug or preparate and used in different pharmaceutical forms in the world.

This study was carried out in the ecological conditions of Konya in 2013 and 2014 at Selcuk University Faculty of Agriculture, The Farm of Medicinal Plants. Mineral compositions (macro elements, Na, K, Ca, and P; micro elements, Fe, Zn, Cu, and Mn; heavy metals, Al, Cd, Co, Ni, Cr, Mo and Pb) were investigated in herb and root specimens obtained from during full bloom period of five different species of Echinacea ((*Echinacea purpurea* var. *purpurea* (L.) Moench, *Echinacea pallida* var. *pallida* (Nutt.) Nutt., *Echinacea paradoxa* var. *paradoxa* (J.B.S. Norton) Britton, *Echinacea purpurea* var. *baby white swan* (L.) Moench and *Echinacea purpurea* var. *double decker* (L.) Moench)).

2. MATERIAL and METHODS

2.1. Plant Material

This study was carried out in the ecological conditions of Konya in 2013 and 2014 at Selcuk University Faculty of Agriculture, The Farm of Medicinal Plants. The seedlings of Echinacea species were growed in the greenhouse in 2012. Because echinacea is a perennial plant, analyses samples were not obtain from the farm the first year. But harvested analyses samples in the 2nd and 3rd years (2013-2014). The herb samples of five different species of Echinacea (*Echinacea purpurea* var. *purpurea* (L.) Moench, *Echinacea pallida* var. *pallida* (Nutt.) Nutt., *Echinacea paradoxa* var. *paradoxa* (J.B.S. Norton) Britton, *Echinacea purpurea* var. *baby white swan* (L.) Moench and *Echinacea purpurea* var. *double decker* (L.) Moench)) harvested during the full blooming period were dried in the shade and ground for analysis. During the short storage time, the plant samples were kept at -20°C until use.

2.2. Determination of Mineral and Heavy Metal Contents of Echinacea Species Cultivated in Turkey

The NMKL 161 method was used to determine the mineral substances. For this purpose, ICP-OES (A Perkin-Elmer Optima 2000 inductively coupled plasma-optical emission spectrophotometer) was used. The determined minerals were Al, Co, Mo, Ca, B, Cd, Cr, Cu, Fe, K, Mn, Na, Ni, P, Pb, S and Zn. The results of the mineral substances were given in ppm (mg / kg) [9].

2.3. Evaluation of Data

Variance analyzes of the data obtained in the study were made by JMP-SAS 7.0 statistical package program and MSTAT-C statistical package program was used to make the letters. The statistically significant group tests between the mean values were determined by LSD (0.01 and 0.05 significance levels).

3. RESULTS and DISCUSSIONS

3.1. Minerals and Heavy Metals Results of Herbs

Mineral compositions (macro elements, Na, K, Ca, and P; micro elements, Fe, Zn, Cu, and Mn; heavy metals, Al, Cd, Co, Ni, Cr, Mo and Pb) were determined five different species of Echinacea ((*Echinacea purpurea* var. *purpurea* (L.) Moench, *Echinacea pallida* var. *pallida* (Nutt.) Nutt., *Echinacea paradoxa* var. *paradoxa* (J.B.S. Norton) Britton, *Echinacea purpurea* var. *baby white swan* (L.) Moench and *Echinacea purpurea* var. *double decker* (L.) Moench)) The average values of mineral substances in the herbs obtained during the full blooming period in 2013 and 2014 are given in the tables section..

