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Evaluation of nutritional content in small grained cereal - *Setaria italica*

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Abstract
In the present study, 50 genotypes of foxtail millet germplasm were studied for various nutritional traits, viz., seed protein, carbohydrate, fat, calcium, phosphrous and iron contents. The range of values for grain nutrients content among the selected genotypes are 6.01-19.56 g/100g for protein, 49.78-73.00 g/100g for carbohydrate, 1.81 to 5.62 g/100g for fat, 5.57-30.55 mg/100g for calcium, 0.11-0.43 g/100g for phosphorus and 1.22-27.73 mg/100g for iron. The genotypes *viz*., Ise-1605, Ise-1354, Ise-1780 and Ise-907 were found to possess maximum carbohydrate, iron, phosphorous and calcium contents. However, the genotypes Ise-1780 and Ise-907 were found to be nutritionally superior in almost all the parameters *viz*., seed fat, carbohydrate, iron, phosphorous and protein contents, followed by the genotypes Ise-838 and Ise-1881, thereby inferring that these genotypes could be further utilised in breeding programmes for bio-fortification.

Keywords: Foxtail millet, protein, carbohydrate, fat, calcium, phosphorus and iron

Introduction
Small millets are small-grained cereals and are the staple food of the millions inhabitating the arid and semiarid tropics of the world. Millets are commonly grown in tropical and semiarid regions of Asia and Africa, where they are served as common staple foods (Chandrasekara *et al*., 2012) [2]. The grains of small millets being nutritionally superior to rice and wheat, provide cheap proteins, minerals and vitamins to poorest of the poor where the need for such ingredients is maximum (Rao, 1989) [9]. Millets have high nutritive quality, and contain substantial amounts of fat and proteins with remarkable essential amino acids content (Kamara *et al*., 2009) [5]. It has been suggested to use foxtail millet protein as a food component to fight type 2 diabetes and cardiovascular diseases (Choi *et al.*, 2005) [3]. Compared to cereals such as maize, rice, wheat, sorghum and pearl millet, foxtail millet remained a neglected crop from the mainstream of crop improvement research inspite of being beneficial to health (Upadhyaya *et al.*, 2011) [15]. In such situation, this study helps in identifying the genotypes with higher nutational quality so that they can be utilized in crop improvement.

Materials and Methods
The experiment was conducted during *kharif*, 2017 at Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh, which is located at 16.10^0 N latitude, 28.29^0 E longitude and 31.5 m altitude. Fifty germplasm accessions of foxtail millet were laid out in Augmented RCBD and the seed samples of this germplam was used for estimation of grain nutrients viz., protein, fat, carbohydrate, iron, phosphorus and calcium content. Seed protein was estimated using Micro Kjeldhal Distillation Method (Sadasivam and Manickam, 1996) [11]. Seed fat and carbohydrate contents were estimated using the procedure given by Sadasivam and Manickam (1997) [12]. Iron content in the grain was estimated with the help of Atomic Absorption Spectrophotometer (AAS) as per Tandon (1999) [13]. Similarly seed phosphorus content was also estimated as per procedure given by Tandon (1999) [13]. While calcium content was estimated using Versenate titration method (Jackson, 1967) [4].

Results and Discussion
In our present study fifty germplasm accessions of foxtail millet were assessed for varietal differences for grain protein (g/100g), fat (g/100g), carbohydrate (g/100g), phosphorus (g/100g) and micronutrients like iron, calcium contents (mg/100g). The analysis of variance

revealed significant difference almost all the traits studied (Table 1). The mean values of all the quality parameters are presented in Table 2 and the results are discussed hereunder.

The protein content among the screened fifty genotypes ranged from 6.01 g to 19.56 g per 100 g of seed sample. The genotype, Ise-838 is containing highest protein content followed by Ise-840, Ise-1881, Ise-179, Ise-364 and Ise-1402. Similar quantum of variability was reported by Kamatar *et al.* (2015) [6] (8.98 to 14.37) and Thippeswamy *et al*. (2017) [14] (6.2 to 10.89%) in foxtail millet. This variability available for protein content in foxtail millet can act as sources for either for direct exploitation using simple selection or by following population approach depending on the gene action.

