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Nutritive evaluation of finger millet [*Eleusine coracana* (L.) Gaertn.] genotypes for quality improvement

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Abstract
Study of Genetic variability in thirty seven genotypes of finger millet [*Eleusine coracana* (L.)] during the *kharif* season 2017-2018. The higher value of seed protein content observed in GN-4 (7.47 per cent), carbohydrate content observed in L-5 (76.40 per cent), oil content observed in GE-942 (4.06 per cent), total mineral compound content observed in WWN-9 (0.95 per cent), calcium content observed in GPU-67, VL-149, MR-6, GN-3 and GN-5 (1.40 per cent), iron content observed in white seeded GN-5 with 105.03 ppm. The highest value of phosphorus content observed in WWN-9 (2.77 per cent), magnesium content observed in GN-5 (0.90 per cent). Result of grain nutrients composition revealed that, wide range for carbohydrate, oil, iron and zinc content; while low range for protein, fiber, total mineral compound, calcium, potassium, phosphorus and magnesium was found.

Keywords: Nutritive evaluation, quality improvement and finger millet

Introduction

Finger millet (*Eleusine coracana* L. Garten.) commonly known as "ragi", is one of the important and nutritious food crop and largely grown in southern states of India. The major ragi growing states are Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Maharashtra, Uttar Pradesh, Bihar and Gujarat. Hill millets are commonly called as "Nutritious millet" or "Nutri-cereal" as the grains are nutritionally superior to many cereals providing fair amount of proteins, minerals, calcium and vitamins in abundance to the people. Finger millet also contain B complex vitamins, especially niacin, B_6 and folic acid, calcium, iron, potassium, magnesium and zinc. Finger millet is a humble grain with low Glycemic index which makes it more suitable for diabetic patients. They maintain the sugar level of diabetic patient. Hence, diabetic people are advised to eat finger millet and other small millets instead of rice. Additionally, finger millet is a rich source of calcium (310-370mg/100g) and helps in supplementing the calcium in human body. The higher fibre content of finger millet helps in many ways as it prevents constipation, high cholesterol formation and intestinal cancer. It is a good source of protein, very rich in carbohydrate, fat, minerals and vitamins and should be considered as essential food for nutritional security (Patil H.E. *et al*., 2018) [15].

Finger millet grains contain higher levels of minerals like Ca, Mg, and K (Saleh *et al.*, 2013 and Devi *et al*., 2014) [16, 6]. It also has high levels of amino acids like methionine, lysine and tryptophan (Bhatt *et al.*, 2011) [2] and polyphenols. The grain protein is rich in essential amino acids. (Chandrasekara and Shahidi, 2011, Devi *et al.*, 2014) [3, 6].

Materials and Methods

The experimental material for present investigation comprised of thirty seven genotypes of Finger millet (*Eleusine coracana* (L.) Garten) obtained from Gujarat, Karnataka, Uttarakhand, Andhra Pradesh, Bihar, Maharashtra, Tamilnadu, Madhya Pradesh, Odisha and Chhatisgarh were grown in a randomized block design during the *kharif*, 2016 at Hill Millet Research Station, Waghai, Dist. The Dangs under Navsari Agricultural University, Navsari. The grains from each entry and each replication were taken for biochemical analysis. In order to determine the nutritional characteristics of these genotypes, protein content (%) was determined by Spectrometer method suggested by Lowry (1951) [11], carbohydrate content (%) was determined by Spectrometer method, oil content (%) was determined with the help of Nuclear Magnetic Resonance (NMR) method, Crude fiber estimated using method developed by Maynard (1970) [13], total mineral compound (%), Mg content (%), Fe content (ppm) and Zn content (ppm) were determined by Atomic Absorption Spectrometric (ASS) method suggested by Lindsay and Norvell (1978) [10], Ca was determined with DTPA and determined by titration method, K content (%) was determined by Spectrometric Method (NH4OAC), P content (%) was determined by Spectrometric Method (Extraction with 0.5 M NaHCO3), Ash content was determined by AOAC (1965) [1] method and Fat (Crude) content is estimated using hexane. The mean values of three randomized observations per replication were used for statistical analysis for all the qualitative characters.