While the highest B (Boron) amount, according to two year mean values, was found in *Echinacea purpurea* var. *double decker* with 135,029 ppm, the lowest was found in *Echinacea paradoxa* var. *paradoxa* with 58,317 ppm. According to years, the mean values of 2014 was found to be higher with 120,306 ppm with respect to the B amount. Although the highest Ca (Calcium) value of 2013 and 2014 mean values was found in 2014 with 28182.381 ppm, it took place in the same group with the average of 2013 according to the statistical evaluation. According to two-year mean values of herbs, the highest Ca amount was found in *Echinacea purpurea* var. *double decker* with 31185.018 ppm. When two-year mean values were analyzed, the highest K (potassium) concentration was found in *Echinacea purpurea* var. baby white swan with 21968.858 ppm and the lowest was found in *Echinacea paradoxa* var. *paradoxa* with 18922.968 ppm. When 2013 and 2014 year mean values were analyzed, the highest K value was found to be higher as 20957.844 ppm in 2014. When the two-year mean values of the herbs were examined, the highest Na (sodium) concentration was found in *Echinacea pallida* var. *pallida* with 104,742 ppm and the lowest Na concentration was found in *Echinacea purpurea* var. *baby white swan* with 41,605 ppm. According to the data of 2013 and 2014, Na in 2013 was found to be 84.238 ppm higher than in 2014. The highest P (phosphor) intensity according to the two-year mean values was found as 2490,672 ppm in *E. purpurea* var. *purpurea*. Although the average P values of 2013 and 2014 were statistically in the same group, the average value for 2014 was higher than 2013 with 2271.622 ppm. The highest value of the herbs were determined to be 1754.594 ppm in *Echinacea paradoxa* var. *paradoxa* according to the mean values of S (sulphur) content for both year. Also, the lowest was found in *Echinacea purpurea* var. *purpurea* with 1087.522 ppm. When both years mean values were considered, S value of 2013 was found to be higher with 1437.124 ppm.

Results belonging to Al, Cd, Co, Cr, Cu, Fe, Mn, Pb, Mo, Ni and Zn heavy metals are shown in "Tables" section. According to the average of the two-year values, the Al (aluminium) content intensity was found to be higher in 2013 with 324.281 ppm. Among the herbs, the highest Al amount was found in *Echinacea purpurea* var. *baby white swan* with 432.195 ppm. The lowest Al amount was found in *Echinacea pallida* var. *pallida* with 115,976 ppm. Looking at 2013 and 2014, while the Cd (cadmium) concentration was found to be higher in 2013 with 0.112 ppm, it was found to be lower in 2014 with 0.101 ppm. When two-year mean values of herbs were examined, the highest Cd amount was found in *Echinacea purpurea* var. *purpurea* with 0.111 ppm. According to the two-year mean values of the herbs, while the highest Co (cobalt) amount was found in *Echinacea paradoxa* var. *paradoxa* with 0,395 ppm, the lowest Co amount was found in *Echinacea purpurea* var. *baby white swan* with 0,316 ppm. When two-year average values were considered the highest Cr (chromium) concentration was obtained in 2013 with 2,102 ppm. In the average of both two-year data of the herbs, the highest Cr concentration was obtained from *Echinacea paradoxa* var. *paradoxa* with 2.615 ppm and lowest in *Echinacea pallida* var. *pallida* with 0.544 ppm. Considering the mean values of 2013

and 2014, Cu (copper) was the highest with 17.095 ppm in 2014. When the average of the two-year data of herbs was taken into consideration, the Cu measure was obtained from *Echinacea purpurea* var. *purpurea* with 22,535 ppm as the highest and *Echinacea purpurea* var. *baby white swan* with 11,581 ppm as the lowest. When the two-year mean values of the herbs were examined, the highest Fe (iron) amount was found in *Echinacea purpurea* var. *baby white swan* with 451,350 ppm and the lowest Fe amount was found in *Echinacea paradoxa* var. *paradoxa* with 158,181 ppm. When mean values of data taken between 2013 and 2014 were analyzed, Fe proportion was found to be higher with 369,942 ppm in 2013. Mn (manganese) proportion in 2013 was found higher than 2014 with 32.988 ppm. In the average of two-year data of the herbs, the highest Mn amount was determined in *Echinacea paradoxa* var. *paradoxa* with 46.217 ppm and the lowest in *Echinacea pallida* var. *pallida* with 9.126 ppm. When each year's Pb (Lead) mean values were examined, the average value in 2013 (0,966 ppm) was found higher than 2014. When the two-year mean values of the herbs were examined, it was seen that *Echinacea paradoxa* var. *paradoxa* had the highest Pb concentration with 1,366 ppm and *Echinacea pallida* var. *pallida* had the lowest value with 0,583 ppm. Mo (molybdenum) amount in 2013 was found higher than 2014 with 2.268 ppm. Looking at the mean values of 2013 and 2014, the highest Mo amount was determined in *Echinacea purpurea* var. *purpurea* with 3,364 ppm. The lowest Mo amount was found in *Echinacea purpurea* var. *double decker* with 0,673 ppm. In the average of two-year data of the herbs, the highest Ni (nickel) mass was determined in *Echinacea paradoxa* var. *paradoxa* with 2,936 ppm and the lowest in *Echinacea pallida* var. *pallida* with 0.941 ppm. Ni mass in 2013 was found higher than 2014 with 2.410 ppm. Zn (zinc) amount in 2013 was found higher than 2014 with 19.809 ppm. The highest Zn proportion was determined in *Echinacea paradoxa* var. *paradoxa* with 22.218 ppm according to two-year mean values of herbs. The lowest Zn concentration was found in *Echinacea pallida* var. *pallida* with 14,710 ppm.

