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Evaluation of lettuce genotypes for mineral content

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ABSTRACT

Lettuce is considered as a high value vegetable due to its richness in phytonutrients. Nowadays, it is produced all the year round and consumed fresh so that all the ingredients stay intact. Estimation of different elements in different types of lettuce is essential in developing nutritionally rich, good quality varieties for cultivation. Sixty two genotypes comprising both heading and non-heading types were analyzed for six mineral content such as Calcium, Sulphur, Zinc, Copper, Manganese and Iron. The genotypes studied belonged to six lettuce types, namely Latin (three), Stem (five), Crisphead (thirteen) Butterhead (Eight), Leaf (twenty three) and Cos (ten). Overall, latin types were rich in sulphur, while crisphead types were rich in calcium and copper and butterhead in zinc, manganese and iron. The stem types, however, were found to be lesser in most of the minerals compared to other types. The Pennlake Crisphead lettuce genotype had highest calcium content (390.07 ppm), New chicken stem type had highest sulphur content (7.80 ppm), L-S-2 leaf type had highest zinc content (29.91 ppm), Balmoral crisphead type had highest copper content (10.98 ppm), Great takes Katrain crisphead type had highest magnesium content (44.94 ppm) followed by Sheetal crisphead type (44.11 ppm) and All source butterhead type had highest iron content (605.52 ppm). The comprehensive analysis helped by providing detailed information about the composition of minerals of different types as well as genotypes. The information so obtained will go a long way in developing mineral content dense lettuce varieties.

Key words: *Lactuca sativa*, minerals, heading types, leafy types, latin types.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a self-pollinated crop belonging to the family Compositae. It is the most widely used salad crop in American and European countries. Among salad crop, lettuce occupies a major place because of its high nutritional value. It is considered as a high value crop and has a great demand in hotels and restaurants. Owing to its nutritional importance, the crop is now being appreciated in India too. The demand of lettuce is increasing day by day. It is also a storehouse of phytonutrients and regular intake of antioxidant compounds present in lettuce is useful in improving the lipid status and preventing lipid peroxidation in tissues (Nicolle *et al*., 10). The beneficial health effects are mainly attributed due to the presence of diverse antioxidant compounds such as anthocyanins, total carotenoids etc. The importance of lettuce has been known since time immemorial; when some American settlers claimed that smallpox could be prevented through the ingestion of lettuce (Watts, 17). The rich content of cellulose in lettuce makes it good roughage for the body. Therefore, it is used for curing constipation and other stomach disorders. Phosphorus present in lettuce helps in better absorption of calcium which results in strengthening bones. Regular intake of lettuce based salads or meals limit the oxidation of cholesterol in body which further leads to balanced cholesterol levels in body and reduced chances of cardiovascular diseases. It is used to a limited extent as a sedative and narcotic. It is also said to be mild diaphoretic, easing colic, inducing sleep and allaying cough (Grieve, 4). Among the different types, the leafy type is rich source of minerals such as calcium, phosphorus and potassium (Sharma, 14). It is almost exclusively used as a fresh vegetable in salads, but sometimes cooked forms are also taken (Lebeda *et al*., 8). Apart from salads, it is also used in other kinds of food, such as soups, sandwiches and wraps. It is a good source of vitamin A, vitamin K and potassium, dietary fiber, carbohydrates, protein and some fat. Variable amounts of vitamins and minerals are largely found in the leaf types.

Of late, lettuce usage has started picking up in India. There is a limited information on mineral content in lettuce. Therefore, the present study was undertaken for mineral profiling of lettuce genotypes belonging to different types for their use as such and for developing mineral down varieties.

MATERIALS AND METHODS

The experiment comprised of sixty two lettuce genotypes belonging to sic types were grown in vegetable research farm of ICAR-Indian Agricultural Research Institute, New Delhi. The nursery was raised

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during second fort night of October and transplanted during last week of November. Freshly harvested leaves of different genotypes from youngest mature leaf from the top of the plant for mineral estimation (Kalra, 7) were washed separately and wiped with tissue paper. Water was removed from plant tissue to stop enzymatic reactions and to stabilize the sample. The dried samples were then ground to fine powder which was used for the mineral estimation. The leaves powder was weighed as per different analytical requirements.