Results and discussion

Seed protein content (%)

Finger millet is an excellent and cheap source of high quality and easily digestible protein. In developing countries inadequate availability of protein has been identified as major cause of wide spread malnutrition among less privilege classes of society, so development of protein rich genotypes has become necessary. Hence an attempt was made to estimate seed protein content among genotypes identified on the basis of their superiority for grain yield.

Narrow range of protein content was observed in thirty seven genotypes of finger millet. The seed protein content ranged from 6.53 per cent (WWN-10) to 7.47 per cent (GN 4) among all the genotypes. The higher value of seed protein content observed in GN 4 (7.47 per cent).

Carbohydrate content (%)

The carbohydrate content ranged from 68.23 per cent (WN-259) to 76.40 per cent (L-5) among all the genotypes. The highest value of carbohydrate content observed in (L-5) 76.40 per cent.

Oil content (%)

Wide range of oil content was observed in thirty seven genotypes of finger millet. The oil content ranged from 0.29 per cent (MR-1) to 4.06 per cent (GE-942) among all the genotypes. The highest value of oil content observed in genotype GE-942.

Fiber content (%)

Narrow range of fiber content was observed in thirty seven genotypes of finger millet. The fiber content ranged from 3.68 per cent (WWN-10) to 4.15 per cent (PPP-2885) among all the genotypes. The highest value of fiber content observed in genotype PPP-2885.

Total mineral content (%)

Narrow range of total mineral compound content was observed in thirty seven genotypes of finger millet. The total mineral compound content ranged from 0.56 per cent (WWN-9) to 0.95 per cent (VR-708) among all the genotypes. The highest value of total mineral compound content observed in genotype WWN-9 which is 0.95 per cent.

Calcium content (%)

Narrow range of calcium content was observed in thirty seven genotypes of finger millet. The calcium content ranged from 0.90 per cent (VR-708 and WWN-9) to 1.40 per cent (GPU-67, VL-149, MR-6, GN-3 and GN-5) among all the genotypes. The highest value of calcium content observed in genotypes viz; GPU-67, VL-149, MR-6, GN-3 and GN-5) which is 1.40 per cent.

Fe content (ppm)

Wide range of iron content was observed in thirty seven genotypes of finger millet. The Iron content ranged from 46.10 ppm (WWN-9) to 105.03 ppm (GN-5) among all the genotypes. The highest value of iron content observed in white seeded GN-5 with 105.03 ppm.

K content (%)

Narrow range of potassium content was observed in thirty seven genotypes of finger millet. The potassium content ranged from 0.42 per cent (L-5, PES-110, MR-1) to 0.51 per cent (GPU-28) among all the genotypes. The highest value of potassium content observed in GPU-28 (0.51 per cent).

P content (%)

Narrow range of phosphorus content was observed in thirty seven genotypes of finger millet. The phosphorus content ranged from 2.69 per cent (KMR-204) to 2.77 per cent (WWN-9) among all the genotypes. The highest value of phosphorus content observed in (WWN-9) 2.77 per cent.

Mg content (%)

Narrow range of magnesium content was observed in thirty seven genotypes of finger millet. The magnesium content ranged from 0.55 per cent (KOPN-237, GE-205 and WWN-11) to 0.90 per cent (GN-5) among all the genotypes. The highest value of magnesium content observed in GN-5 (0.90 per cent).

Zn content (ppm)

Wide range of zinc content was observed in thirty seven genotypes of finger millet. The zinc content ranged from 43.33 ppm (WWN-8) to 64.32 ppm (GPU-28) among all the genotypes. The highest value of zinc content observed in genotype GPU-28 (64.32 ppm).

Fat content (%)

The variation observed for fat content was ranged from 2.23% in GPUL-7 to 4.37% in WN-28 with mean of 3.44%.