3.2. Minerals and Heavy Metals Results of Roots

Mineral compositions (macro elements, Na, K, Ca, and P; micro elements, Fe, Zn, Cu, and Mn; heavy metals, Al, Cd, Co, Ni, Cr, Mo and Pb) were examined in root samples obtained during full bloom period of five different species of Echinacea (*Echinacea purpurea* var. *purpurea* (L.) Moench, *Echinacea pallida* var. *pallida* (Nutt.) Nutt., *Echinacea paradoxa* var. *paradoxa* (J.B.S. Norton) Britton, *Echinacea purpurea* var. *baby white swan* (L.) Moench and *Echinacea purpurea* var. *double decker* (L.) Moench) The average values of mineral substances in the roots obtained during the full blooming period in 2013 and 2014 are given in the "Tables" section.

When the two-year average B values of roots were examined, it was found to be the highest at *Echinacea purpurea* var. *double decker* root with 102.620 ppm. B content value was found to be higher in 2013 with 74.440 ppm according to the mean values at the roots in 2013 and 2014. According to years, Ca was found to be higher in 2013 with 37570.5 ppm, while it was found the highest in root of *Echinacea purpurea* var. *purpurea* with 38805.7 ppm when average two-year Ca concentration of roots was compared. When both years mean values were considered, K value in 2013 was found to be higher with 16853.219 ppm. When the two-year average K amounts of plant roots were examined, *Echinacea paradoxa* var. *paradoxa* root was found the highest with 20656.313 ppm. The lowest K mass was obtained from *Echinacea purpurea* var. *baby white swan* root with 10287.899 ppm. When the average values of the two years were examined, the proportion of Na in 2014 with 379.402 ppm was higher than Na of 2013 (627.201 ppm). According to the two-year mean Na values of the herbs' roots, the highest was examined in *Echinacea pallida* var. *pallida* root with 2062.226 ppm and the lowest was found in *Echinacea purpurea* var. *baby white swan* with 605,483 ppm. When two-year mean values of P values were examined, the highest P concentration was found in *Echinacea*

paradoxa var. *paradoxa* root with 2262.165 ppm. P concentration, according to years, was found to be higher with 1856.940 ppm in 2013. According to years, the average S amount in 2013 was found to be higher with 1988.549 ppm. When the two-year average S amounts of plant roots were examined, it was found the highest in *Echinacea paradoxa* var. *paradoxa* root with 2181.838 ppm. The lowest S amount was found in *Echinacea purpurea* var. *purpurea* root with 1441.389 ppm.