Estimation of Sulphur in lettuce samples was done by digestion method where either tri-acid mixture (HClO4 +H_2SO_4+ HNO_3; 3:1:10) or di-acid mixture ($HClO_4$+ $HNO_{3;}$ 3:10) was used. Exclusion of H_2SO_4 permits the use of same extract for estimation of Ca, Cu, Mn, and Zn on an Atomic Absorption Spectrometer (AAS) (Prasad *et al*., 17).

Calcium was estimated by the EDTA method (Prasad *et al*., 12). Calculations were done as mentioned hereunder:

Ca in plant sample (%) = (ml EDTA used for sample- ml EDTA used for blank)*Normality of EDTA*20*400(dilution factor)/ sample weight in mg.

Metals like Iron, Zinc, Manganese, Copper were estimated from digested plant samples by using atomic absorption spectrometer (Model-Analyst 400) using air acetylene flame and particular wavelengths and lamps specific to the nutrient (Jackson, 6). The average values of 3 replications were used for statistical analysis. Differences between samples were tested by analysis of variance (ANOVA) to assess differences of group means. P values < 0.5 were considered significant.

The data were subjected to analysis of variance as per the design using standard statistical procedure (Panse and Sukhatme, 11). The replication and treatment mean sum of squares (MSS) were tested against error mean sum of square by F-test for characters under consideration. All statistical analyses were performed using Statistical Analysis Software (SAS, 13).

RESULTS AND DISCUSSION

Mineral content of sixty two genotypes comprising both heading and non-heading types were estimation. The minerals like calcium, sulphur, zinc, copper, manganese and iron and its composition in different genotypes has been represented in Table 1. The calcium content ranged from 19.05 to 390.07 ppm. Pennlake, a crisphead type recorded maximum while in leaf type, Revolution recorded the least. The sulphur content varied from 0.84 ppm in Sigmadeep to 7.80 in New Chicken. Most of them are in the range of 1 to 6 ppm. Sulphur content in Criolla Verda, Sheetal, L-S-1 and LT-5 was more than 6 ppm. Zinc content among the genotypes ranged from 2.56 to 29.91 ppm. Genotypes like L-S-2 (29.91 ppm) and Proeftuins Black Pool (27.75 ppm) were close to the maximum range and minimum was observed in Iceberg NVRS 10:001857. Similarly, in 0.10 ppm in Curled lettuce to copper the range was from 10.98 ppm in Balmoral. Mostly the copper content in the lettuce genotypes were in between 0 to 4 ppm. Similarly the range for the manganese content was 0.10 to 44.94 ppm. The highest manganese content were found in the Sheetal crisphead (44.11 ppm), whereas Chinese Yellow, Leafy type. Iron content ranged from 29.82 to 605.52 ppm, maximum being in the All Season butter head type and lowest in Sigmadeep leafy type. Among the Latin types, Criolla Verde recorded maximum calcium (175.72 ppm), Sulphur (6.02 ppm), Zinc (21.24 ppm), Copper (2.53) ppm and Manganese (18.91 ppm), while Criolla Blanca had maximum iron content with 201.42 ppm (Table 1). In stem type, New Chicken was found to have highest content of calcium (105.80 ppm), Sulphur (7.80 ppm), Zinc (18.28 ppm) Copper (30.29 ppm) and iron (134.61 ppm) crisp-head type. Among crisp-head type highest calcium was estimation in Pennlake (390.07 ppm), sulphur in Sheetal (7.46 ppm); zinc in Iceberg Dublin F_1 hybrid (22.60 ppm), Copper in Balmoral (10.98 ppm), Manganese in Great Lakes Katrain (44.94 ppm), and Iron in Sheetal (254.09 ppm).

Among butter-head types, Proeftuins Black Pool ranked highest in calcium (134.43 ppm) and Zinc (27.75 ppm), Reine De Mai Pleine Terre in sulphur and manganese (3.69 and 35.68 ppm), Stanton Favourite in copper (4.07 ppm) and all season in Iron in (605.52 ppm). Among cos type genotypes, Lobjoits recorded highest calcium, copper and manganese (124.09, 3.39 and 24.01 ppm) respectively, the genotype Sulphur and Zinc were highest in the genotype Winter Density (5.66 and 14.88 ppm), while Iron was highest in Romaine Rouge D Hiver (243.38 ppm).