Ganapathy *et al.* (2011) [7] showed the difference between PCV and GCV was lower for most of the characters suggesting negligible role of environment in expression of traits. Thereby, phenotypic selection would be effective for the traits with high values of GCV and PCV. The mean values under analysis indicated wider genetic diversity for quality parameters among the thirty-seven genotypes which were studied.

Kempanna and Kavallappa (1968) [8] chemically analyzed grains of nineteen finger millet genotypes for crude proteins, crude fat, calcium, phosphorus and total ash contents. There seemed to have been a recognizable variation among genotypes in respect of most of the nutrient elements. Variation in relation to protein and fat were statistically significant which revealed the presence of wide diversity between the genotypes and selection for these traits could be effective in improving the quality traits in the genotypes.

Singh and Srivastava (2006) [18] examined the chemical composition of finger millet varieties and revealed that total carbohydrate content of finger millet has been reported to be in the range of 72 to 79.5 per cent. Finger millet has nearly 7% protein but large variations in protein content from 5.6 to 12.70 per cent was reported that total ash content is higher in finger millet than in commonly consumed cereal grains. The ash content has been found to be nearly 1.7 to 4.13 per cent in finger millet. Calcium content of 36 genotypes of finger millet ranged from 162 to 487 mg.

Upadhyaya, *et al.* (2011) [19] evaluated of finger millet core germplasm for grain nutrients and agronomic traits revealed a substantial genetic variability for grain Fe, Zn, calcium (Ca) and protein contents. The accessions rich in nutrient contents were identified and their agronomic diversity assessed. The accessions rich in Zn content have significantly higher grain yield potential than those rich in Fe and protein content. Grain nutrient specific accessions and those contrasting for nutrient contents were identified for use in strategic research and cultivar development in finger millet.

Maloo *et al.* (1998) [12] evaluated finger millet genotypes for quality traits for three years. Analysis of variance showed that, genotypes differed significantly. Range of seed protein varied from 6.37 to 13.00%, calcium content varied from 286-507 mg per 100 g and seed iron varied from 3.12 to 5.10%. They suggested that, these quality traits were largely governed by additive gene effects that in turn could be improved by selection.

Khouloudbachar *et al.* (2013) [9] worked on mineral and fiber characterizations performed for 30 samples collected from four oases of Gabes in finger millet. For each sample 11 nutrients (Na, K, P, Ca, Mg and N), the crude protein, the neutral detergent fiber, the acid detergent fiber, the crude fiber and ash contents, were studied. Results of minerals analysis showed that calcium and magnesium were the most concentrated nutrients. (189.93 1272.36 mg/100g and 84.71 567.45 mg/100g respectively), followed by potassium (11.24 284.7 mg/100g), sodium (13.73 42.47 mg/100g) and phosphorus (2.208 11.033 mg/100g).

Savitha *et al.* (2013) [17] studied ten parents and twenty one hybrid combinations obtained by crossing seven lines (female) and three testers (male) in line x tester mating design in a randomized complete block design (RCBD) with three replications. They were found that line GPU 48 have high GCA effect for protein content, tester PR 202 showed high GCA effects for iron content. However, hybrids OEB 259 x K 7, CO(Ra) x K 7, hybrid RAU 8 x PR 202, GPU 28 x PR 202, VR 708 x KM 525, hybrids GPU 28 x K 7, VR 708 x PR 202, GPU 48 x PR 202 shows high sca effects for grain protein, iron (mg/100g) and zinc content (mg/100g) respectively. Hybrids CO(Ra)14 x K 7, CO(Ra) 14 x PR 202 CO (Ra) 14 x KM 252, Hybrids GPU 28 x PR 202 VR 708 x KM 252 RAU 8 x PR 202, Hybrids OEB 259 x KM 252 VR 708 x PR 202 RAU 8x KM252 shows high standard heterosis for protein, iron (mg/100g) and zinc (mg/100g) respectively. Hybrids CO (Ra) 14 x PR 202, CO(Ra) 14 x KM 525 and CO(Ra) 14 x KM 252 were found to be significant for all the three types of heterosis for grain protein content. Hybrid VR 708 x KM 252 were found to be significant for all the three types of heterosis for iron content. Hence, these results will be very helpful for quality improvement through heterosis breeding.

