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Short communication

Screening and identification of lettuce genotypes for leaf yield and its quality attributes in Kashmir valley

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Lettuce is a herbaceous self-pollinated annual belongs to family composite. It is a major salad crop in North America, Australia and most countries in Europe and South America. In India, it is grown in the kitchen gardens and to meet the demand of continental hotels. It is unique among major vegetables in its nearly exclusive use as a fresh raw product. Lettuce is rich in vitamin C, pro-vitamin A and minerals like potassium, calcium, phosphorus and sodium. High vitamins C, fibre, folic acid, high protein and high volume of water make it heart healthy green vegetables as it help in lowering blood cholesterol level, high blood pressure and other risk factor for heart diseases. â-carotene is the most potent pro-vitamin A, its deficiency can result in xerophthalmia, blindness and premature death (Mayne, 9). α-carotene was proved to have anti-cancer activity as a free radical quencher and antioxidant (Polyakov *et al*., 12). Moreover, lettuce contains sufficient ascorbic acid which is a water soluble vitamins, deficiency of which causes scurvy, unhealthy gums and tooth decay. It cannot be synthesis in human body and thus obtained from greens as they are rich sources of vitamins. Lettuce contains also several minerals and traces elements. The quality produce has now been an important objective and development of new varieties with high level of nutrients is currently one of the priorities of plant breeders. Enhancing the nutritional level of vegetables would improve the nutrient intake without requiring an increase in consumption. To assist the breeding programmes, it is necessary to analyze typical varieties in terms of minerals and vitamins. Increasing the bio-availability of these elements in plant food is particularly important for human nutrition. The objective of this work was to examine the differences between several genotypes of lettuce in their carotenoids, vitamins and minerals content.

The present investigation was carried out at Experimental Farm, Division of Olericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology (K), Shalimar during winter 2006 and summer, 2007. Twenty-five diverse genotypes including two purple colour genotypes were takes for the study. Experiment was laid out in Randomized Block Design with three replications. Sowing was done in mid August 2006 for winter crops and in first week of February 2007 for summer crop. Five week old seedlings were transplanted in the field at spacing of 45 x 45 cm between rows and plants in three rows of 2.25 metre accommodating 15 plants of each genotype in each replication and all the recommended agronomic package of practices were followed. For each growing season, lettuce cultivars were harvested when they reached commercial size. Five randomly selected plants were harvested from each plot in the morning and immediately transported to the lab and weighted. Carotenoids were extracted at room temperature in plant samples as follows according an adoption of the method developed by (Mahadevan and Sridhar; 8).Vitamin C was extracted from 10 g fresh leaves excluding the midrib and mixed with 50 ml of 3 percent chilled metaphosphoric acid. The mixture was crushed in juicer (mixer) and clear extract were collected in beaker. Ascorbic acid was determined according to 2, 6-dichlorophenol indophenol visual titration method (A.O.A.C., 1).

For Mineral measurement 100 g of fresh leaves were weighed and were thoroughly washed with tap water followed by distal water and were kept of room temperature for removal of water. Finally, the leaves were oven dried in an oven at 62 ± 1^{0}C till the constant weight was obtained and weighed again. One gram of dry powder was takes in 100 ml flask and was digested in tri-acid mixture of HNO_3, $HClO_4$ and HCl in 9:4:1 ratio. The flasks were placed on a hot plate for digestion. The digested sample was diluted with double distilled water to make known volume. The phosphorus was determined by using ammonium molybdate: ammonium metavanedate (Chapman and Pratt, 4) and calcium and potassium were measured by flame-photometry technique using corning flame-photometer, (Jackson, 5). The analysis of variance were carried out as suggested by Panse and Sukhatme (11) and values were given as the mean.

Mean performance of genotypes for different quality

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Table 1. Mean performance of various lettuce genotypes for different quality characters under Kashmir conditions.