The among leafy types, the L-S-2 genotype highest recorded zinc (29.91 ppm). HRI 10:006619 had highest calcium and manganese (182.01 and 31.70 ppm) respectively. LT-5 recorded highest sulphur content (6.89 ppm), Progambo has highest copper (7.48 ppm) and Simpson had Iron content (370.52 ppm). Consumption of fresh vegetables enables full assimilation of vitamins in the human body. Vegetables are well represented in the composition of numerous minerals such as those of Ca, Fe, Cu, Zn and others. The dominant basic elements in plants and vegetables are Ca, Fe etc. These provide alkalizing effects, neutralizing the acidity produced

Table 1. Nutrient composition in different lettuce genotypes.

S. No.	Genotype	Type	Calcium (ppm)	Sulphur (ppm)	Zinc (ppm)	Copper (ppm)	Manganese (ppm)	Iron (ppm)
1	Criolla Blanca	Latin	21.19	4.37	11.13	0.37	15.84	201.42
2	Criolla Verde	Latin	175.72	6.02	21.24	2.53	18.91	95.51
3	Gallega	Latin	75.24	3.57	18.84	2.18	0.16	86.63
4	Wo Suen	Stem	74.70	1.57	4.06	0.58	20.36	52.53
5	HRI 10:006780	Stem	70.21	3.73	12.64	0.34	15.84	72.41
6	NVRS10:001818	Stem	67.52	2.37	4.98	0.49	10.52	75.71
7	New Chicken	Stem	105.80	7.80	18.28	1.87	30.29	134.61
8	HRI 10: 001730	Stem	69.86	3.16	11.07	1.18	19.87	69.83
9	Great Lakes Katrain	Crisphead	68.88	4.15	19.54	3.63	44.94	186.57
10	Yatesdale	Crisphead	141.26	4.59	10.41	1.16	21.70	109.78
11	Iceburg Dublin F1 hybrid	Crisphead	242.87	5.64	22.60	1.13	20.04	90.53
12	Tezier Lactuca Batavia	Crisphead	45.05	2.31	7.33	0.59	12.74	191.23
13	Costa Verde	Crisphead	119.54	3.19	9.30	0.67	26.82	73.56
14	El Toro	Crisphead	107.28	4.28	13.81	1.59	17.58	119.11
15	Pennlake	Crisphead	390.07	3.10	21.21	1.86	0.15	177.00
16	Sheetal	Crisphead	26.40	7.46	11.27	5.23	44.11	254.09
17	Great Lakes 366A	Crisphead	56.07	3.28	20.00	4.65	18.36	180.68
18	Cappaciuno Regei De Gacchi	Crisphead	31.35	1.88	8.65	1.74	8.85	53.79
19	Winter Lake	Crisphead	194.89	2.90	12.88	1.78	13.49	161.80
20	Balmoral	Crisphead	140.18	4.10	11.62	10.98	24.70	143.99
21	Iceberg NVRS 10:001857	Crisphead	38.02	1.22	2.56	2.81	9.79	43.82
22	Proeftuins Black Pool	Buttterhead	134.43	3.46	27.75	2.70	21.58	171.99
23	Reine De Mai Pleine Terre	Butterhead	21.73	3.69	21.66	1.11	35.68	143.41
24	All Season	Butterhead	20.36	1.39	8.61	1.53	16.85	605.52
25	Imperial Winter Reselected	Butterhead	122.21	2.96	24.07	2.32	18.71	141.68
26	Wonder Von Stuttgart	Butterhead	49.53	2.75	20.20	2.75	22.24	112.43
27	Stanton favourite	Butterhead	32.88	1.03	8.96	4.07	12.89	62.25
28	Arctic Kwig	Butterhead	61.13	2.69	16.78	1.84	23.23	143.81
29	Rondnicky	Butterhead	113.63	3.37	4.57	1.69	18.45	86.37
30	Parris Island cos	Cos	46.35	1.30	6.52	0.36	0.13	91.85
31	IHRGRU 10:006620	Cos	44.32	3.61	9.77	0.65	0.14	87.55
32	Valmaine Cos	Cos	51.37	1.98	8.85	1.56	8.06	91.37
33	Lobjoits	Cos	124.09	3.91	11.42	3.39	24.01	196.53
34	IHRGRU 10: 006614	Cos	47.10	3.16	8.73	1.99	13.88	101.49
35	Romaine Rouge D Hiver	Cos	106.02	3.91	7.79	0.92	21.15	243.38
36	IHRGRU 10:008206	Cos	41.65	4.63	14.25	2.12	11.74	110.69
37	Winter Density	Cos	72.82	5.66	14.88	2.39	7.79	126.85
38	IHRGRU 10:8194	Cos	83.52	2.77	12.60	1.69	13.98	104.62
39	Amasyl Wo5	Cos	84.76	2.66	8.08	3.46	15.00	106.07
40	Frisee D Australie	Leaf	77.41	2.79	12.27	2.72	14.74	111.82
41	Simpson	Leaf	56.33	5.19	22.83	4.03	25.65	370.52
42	VO9E0003	Leaf	73.14	4.92	9.12	1.63	11.24	88.19
43	Lolla rosa	Leaf	59.16	1.96	5.14	0.80	9.20	180.10