Das *et al*. (2017) [4] studied 48 germplasm lines of finger millet and found that calcium content of the genotypes ranged from 188.66 mg/100 g of grain to 324.33 mg/100 g of grain with an average value of 235.34 mg/100 g. The genotypic coefficients of variability were moderate and high for protein (16.4) and calcium (31.21), respectively. Protein content, calcium content and grain yield have Sho WWN high heritability *viz.*, 99.47, 97.74, 75 respectively. Genetic advance as percentage of mean was also high for these three characteristics, protein 34.5, calcium 46.44, grain yield/plot 39.65. High heritability coupled with high genetic advance indicated their governance by additive gene action.

Devaliya *et al.* (2018) [5] examined 68 genotypes of finger millet and the data were recorded on 13 quantitative traits to assess the magnitude of genetic variability, heritability and genetic advance for yield and yield contributing traits. High estimates of genotypic and phenotypic variance were observed for iron content. Phenotypic coefficients of variability were greater than genotypic coefficients of variability for all the traits studied which are indicated possibilities of improvement in this trait.

Finger millet grains contain higher levels of minerals like Ca, Mg, and K (*Saleh et al.*, 2013 and Devi *et al.*, 2014) [16, 6]. It also has high levels of amino acids like methionine, lysine and tryptophan (Bhatt *et al.*, 2011) [2] and polyphenols (Chandrasekara and Shahidi, 2011, Devi *et al.*, 2014) [3, 6]. The grain protein is rich in mineral matter and fiber content (Upadhyaya *et al.*, 2016) [20]. Finger millet grains contain higher levels of minerals like Ca, Mg, and K. It also has high levels of amino acids like methionine, lysine and tryptophan and polyphenols. (Patil H.E. *et al*., 2018) [15]. The higher fiber content of finger millet prevents constipation, high cholesterol formation and intestinal cancer. Hence, it is recommend diabetic patients to eat finger millet and other small millets instead of rice. The presence of certain anti-nutritional factors in whole finger millet fractions (like phenolics, tannins and phytates) may also help to lower the glycemic response due to decreased starch digestibility and absorption. (Patil H.E. *et al*., 2017) [14].

Summary and Conclusion

The highest value of fiber content observed in genotype PPP-2885. The highest value of total mineral compound content observed in genotype WWN-9 which is 0.95 per cent. The highest value of calcium content observed in genotypes viz; GPU-67, VL-149, MR-6, GN-3 and GN-5 which is 1.40 per cent. The highest value of iron content observed in white seeded GN-5 with 105.03 ppm. The highest value of potassium content observed in GPU-28 (0.51 per cent). The highest value of zinc content observed in genotype GPU-28 (64.32 ppm). From the result of nutrients content wide range for carbohydrate, oil, iron and zinc content, while low range for protein, fiber, total mineral compound, calcium, potassium, phosphorus and magnesium was found. The accessions rich in Zn content have significantly higher grain yield potential than those rich in Fe and protein content. Grain nutrient specific accessions and those contrasting for nutrient contents were identified for use in strategic research and cultivar development in finger millet.

Table 1: Mean, range, component of variance for different nutritional parameters in thirty seven genotypes of finger millet