When the data of heavy metals of Al, Cd, Co, Cr, Cu, Fe, Mn, Pb, Mo, Ni and Zn in roots were determined, according to the average of the two-year values, the Al content mass was found to be higher in 2013 with 2197.75 ppm. Among the roots, the highest Al mass was found in *Echinacea purpurea* var. *purpurea* with 3966.88 ppm. The lowest Al mass was found in *Echinacea purpurea* var. *double decker* with 415.25 ppm. Looking at the two-year average Cd proportions, 2013 was identified higher than 2014 with 0,144 ppm. When the two-year mean values of the roots were studied, the highest and the lowest Cd values were respectively; in *Echinacea purpurea* var. *purpurea* root with 0.174 ppm and in *Echinacea purpurea* var. *purpurea* root with 0.099 ppm. When two-year mean Co values of roots were studied, the highest was found in *Echinacea purpurea* var. *purpurea* root with 0,712191 ppm. Zn was found to be higher in 2013 with 0,496637 ppm according to the mean values at the roots in 2013 and 2014. Cr concentration, according to mean values of years, was found to be higher with 4,439 ppm in 2013. When the two-year mean values of the roots were determined, the highest Cr amount was found in *Echinacea purpurea* var. *purpurea* root as 7.755 ppm. When Cu mass of the roots were taken into account, the highest value was obtained from *Echinacea purpurea* var. *purpurea* root with 25.305 ppm. Cu amount was found to be higher with 24,548 ppm in 2014 among the mean values of 2013 and 2014. When the two-year average Fe mass of plant roots were considered, the highest was found in *Echinacea purpurea* var. *purpurea* root with 4137.818 ppm and also the lowest in *Echinacea purpurea* var. *double decker* root with 528,373 ppm. When the average Fe concentrations of 2013 and 2014 were determined,, the average Fe concentration of 2013 was obtained to be higher with 2358.044 ppm. When the average Mn values of the two years were examined, the Mn amount of 2013 with 99,918 ppm was determined higher than Mn amount of 2014 (67.437 ppm). Looking at the average values of roots in 2013 and 2014, the highest Mn value was found in *Echinacea purpurea* var. *purpurea* root with 166.595 ppm and the lowest *Echinacea purpurea* var. *double decker* root with 49.624 ppm. According to years, the average Pb proportion was found to be higher in 2013 with 2.440 ppm. When the two-year average Pb proportions of roots were studied, *Echinacea purpurea* var. *purpurea* root was found the highest with 4,508 ppm. The lowest Pb amount was found in *Echinacea paradoxa* var. *paradoxa* root with 1,089 ppm. Looking at the two-year mean values of the roots, the highest Mo mass was found in *Echinacea purpurea* var. *purpurea* root as 10.6734 ppm. The lowest Mo amount was obtained from *Echinacea purpurea* var. *baby white swan* root with 0.7236 ppm. According to the average of 2013-2014 values, Ni content was found to be higher in 2013 with 5.415 ppm. When the two-year Ni averages of roots were examined, the highest Ni amount was determined to be 9.731 in *Echinacea purpurea* var. *purpurea* root. When the average of the two-year values were examined with respect to Zn concentration, it was found to be higher in roots taken at 2013 with 50.068 ppm. When the two-year average Zn amount of plant roots were considered, the highest was found in *Echinacea purpurea* var. *purpurea* root with 96,978 ppm and the lowest in *Echinacea purpurea* var. *double decker* root with 23,772 ppm.

The role of each element is different so that plants can nourish and sustain their vital activities. 16 of these elements are absolutely necessary for plants, these are; C, H, 0, N, P, K, S, Ca, Mg, Fe, Zn, Mn, Cu, B, CI, and Mo. Some elements are important for some plants, these are; Co, Al, Na, Si, Ni and V. In this study, considering the above information, minerals of Al, Co, Mo, Ca, B, Cd, Cr, Cu, Fe, K, Mn, Na, Ni, P, Pb, S and Zn were determined in Echinacea

herbs and roots. Al, Cd, Cr, Co, Cu, Fe, Mn, Pb, Mo, Ni, Zn of these elements are heavy metals and the others (Ca, Na, B, P, S, and K) are important for plants. According to obtained results, it is seen that heavy metals were not found in much amounts in the herbs. Nutrients are taken not only by root systems, but also by above-ground organs, especially by the leaves. Since leaves, stem and flowers are parts of the herb; the mineral proportions we have determined have been found to be higher in Echinacea species with higher leaf density (*Echinacea purpurea* var. *purpurea* (L.) Moench, *Echinacea pallida* var. *pallida* (Nutt.) Nutt., *Echinacea paradoxa* var. *paradoxa* (J.B.S. Norton) Britton, *Echinacea purpurea* var. *baby white swan* (L.) Moench and *Echinacea purpurea* var. *double decker* (L.) Moench) as seen in Table 1. Heavy metal concentration was determined to be higher in Echinacea roots according to results. Especially Al (aluminum) content were found high. It is thought that the reason of heavy metals to be high in the *E. purpurea* var. *purpurea* root is due to the fact that root structure of them are hairy root so the root ends are improved. At the same time, it is thought that the higher levels of heavy metals in the *E. purpurea* var. *purpurea*, *E. purpurea* var. *baby white swan* and *E. purpurea* var. *double decker* roots are due to the hairy root structures and therefore the roots propagate sideways. The heavy metal concentrations were observed lower because they have taproot structure and reach the depths of the soil.

4. CONCLUSION

Table 1 and Table 2 indicate that there were significant ($p<0.01$) differences between the herbs and roots of Echinacea species with respect to their mineral compositions. The results of this study demonstrate that the aim of the study to compare of differences between the herbs and roots of Echinacea species. It was observed that the minerals of herbs and roots of Echinacea species were significantly differences. *Echinacea* spp. contain a lot of the minerals. Furthermore, the mineral composition of *Echinacea* samples showed a balance as good nutritional quality. However, further detailed studies on the mineral compositons of Echinacea spp are required. In conclusion, the Echinacea spp. contain many valuable minerals that is importance.