S. No.	Genotype	Type	Calcium (ppm)	Sulphur (ppm)	Zinc (ppm)	Copper (ppm)	Manganese (ppm)	Iron (ppm)
44	Grandrapid	Leaf	112.98	4.69	22.01	2.25	17.65	68.20
45	HRI 10:006619	Leaf	182.01	5.86	9.06	0.62	31.70	88.73
46	L-S-1	Leaf	102.55	6.76	13.64	0.76	22.33	100.44
47	Curled Lettuce	Leaf	49.33	5.12	10.28	0.10	12.50	92.90
48	Bogampo	Leaf	61.18	5.78	14.70	1.99	19.79	110.59
49	LT-5	Leaf	115.36	6.89	13.49	1.34	30.30	94.41
50	Red Revolution F1 hybrid	Leaf	62.23	2.67	10.51	0.98	0.12	102.28
51	GR-603	Leaf	51.69	1.51	12.32	0.88	0.20	102.45
52	Webbs wonderful	Leaf	80.79	1.72	14.35	2.71	15.38	241.25
53	Imperial 152	Leaf	66.22	2.23	15.30	1.75	0.13	75.82
54	Revolution	Leaf	19.05	4.23	16.24	1.24	11.67	135.37
55	Sigmadeep	Leaf	81.89	0.84	3.53	0.15	3.55	29.82
56	L-S-2	Leaf	48.64	3.42	29.91	2.34	19.86	158.93
57	Salinas	Leaf	54.84	3.84	16.78	2.24	18.22	115.22
58	Yellow Lettuce	Leaf	59.83	3.18	10.81	1.94	16.46	71.99
59	Waldmans dark Green	Leaf	78.71	3.73	14.76	4.55	6.26	252.30
60	Chinese yellow	Leaf	36.36	2.52	14.19	0.28	0.10	100.38
61	IHRGRU 10:006616	Leaf	73.37	4.30	14.32	4.19	0.16	112.18
62	Progambo	Leaf	56.70	3.30	9.13	7.48	14.93	101.60
	CD at 5%		14.86	0.39	1.48	0.45	2.53	21.39
	CV		71.45	44.09	44.91	85.51	64.01	64.90
	SEM		7.58	0.20	0.76	0.23	1.29	10.91

by other foods, especially those of animal origin (Genders, 3). Minerals are important constituents of human diet as they serve as co-factors for many physiological and metabolic processes.

A comparative analysis was done among the different types by pooling and average to have information about the mineral composition. The crisphead and butterhead types were form to be high in calcium and iron, while leaf, cos and latin types were at par. (Fig. 1a). Stem type, however was again low the butterhead types had highest manganese content followed by crisptype and stem type. Zinc wad highest in butterhead type followed by latin, crisphead and leaf types respectively (Fig. 1b).

Calcium is needed to build and maintain bones and teeth regulate muscle contractions, contract heartbeat and blood pressure. Calcium makes up 920 to 1200 grams of adult body weight, with 99% of it contained in bones and teeth (Berdanier *et al.*, 3). The absorption of calcium in the body decreases with age. Hence there should be regular supply of calcium through the diet to fulfill the calcium needs of the body. Calcium supplements in our diet especially the leafy vegetables will help to play a pivotal role in maintaining healthy life. The mean calcium content was 83.54 ppm and the coefficient of variation was 71.45 %.

Sulphur is another most abundant mineral in the body. Sulphur performs a number of important functions, such as providing a place for these amino acids to bond together, thus solidifying a protein structure. It is found in high concentrations in the protein structure of the muscles, joints, hair, nails, and skin. In the case of arthritis, adequate sulfur intake through supplementation can help repair the cartilage. It is essential for life as it makes up vital amino acids used to create protein for cells, tissues, hormones, enzymes, and antibodies. The mean of sulphur content in the lettuce genotypes analysed was 3.60 ppm and the coefficient of variation was 44.09 %.