Sr. No.	Finger millet Genotypes	Pr (%)	Ch (%)	Oil (%)	Fiber (%)	TMC (%)	Ca (%)	Fe (ppm)	K (%)	P (%)	Mg (%)	Zn (ppm)	Fat (%)
1	GPU-28	6.80	70.33	1.86	3.92	0.61	1.20	88.20	0.51	2.72	0.80	64.32	3.50
2	GPU-48	7.00	69.70	2.02	3.85	0.75	1.30	81.00	0.48	2.71	0.70	53.29	3.23
3	GPU-67	7.07	74.00	1.99	3.82	0.73	1.40	63.00	0.45	2.72	0.70	51.15	3.48
4	VL-149	7.00	72.93	2.97	4.05	0.82	1.40	64.20	0.47	2.74	0.70	59.69	3.33
5	PR-202	7.17	73.90	2.33	4.15	0.86	1.10	79.80	0.45	2.71	0.70	55.69	3.32
6	RAU-8	7.07	71.40	2.46	4.12	0.86	1.00	81.00	0.45	2.72	0.80	53.64	3.51
7	VR-708	7.00	70.10	1.97	4.10	0.95	0.90	69.00	0.46	2.76	0.75	57.20	3.50
8	KOPN-235	7.17	73.23	0.82	4.12	0.69	1.33	87.00	0.45	2.75	0.55	62.18	3.69
9	KMR-204	6.90	73.40	3.12	4.00	0.78	1.30	65.33	0.44	2.69	0.75	49.73	3.60
10	L-5	6.80	76.40	1.32	3.87	0.74	1.30	57.00	0.42	2.72	0.70	56.13	3.50
11	MR-6	7.10	70.33	0.65	4.04	0.82	1.40	66.60	0.45	2.74	0.65	58.27	2.70
12	WN-259	7.20	68.23	0.85	3.90	0.73	1.33	59.33	0.47	2.73	0.60	50.80	4.02
13	GPU-45	6.90	72.77	1.64	3.82	0.89	1.10	67.80	0.47	2.72	0.75	55.06	3.70
14	GPU-66	7.00	73.03	3.37	3.82	0.69	1.30	60.53	0.47	2.71	0.75	56.84	3.29
15	TNAU 1022	6.97	70.03	1.05	3.77	0.79	1.20	58.13	0.46	2.74	0.80	56.85	3.24
16	DM 7	7.10	71.20	1.83	3.97	0.73	1.30	50.93	0.44	2.75	0.60	58.27	4.37
17	PPP 2885	6.97	73.30	1.53	4.15	0.66	1.10	59.40	0.46	2.72	0.75	60.76	3.61
18	OEB 530	7.10	74.80	0.48	4.01	0.85	0.97	49.73	0.47	2.73	0.65	51.86	3.74
19	GE-205	6.97	75.13	2.09	3.95	0.72	1.10	75.00	0.49	2.72	0.55	53.43	3.22
20	GE-406	7.07	72.00	2.52	3.82	0.90	1.10	52.10	0.45	2.75	0.70	59.69	3.60
21	PES-110	7.00	70.00	1.22	3.80	0.82	1.30	88.20	0.42	2.74	0.80	48.66	3.22
22	MR-1	7.17	70.23	0.29	4.00	0.80	1.30	53.33	0.42	2.73	0.75	55.78	3.40
23	GE-942	7.17	73.50	4.06	4.05	0.88	1.10	84.60	0.44	2.73	0.60	47.60	3.60
24	WWN-8	6.87	74.20	1.89	3.80	0.72	1.00	59.40	0.46	2.74	0.80	43.33	3.44
25	WWN-9	6.90	69.70	3.70	3.82	0.56	0.90	46.10	0.45	2.77	0.75	52.22	3.49
26	WWN-10	6.53	71.33	2.47	3.68	0.77	1.03	56.93	0.45	2.75	0.70	48.31	2.70
27	WWN-11	7.17	71.30	1.22	3.80	0.80	1.13	52.13	0.46	2.74	0.55	53.29	3.78
28	WWN-13	7.17	73.00	1.29	3.85	0.63	1.27	51.73	0.47	2.70	0.70	51.87	3.98
29	BR 6	7.07	73.30	2.18	3.98	0.78	1.00	55.73	0.45	2.74	0.75	55.07	2.60
30	GPU 80	7.20	73.40	2.14	4.07	0.69	1.20	49.73	0.47	2.74	0.75	50.08	3.79
31	GN-1	7.27	74.00	1.22	4.00	0.84	1.10	55.73	0.50	2.74	0.75	47.60	3.10
32	GN-2	7.07	73.73	2.38	3.85	0.85	1.00	66.60	0.50	2.75	0.60	47.95	3.78
33	GN-3	6.87	72.90	3.47	3.98	0.85	1.40	87.03	0.47	2.73	0.75	51.51	3.52
34	GN-4	7.47	72.23	2.72	4.05	0.82	1.20	58.10	0.47	2.74	0.85	50.44	3.48
37	GN-5	7.40	72.70	2.22	3.97	0.84	1.40	105.03	0.43	2.72	0.90	57.91	3.88
36	GPU-28	7.46	72.30	3.10	4.12	0.90	1.40	103.30	0.41	2.70	0.84	64.20	3.70
37	GPU-48	7.40	71.23	2.90	4.03	0.86	1.33	110.20	0.50	2.76	0.89	60.12	3.81
	Mean	7.047	72.336	1.981	3.943	0.778	1.185	65.871	0.461	2.731	0.713	53.90	3.44
	Range	6.53-7.47	68.23-76.40	0.29-4.06	3.68-4.15	0.56-0.95	0.90-1.40	46.10-105.03	0.42-0.51	2.69-2.77	0.55-0.90	43.33-64.32	2.60-4.70
Component of Variance	Genotype	0.015	1.765	0.844	0.010	0.007	0.022	204.473	0.0004	0.0001	0.007	20.212	0.013
	Phenotype	0.060	6.646	0.849	0.025	0.008	0.025	212.813	0.0007	0.0006	0.008	25.955	0.015
	Environment	0.045	4.881	0.005	0.014	0.001	0.003	8.339	0.0004	0.0004	0.001	5.742	0.002
	GCV	1.761	1.836	46.381	2.592	10.997	12.636	21.708	4.061	0.437	11.683	8.341	21.23
	PCV	3.499	3.564	46.530	3.988	11.908	13.514	22.146	5.813	0.868	12.466	9.452	23.01