Table-1. Mean values and groupings of mineral values of Echinacea herbs (ppm)

Year	Types of Echinacea	Al	Co	Mo	Ca	B	Cd	Cr	Cu	Fe	K	Mn	Na	Ni	P	Pb	S	Zn
2013	1	184,118 cd	0,359 e	3,663 ab	21611,681 cd	66,619g	0,112ab	0,643c	8,979e	228,719d	17482,814e	9,345f	117,663a	0,898e	1879,808e	0,412c	1672,301b	14.957
	2	225,044 c	0,382 d	4,875 a	25892,648 bcd	89,801def	0,104abc	2,195b	17,194c	325,565c	21365,645bc	25,213cd	89,913ab	2,485b	2373,017bc	1,015b	1193,171ef	21.445
	3	721,829 a	0,308 g	1,078 c	17199,606 d	108,367c	0,112ab	2,124b	12,709d	713,692a	24091,280a	32,055bc	53,547ab	2,399b	2324,607cd	0,834bc	1489,217c	19.370
	4	322,765 b	0,324 f	0,737 c	23132,006 cd	92,731de	0,107abc	0,870bc	10,350e	381,326b	19628,651d	19,656de	50,407ab	1,445cd	2007,012e	0,390c	1124,540f	16.278
	5	167,647 cd	0,436 b	0,986 c	28679,245 bc	39,904h	0,127a	4,677a	23,762b	200,410d	16969,524e	78,669a	109,660a	4,821a	2216,603cd	2,180a	1706,390b	26.995
	Mean	**324,281a**	**0,356**	**2,268a**	**23303,037a**	**79,484b**	**0,112a**	**2,102a**	**14,599b**	**369,942a**	**19907,583b**	**32,988a**	**84,238**	**2,410a**	**2160,209a**	**0,966a**	**1437,124a**	**19.809**
2014	1	47,835 e	0,423 c	0,612 c	20330,502 cd	83,194ef	0,107abc	0,445c	22,241b	95,784e	20660,910bcd	8,906f	91,821ab	0,983de	2493,166ab	0,753bc	987,354g	14.463
	2	138,815 d	0,356 e	1,853 bc	34035,310 ab	162,137b	0,117ab	0,599c	27,875a	209,224d	21310,926bc	24,800cd	96,216ab	1,229de	2608,327a	0,345c	981,873g	22.577
	3	142,561 d	0,324 f	1,172 c	20891,804 cd	102,141cd	0,085c	0,300c	10,453e	189,008d	19846,436cd	16,537def	29,664b	1,208de	1846,342e	0,648bc	1351,915d	18.798
	4	210,213 c	0,452 a	0,608 c	39238,030 a	177,327a	0,103abc	0,655c	14,509d	289,114c	22094,535b	41,127b	104,710ab	1,837c	2207,149cd	0,793bc	1230,315e	19.621
	5	71,654 e	0,354 e	0,722 c	26416,262 bcd	76,731fg	0,093bc	0,553c	10,397e	115,952e	20876,412bcd	13,765ef	57,703ab	1,052de	2203,125d	0,551bc	1802,799a	17.441
	Mean	**122,215b**	**0,382**	**0,993a**	**28182,381a**	**120,306a**	**0,101b**	**1,306**	**17,095a**	**179,816b**	**20957,844a**	**21,027b**	**76,023**	**1,262b**	**2271,622a**	**0,618a**	**1270,851b**	**18,580**
LSD Herb		**44.04**	**0.001643**	**1.335**	**9782**	**13.22**	**-**	**1.451**	**1.909**	**55.52**	**1563**	**9.695**	**75.62**	**0.4928**	**168.5**	**0.5691**	**90.51**	**11.36**
LSD Year		**76.27**	**-**	**2.312**	**11980**	**13.22**	**0.02845**	**1.451**	**1.909**	**55.52**	**1563**	**9.695**	**-**	**0.4928**	**168.5**	**0.5691**	**90.51**	**-**