Adequate dietary intake of iron, zinc and copper is essential to human health. Zinc is required for protein and carbohydrate metabolism, immune system, wound healing, growth and vision. Inadequate zinc intake can result in retarded growth, delayed wound healing, reduced immune system, loss of taste sensation and dermatitis (Umeta *et al.*, 15). The mean of zinc content in the lettuce genotypes analysed was 13.28 ppm and the coefficient of variation was

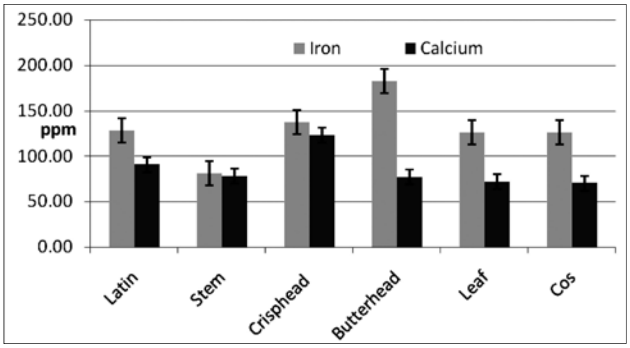

Fig. 1a

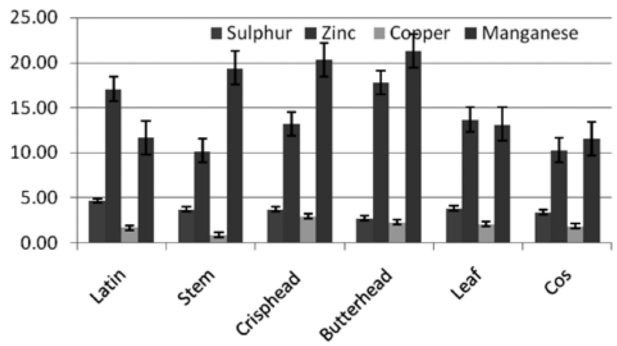

Fig. 1b

Fig. 1. Mineral composition in different types of lettuce

44.91 %. Zinc has the ability to catalyze vital chemical reactions.

The adult body contains approximately about 80 mg copper mainly stored in liver, followed by brain and muscle. Deficiency signs of copper include anemia, vascular complications, osteoporosis and neurological manifestations. The relative significance of copper was more than that of ascorbic acid in iron-deficiency anaemia (Chiplonkar *et al.*, 2). Copper is a component of many different enzymes and important to pigment formation and development of bone and connective tissues. It is also required for proper clotting of blood. Copper required in the production of red blood cells. The mean of copper content in the lettuce genotypes analysed was 2.11 ppm and the coefficient of variation was 85.51 %. Maximum the coefficient of variation was observed in copper amongst all the minerals.

Manganese improves glucose tolerance in the blood. It also helps in the development of sex hormones and the formation of proteins. The body uses manganese as a co-factor for the antioxidant enzyme, *superoxide dismutase*. The mean of manganese content in the lettuce genotypes analysed was 15.85 ppm and the coefficient of variation was 64.01 %. Iron is necessary for oxygen transport in the blood while magnesium stimulates enzyme activity in blood cells, produces and transports energy. More than 2 billion people worldwide are anaemic, and this can be mainly attributed to iron deficiency. Iron is an essential component of body systems involved in the utilization of oxygen. Iron deficiency during childhood and adolescence impairs physical and mental development (WHO/FAO, 18). Iron is essential for red blood cell formation. The mean of iron content in the lettuce genotypes analyzed was 132.39 ppm and the coefficient of variation was 64.90 %.

The abundance of different types and varieties of lettuce and its affiliation with yellow-green-red vegetables provides human nutrition with a very significant and high content of biologically important active substances (mineral substances, vitamins, and organic substances) as well as coloured substances from chlorophyll to anthocyanin. The nutrient and phytochemical content varies depending on lettuce type (Mou, 9 and USDA, 16). Altogether, these results clearly show that lettuce is an important leafy vegetable with good nutritional value and the genotypes identified in this study can be utilized to develop nutritionally rich lettuce varieties. Among different types, the heading types were found to be nutritionally high. The level of variability observed for different minerals in this study would be useful for developing mineral rich varieties of lettuce.

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