Pr-Protein content (%)	Fiber-Fiber content (%)	Fe-Iron content (ppm)	Mg-Magnesium content (%)
Ch-Carbohydrate content (%)	TMC-Total Mineral compound (%)	K-Potassium content (%)	Zn-Zinc content (ppm)
Oil-Oil content (%)	Ca-Calcium content (%)	P-Phosphorus content (%)	Fat-Fat content (%)

Table 2: Phenotypic (PCV), genotypic (GCV), heritability, genetic advance and genetic advance as present of mean of twelve characters in thirty seven genotypes of finger millet

Sr. No.	Qualitative Characters	GCV%	PCV%	Heritability (Broad sense %)	Genetic advance	Genetic Advance % of mean
1.	Protein content (%)	15.69	17.53	80	1.47	28.93
2.	Carbohydrate content (%)	11.55	13.79	70	6.70	19.92
3.	Oil content (%)	18.14	18.98	91	1.00	35.71
4.	Fiber content (%)	7.99	8.92	80	15.79	14.75
5.	Total Mineral compound (%)	9.21	11.97	59	1.01	14.60
6.	Ca content (mg)	16.19	16.58	95	72.59	32.58
7.	Fe content (mg)	11.69	12.75	84	1.48	22.07
8.	K content (mg)	9.95	10.42	91	1.33	19.60
9.	P content (mg)	22.01	23.24	89	3.08	42.94
10.	Mg content (mg)	19.14	19.80	93	0.68	38.11
11.	Zn content (mg)	9.95	10.42	91	1.33	19.60
12.	Fat content (%)	7.37	9.73	61	19.63	11.95