Types of Echinacea; 1. *E. pallida* var. pallida, **2.** *E. purpurea* var. purpurea, **3.** *E.purpurea* var. baby white swan, **4.** *E. purpurea* var. double decker, **5.** *Echinacea paradoxa* var. paradoxa

Table-2. Mean Values and Groupings of Mineral Values of Echinacea Roots (ppm)

Year	Types of Echinacea	Al	Co	Mo	Ca	B	Cd	Cr	Cu	Fe	K	Mn	Na	Ni	P	Pb	S	Zn
2013	1	1995,19b	0,474b	3,2056	31370,54cd	26,239cd	0,146b	5,382b	18,420abcd	2523,769	14174,932c	97,373b	1724,250c	5,983b	1504,835e	2,989b	2350,287a	39.604c
	2	7238,52a	0,883a	1,1871	57735,36a	29,171c	0,239a	13,868a	25,284abc	7433,549	10115,795e	272,786a	561,455f	16,155a	1217,353f	7,247a	1311,088f	142.233a
	3	1381,08bc	0,268c	0,7997	16533,75e	25,200cde	0,120bcd	2,714cd	16,459bcd	1372,948	11924,874d	54,501cde	743,304e	3,625c	2167,370c	1,198de	2019,214c	23.569e
	4	190,31d	0,494b	0,6770	43683,77b	179,552a	0,098e	0,096e	8,495cd	225,475	24476,304a	41,274de	47,980g	0,595d	2671,024b	0,481e	2129,627bc	23.755de
	5	183,62d	0,367bc	0,7398	38529,02bc	112,037b	0,116cde	0,135e	6,173d	234,479	23574,192a	33,653e	59,018g	0,716d	1724,119d	0,286e	2132,531bc	21.178e
	Mean	**2197,75a**	**0,496637**	**1,32182**	**37570,5a**	**74,440a**	**0,144a**	**4,439a**	**14,966ab**	**2358,044a**	**16853,219a**	**99,918a**	**627,201b**	**5,415a**	**1856,940a**	**2,440a**	**1988,549a**	**50.068a**
2014	1	604,07cd	0,529b	1,0436	24383,36de	22,488def	0,133bc	2,528cd	15,164bcd	822,011	10299,884e	81,355bc	2400,203a	3,689c	1029,314g	2,305bc	1752,724d	28.787de
	2	695,24cd	0,542b	20,1598	19876,03e	21,081f	0,110cde	1,643de	25,326abc	842,086	11969,075d	60,405cde	703,942e	3,307c	1459,487e	1,770cd	1571,690e	51.724b
	3	1770,43b	0,379bc	0,6476	19337,41e	21,989ef	0,133bc	3,502c	29,079ab	2095,701	8650,925f	70,810bc	467,663f	4,481c	1831,122d	2,211bc	1365,101f	27.267de
	4	640,19cd	0,484b	0,8731	19208,06e	25,689cde	0,100de	2,078cd	17,822abcd	831,272	13322,171c	57,974cde	1251,495d	3,412c	1447,093e	1,818cd	1770,757d	23.789de
	5	756,36cd	0,479b	3,9546	22157,66e	25,476cde	0,130bc	2,245cd	35,347a	910,891	17738,435b	66,638cd	2073,708b	3,927c	2800,211a	1,893cd	2231,145ab	32.894cd
	Mean	**893,25b**	**0,482621**	**5,33574**	**20992,5b**	**23,344b**	**0,121b**	**2,399b**	**24,548a**	**1100,392b**	**12396,098b**	**67,437b**	**1379,402a**	**3,763b**	**1713,445b**	**1,999a**	**1738,283b**	**32.892b**
LSD Herb		**953.7**	**0.2076**	**0.125**	**8352**	**3.983**	**0.02012**	**1.828**	**18.12**	**737.1**	**948.3**	**28.45**	**120**	**1.494**	**128.3**	**0.9145**	**153.7**	**9.158**
LSD Year		**953.7**	-	-	**8352**	**3.983**	**0.02012**	**1.828**	**18.12**	**737.1**	**948.3**	**28.45**	**120**	**1.494**	**128.3**	**0.9145**	**153.7**	**9.158**

Types of Echinacea; 1. *E. pallida* var. pallida, **2.** *E. purpurea* var. purpurea, **3.** *E.purpurea* var. baby white swan, **4.** *E. purpurea* var. double decker, **5.** *Echinacea paradoxa* var. paradoxa

Conflict of Interests

Authors declare that there is no conflict of interests.

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