S.No.	Genotypes	Leaf yield/ha (q)			Dry matter content (%)			Vitamin C (mg/100g)			Carotenoids (mg/100 g)		
		Winter	Summer	Pooled	Winter	Summer	Pooled	Winter	Summer	Pooled	Winter	Summer	Pooled
1.	LC-2	146.71	124.32	135.51	9.58	10.01	9.79	34.33	21.70	28.01	2.73	2.68	2.71
2.	LC-4	165.81	142.27	154.04	9.37	9.73	9.55	45.60	46.76	46.18	1.87	2.03	1.95
3.	LC-5	127.77	144.08	135.92	8.70	8.00	8.35	39.40	43.63	41.51	1.56	1.55	1.56
4.	LC-9	164.82	141.11	152.96	8.48	8.73	8.61	45.40	42.30	43.85	3.04	2.70	2.87
5.	LC-14	123.66	129.59	126.62	9.18	9.16	9.17	41.40	31.80	36.60	2.81	2.91	2.86
6.	LC-15	119.05	140.95	130.00	9.41	9.30	9.36	37.36	38.56	37.96	3.02	3.40	3.21
7.	LC-16	127.45	120.53	123.99	9.73	8.57	9.15	49.83	39.13	44.48	2.43	1.30	1.24
8.	LC-24	179.48	151.16	165.32	8.39	8.46	8.47	39.86	41.00	40.43	2.12	2.21	2.16
9.	LC-29	93.69	88.46	91.07	9.20	7.50	8.38	28.66	24.60	26.63	2.09	2.29	2.19
10	LS-2	186.56	171.74	179.15	9.77	9.46	9.62	44.93	33.43	39.18	1.71	2.12	1.92
11.	LS-8	106.04	123.66	114.85	9.27	8.55	8.91	42.86	36.56	39.71	2.36	2.91	2.64
12.	LS-11	159.39	175.86	167.62	8.76	8.54	8.65	41.00	41.30	41.15	2.86	2.01	2.44
13.	LS-15	156.59	145.07	150.83	10.30	10.17	10.23	37.10	21.46	29.28	1.75	1.40	1.58
14.	LS-16	126.62	109.99	118.30	9.50	8.87	9.19	39.86	42.20	41.03	2.56	3.12	2.84
15.	LS-17	184.25	178.50	181.37	8.54	8.21	8.54	46.70	33.60	40.15	2.73	1.93	2.33
16.	LS-18	111.47	131.73	121.60	8.22	8.68	8.45	34.50	28.86	31.68	4.00	3.13	3.57
17.	LS-19	100.11	128.11	114.11	9.60	9.61	9.60	30.66	36.00	33.33	2.66	2.54	2.60
18	LS-20	68.16	61.91	65.06	9.73	10.43	10.08	33.93	30.96	34.44	0.90	0.73	0.82
19.	LS-21	140.95	136.48	138.71	8.63	8.20	8.41	30.06	25.16	27.61	3.77	3.06	3.42
20.	SS-7	146.38	135.68	141.03	8.14	7.13	7.64	37.10	28.43	32.76	3.73	2.32	3.03
21.	SS-11	156.92	131.40	144.16	7.87	9.02	8.76	35.80	38.60	37.10	1.82	1.89	1.86
22.	SS-12	131.73	140.13	135.93	10.66	8.47	9.56	41.30	29.26	35.28	4.18	2.90	3.54
23.	DPHL-I	134.36	190.19	162.27	9.51	7.94	8.73	24.50	20.96	22.73	3.02	2.52	2.77
24.	Simpson	137.66	161.04	149.35	8.33	8.72	8.53	27.86	27.23	27.54	3.54	2.22	2.88
25.	RM(C)	129.59	128.43	129.01	9.25	8.65	8.92	34.76	21.23	27.99	1.76	1.38	1.57
	G. Mean	137.01	137.29	137.15	9.12	8.81	8.96	37.79	33.00	35.39	2.60	2.27	2.43
	LSD at 5%	9.97	8.68	9.32	0.37	0.67	0.52	3.84	3.35	3.59	0.26	0.24	0.27
	CV (%)	4.43	5.21	4.82	2.47	4.65	3.56	6.20	6.19	6.19	6.30	6.40	6.35

Contd...