References

1. AOAC. Official Methods of Analysis of the Association of official Agricultural Chemists, 10th edn. Washington, D.C., 1965.
2. Bhatt D, Negi M, Sharma P, Saxena SC, Dobriyal AK, Arora S. Responses to drought induced oxidative stress in five finger millet varieties differing in their geographical distribution. Physiol. Mol. Biol. Plants. 2011; 17:347-353.
3. Chandrasekara A, Shahidi F. Inhibitory activities of soluble and bound millet seed phenolics on free radicals and reactive oxygen species. J Agric. Food Chem. 2011; 59:428-436.
4. Das R, Pandravada SR, Harikrishnan PJ. Estimation of grain nutrient and their association with grain yield in finger millet (*Eleusine corcana* (L.) Gaertn). Plant Archives. 2017; 17(1):241-146.
5. Devaliya SD, Singh M, Intwala CG, Bhagora RN. Genetic Variability Studies in Finger Millet (*Eleusine coracana* (L.) Gaertn., Int. J Pure App. Biosci. 2018; 6(1):1007-1011.
6. Devi PB, Vijayabharathi R, Sathyabama S, Malleshi NG, Priyadarisini VB. Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: A Review. J Food Sci. Technol. 2014; 51:1021-1040.
7. Ganapathy S, Nirmalakumari A, Muthiah AR. Genetic variability and interrelationship analysis for economic traits in finger millet germplasm. World J Agric. Sci. 2011; 7(2):185-188.
8. Kempanna C, Kavallappa BN. Quantitative assessment for nutritive quality of *Eleusine coracana* L. Gaertn. Mysore Journal of Agricultural Sciences. 1968; 2:324-329.
9. Khouloudbachar Elhemmansour, Abdennaceur Ben Khaled, Mabrouka Abidl Mansohaddad. Fiber Content and Mineral Composition of the Finger Millet of the Oasis of Gabs. Tunisia J Agric. Sci. 2013; 5(2):213 216.
10. Lindsay WL, Norvell WA. Development of a DTPA micronutrient plant test for Zinc, Iron, Manganese and copper. Soil Science American Journal. 1978; 42:421-501.
11. Lowry OH, Rosebrough AL, Farr and Randall RJ. J Biol. Chem., 1951, 193-265.
12. Maloo SR, Solanki JS, Sharma SP. Genotypic variability for quality traits in finger millet (*Eleusine coracana* (L.) Gaertn). International Sorghum and Millets Newsletter. 1998; 20:53-55.
13. Maynard AJ. (ed.). Methods in Food Analysis, Academic press, New York, 1970, 176.
14. Patil HE, Patel BK, Patel SN. Assessment of Genetic Diversity in Finger Millet (*Eleusine coracana* L.) through Multivariate Analysis Approach, International Journal of Economic Plants. 2017; 04(04):148-151.
15. Patil HE, Patel BK, Vavdiya P, Pali V. Breeding for Quality Improvement in Small Millets: A Review. International Journal of Genetics, 0975-9158. 2018; 10(9):507-510.
16. Saleh ASM, Zhang Q, Chen J, Shen Q. Millet grains: nutritional quality, processing, and potential health benefits Compr. Rev. Food Sci. Food Safety. 2013; 12:281-295.
17. Savitha P, Nirmalakumari A, Maheswaran M, Raguchander T. Combining Ability Analysis and Estimates of Heterosis for Grain Yield and Nutritional traits in Finger millet (*Eleusine coracana (L.)* Geartn). *Madras* Agricultural Journal. 2013; 100(1-3):15-19.
18. Singh P, Srivastava S. Nutritional composition of sixteen new varieties of finger millet. J Community Mobilization Sustainable Development. 2006; 1(2):81-84.
19. Upadhyaya HD, Ramesh S, Shivali Sharma Singh SK, Varshney SK, Sarma NDRK, Ravishankar CR *et al*. Genetic diversity for grain nutrients contents in a core collection of finger millet (*Eleusine coracana* (L.) Gaertn.) germplasm. Field Crops Research. 2011; 121:42-52.
20. Upadhyaya HD, Vetriventhan M, Dwivedi SL, Pattanashetti SK, Singh SK. Proso, barnyard, little, and kodo millets in Genetic and Genomic Resources for Grain Cereals Improvement. Frontiers in Plant Science, 2016, 321-343.