Table1. (*Contd.*)

S.No.	Genotypes	Calcium (mg/100 g)			Phosphorus (mg/100g)			Potassium (mg/100g)		
		Winter	Summer	Pooled	Winter	Summer	Pooled	Winter	Summer	Pooled
1.	LC-2	118.20	104.89	111.55	60.73	39.00	49.87	161.88	257.11	209.50
2.	LC-4	94.35	81.46	87.90	53.22	36.08	44.65	207.21	194.15	200.68
3.	LC-5	103.98	81.99	92.94	48.77	39.75	44.26	214.21	221.07	217.64
4.	LC-9	91.08	103.25	97.17	47.74	35.71	41.72	145.97	194.75	170.31
5.	LC-14	105.49	98.00	101.75	52.91	39.83	46.37	155.12	228.37	191.75
6.	LC-15	103.54	84.31	93.93	62.63	36.14	49.39	213.63	265.95	239.79
7.	LC-16	131.35	92.27	111.81	59.96	44.28	52.12	226.87	239.59	233.23
8.	LC-24	67.06	65.30	66.10	47.18	36.07	41.63	204.23	274.15	239.19
9.	LC-29	101.27	60.18	80.73	52.55	32.96	42.75	179.26	201.51	191.39
10	LS-2	96.56	66.13	81.18	66.97	48.61	57.79	222.62	261.74	242.18
11.	LS-8	124.11	70.67	97.39	48.32	31.60	39.96	168.72	173.53	171.13
12.	LS-11	124.65	61.70	93.18	57.75	37.50	47.58	194.75	223.69	209.22
13.	LS-15	138.78	111.17	123.81	68.03	36.66	52.38	210.61	259.27	234.94
14.	LS-16	130.54	108.94	119.74	58.23	34.53	46.38	152.11	161.69	156.90
15.	LS-17	101.23	96.36	98.79	48.33	39.04	43.69	192.15	233.08	212.62
16.	LS-18	111.47	71.57	91.52	49.73	37.14	43.44	175.12	185.80	186.46
17.	LS-19	89.24	112.90	101.07	61.24	39.92	50.58	205.36	183.97	194.66
18	LS-20	105.88	80.75	93.32	41.85	49.03	45.44	149.44	204.63	177.04
19.	LS-21	75.44	71.95	73.70	54.85	38.01	46.43	143.39	159.08	151.24
20.	SS-7	120.06	113.98	117.02	46.04	42.49	44.27	252.79	259.46	256.13
21.	SS-11	67.78	77.83	71.30	53.45	52.90	53.18	200.67	248.51	224.59
22.	SS-12	138.72	103.80	121.26	68.16	45.31	56.74	196.31	215.15	255.73
23.	DPHL-I	97.38	42.44	69.91	53.67	38.43	46.05	203.66	191.70	197.68
24.	Simpson	68.04	76.27	72.16	52.97	35.79	44.38	173.44	215.32	194.38
25.	RM(C)	92.57	84.93	88.75	56.97	47.63	52.30	206.35	195.84	201.09
	G. Mean	103.95	84.92	94.43	54.89	39.78	47.33	190.23	217.96	204.09
	LSD at 5%	7.85	6.00	6.92	3.69	3.44	3.56	9.93	13.81	11.87
	CV (%)	4.60	4.30	4.45	4.09	5.27	4.68	3.18	3.86	3.52

traits given in Table 1 and best five genotypes based on mean performance is given in Table 2. Vitamin C, carotenoids, calcium, potassium and phosphorus concentration differed significantly among lettuce genotypes and season ($p<0.05$). This indicated that there is genetic variation in the nutrient accumulation among the lettuce genotypes tested, despite the influence of environment.

The dry matter content of the genotypes ranged from 8.14 percent (SS-7) to 10.66 percent (SS-12) in winter and 7.13 percent (SS-7) to 10.43 percent (SS-20) in summer with an overall mean of 9.12 percent and 8.81 percent, respectively. The genotypes LC-16 (49.83, 39.13 mg/100 g), LC-4 (45.60, 46.76 mg/100 g) and LS-9 (45.40, 42.30 mg/100 g) consistently had higher vitamin C concentration in winter and summer, respectively than other genotypes. The genotypes DPHL-1 (24.50, 20.96 mg/100g) and LC-29 (28.66, 24.60 mg/100 g) had the lowest concentration in both winter and summer season, respectively. Our data were slightly higher than those reported by Catherine *et al*. (3). The variation was observed due to different varieties and geographical location. Carotenoids concentration was much lower in purple colour genotypes LS-20 in winter (0.90 mg/100

Table 2. Best five genotypes on the basis of mean performance for different quality traits.

S.No	Traits	Winter	Summer	Pooled
1	Leaf yield (q/ha)	LS-2 (186.56)	DPHL-1 (190.19)	LS-17 (181.37)
		LS-17 (184.25)	LS-17 (178.50)	LS-2 (179.15)
		LC-24 (179.48)	LS-11(175.86)	LS-11 (167.62)
		LC-4 (165.81)	LS-2 (171.74)	LC-24 (165.32)
		LC-9 (164.82)	Simpson (161.04)	DPHL-1(162.27)
2.	Dry matter content (%)	SS-12 (10.66)	LS-20 (10.43)	LS-15 (10.23)
		LS-15 (10.30)	LS-15 (10.17)	LS-20 (10.08)
		LS-2 (9.77)	LC-2 (10.01)	LC-2 (9.79)
		LS-20 (9.73)	LC-4 (9.73)	LS-2 (9.62)
		LC-2 (9.58)	LS-19 (9.61)	LS-19 (9.60)
3.	Vitamin C (mg/100g)	LC-16 (49.83)	LC-4 (46.76)	LC-4 (46.18)
		LS-17 (46.70)	LC-5 (43.63)	LC-16 (44.48)
		LC-4 (45.60)	LC-9 (42.30)	LC-5 (41.51)
		LC-9 (45.40)	LS-16 (42.20)	LS-11 (41.15)
		LS-2 (44.93)	LS-11 (41.30)	LS-16 (41.03)
4	Carotenoids (mg/100g)	SS-12 (4.18)	LC-15 (3.40)	LS-18 (3.57)
		LS-18 (4.00)	LS-18 (3.13)	SS-12 (3.54)
		LS-21 (3.77)	LS-16 (3.12)	LS-21 (3.42)
		SS-7 (3.73)	LS-21 (3.06)	LC-15 (3.21)
		Simpson (3.54)	LS-8 (2.91)	SS-7 (3.03)
5.	Calcium (mg/100g)	LS-15 (138.78)	SS-7 (113.98)	LS-15 (123.81)
		SS-12 (138.72)	LS-19 (112.9)	SS-12 (121.26)
		LC-16 (131.35)	LS-15 (111.17)	LS-16 (119.74)
		LS-16 (130.54)	LS-16 (108.94)	SS-7 (117.02)
		LS-11 (124.65)	LC-2 (104.89)	LC-16 (111.81)
6.	Phosphorus (mg/100g)	SS-12 (68.16)	SS-11 (52.9)	LS-2 (57.79)
		LS-15 (68.03)	LS-20 (49.03)	SS-12 (56.74)
		LS-2 (66.97)	LS-2 (48.61)	SS-11 (53.18)
		LC-15 (62.63)	RM (47.63)	LS-15 (52.38)
		LS-19 (61.24)	SS-12 (45.31)	RM (52.30)
7.	Potassium (mg/100g)	SS-7 (252.79)	LC-24 (274.15)	SS-7 (256.13)
		LC-16 (226.87)	LS-2 (222.62)	LC-15 (265.95)
		LS-2 (261.74)	SS-12 (255.73)	LS-2 (242.18)
		LC-5 (214.21)	SS-7 (259.46)	LC-15 (239.79)
		LC-15 (213.63)	LC-2 (257.11)	LC-24 (239.19)

g) as well as in summer (0.73 mg/100 mg) than other genotypes and were highest in genotype LS-18 (4.00 mg/100 g) during winter and LS-15 (3.40 mg/100 g) in summer with a overall mean of 2.60 and 2.27 mg/100 g, respectively. Mou (10) reported that seasonal variation between winter and summer production in â-carotene and lutein level of two kale cultivars grown in Brazil. Kopsell *et al*. (6) also found variation in â-carotene and vitamin C content among 23 *Brassica oleraceae* cultigens. Kumar *et al.* (7) reported higher â-carotene content in lettuce genotype CGN-19088.

Among minerals, the genotypes LS-15 (138.78; 111.17 mg/100 g) and SS-12 (138.72; 103.80 mg/100 g) had higher level of calcium in both winter and summer with overall mean value of 103.95 and 84.92 mg/100g on fresh weight basis, respectively. Phosphorus concentration ranges from 68.16 (SS-12) to 41.85 mg/100 g (LS-20) during winter and 52.90 (SS-11) to 31.60 mg/100 g (LS-8) during summer with a mean of 54.89 and 39.78 mg/100 g on fresh weigh. The genotypes SS-7 (252.79 mg/100 g) followed by LC-16 (226.87 mg/100 g) and LS-2 (222.62 mg/100 g) had highest concentration of potassium during winter, while genotypes LC-24 (274.15 mg/100 g) followed by LC-15 (265.95 mg/100 g) and LS-2 (261.74 mg/100 g) had highest potassium during summer with a overall mean value of 190.23 mg/100 g and 217.96 /100 g on fresh weight basis. Similar finding was observed by Bernardi *et al*. (2), Singh. *et al*. (13) for vitamin C and mineral content in lettuce.

There was wide variation in leaf yield in lettuce, it ranges from 68.16 (LS-20) to 186.56 q/ha LS-2) with a overall mean of 137.01 q/ha during winter, while as in summer highest leaf yield were obtained from DPHL-1 (190.19 q/ha) followed by LS-17 (178.74 q/ha) with a overall mean of 137.29 q/ha. The mean leaf yield of lettuce in both the seasons remains same although the genotypes differ significantly in leaf yield in one or other seasons. High range of variability also been observed by Singh *et al.* (14) in lettuce for vitamin C, dry matter content and yield per plant.

Along with genetic variability, there also appears to be an environmental influence on nutrient accumulation in lettuce. The concentration of all the quality parameters studied was in general higher in winter than the summer except potassium. The synthesis of these nutrients is light dependent and during winter, the plant obtained optimum requirement of solar radiation and temperature than in summer as the lettuce crop is cool loving leaf vegetables.

The major product from agricultural production in food that is fundamental to human life and health. Consumers have becomes more demanding for safe and nutritious food that improves physical performance, reduce risk of diseases and increase the life span. In this study, we found a wide range of genetic variability in carotenoids, vitamin C, minerals and leaf yield in lettuce genotypes studies. It may therefore be possible to increase the nutritional value of those genotypes which although gives higher yield but were low in vitamins and minerals content, through crosses with other genotypes with high level of vitamin, carotenoids and major minerals and subsequent selection.

Thus, it can be concluded that, on the basis of two season performance there were large differences among genotypes in vitamin C content (22.73 to 46.18 mg/100 g of fresh weight) and the concentration of carotenoids (0.82-3.57 mg/100 g of fresh weight). Significant differences among genotypes were also recorded for minerals and green leaf yield. However, different genotypes were identified to be superior for different quality characters. Further, there is seasonal variation in the content of minerals and vitamins among the genotypes studied and genotype SS-12 and SS-7 were found superior for most of the quality traits along with average yield, which can be commercially adopted after multi-location testing and also used in breeding programme for improving the nutritional quality along with leaf yield.

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