For seed fat content, the range of values observed was 1.81g to 5.62 g per 100 g of seed sample. Ise-1269 showed highest seed fat (5.62 g) content followed by Ise-838, Ise-796, Ise-785, Ise-1805 and Ise-1780, which were better than all the three check varieties (Korra local, Prasad and Suryanandi). Kamatar *et al.* (2015) [6] also observed considerable variation for fat per cent ranging from 2.79 to 4.16 with a mean value of 3.52. And similar observations were made by Zheng-li *et al.* (2006) [17] in their studies where they reported 3.0-4.6% of crude fat content.

For seed carbohydrate content, the studied genotypes ranged from 49.78 g to 73.00 g per 100 g of seed sample. Ise-1605 showed highest seed carbohydrate content (73.00 g) followed by Ise-31, Ise-1881, Ise-1892, Ise-195 and Ise-769. A total of nine genotypes were found superior to all the three check varieties (Korra local, Prasad and Suryanandi). Different studies carried out by various researchers have reported the fat content up to 69.45 g/100g (Lata and Rama, 1999) [7], 72% (Nazni and Shobanadevi, 2016) [8] and 75.51% (Abdoulaye and Jie, 2011) [1]. All these reports are in accordance with our current results and are confirming that the there is considerable quantum of carbohydrate in seed of foxtail millet.

For seed iron content, the range of values observed among the varieties was 1.22 mg to 27.73 mg per 100 g of seed sample. The genotype, Ise-1354 had showed highest iron (27.73 mg/100 g) content followed by Ise-364, Ise-745, Ise-838 and Ise-254. A total of 17 genotypes were found superior to all the three check varieties (Korra local, Prasad and Suryanandi). Similar but, little less range was indicated by Thippeswamy *et al*. (2017) [14] i.e., from 0.33 to 16.26 mg/100g.

For seed phosphorus content, the range of values observed was 0.11 g to 0.43 g per 100 g of seed sample. Ise-1780 showed highest phosphorus (0.43g/100g) content followed by Ise-179, Ise-364, Ise-931, Ise-362 and Ise-795 which were better than all the three check varieties (Korra local, Prasad and Suryanandi). However least phosphorus content was recorded by Ise-1026 (0.11g/100g). Ravindran (1991) [10] reported 0.27 g/100g mean phosphorus content of foxtail millet.

For seed calcium content, the range of values observed among the test genotypes was 5.57 to 30.55 mg/100g. Ise-907, Ise-1059 and Ise-1593 are the three varieties that have shown highest calcium content (30.55 mg/100g) followed by Ise-1269, Ise-195, Ise-179 and Ise-1900, which were better than all the three check varieties (Korra local, Prasad and Suryanandi). The mean calcium content was earlier reported up 37.08 mg/100g in Italian millet (Lata and Rama, 1999) [7] which is in accordance with our current results. Similarly Veena *et al.* (2005) [16] reported that the calcium content of barnyard millet varieties ranged from 17.1 to 32.7 mg/100g seed. Thippeswamy *et al*. (2017) [14] also reported that the calcium content among the selected genotypes of foxtail millet ranged from 1.99 to 22.69 mg/100g.

Table 1: Analysis of variance for grain yield and quality component characters in foxtail millet [*Setaria italica* (L.) Beauv.]

Sources of variations	d.f	Protein (g/100g)	Fat (g/100g)	Carbohydrate (g/100g)	Iron (mg/100g)	Phosphorus (g/100g)	Calcium (mg/100g)
		Mean sum of squares					
Block	2	0.089	0.056	0.107	0.090	0.000	0.132
Entries	52	7.712*	1.034*	22.661**	46.204**	0.006**	36.669**
Checks	2	22.745*	1.180*	15.664**	5.843*	0.001*	6.375
Varieties	49	7.131	0.928*	23.372**	48.794**	0.007**	38.610**
Checks vs. Varieties	1	6.136	5.927**	1.805	0.020	0.006**	2.146
Error	4	1.341	0.126	0.779	0.527	0.000	0.938

* Significant at 5% level

** Significant at 1% level

Table 2: Mean performance of 50 foxtail millet [*Setaria italica* (L.) Beauv.] Genotypes for the nutritional traits under study

S. No.	Genotype	Protein (g/100g)	Fat (g/100g)	Carbohydrate (g/100g)	Iron (mg/100g)	Phosphorus (g/100g)	Calcium (mg/100g)
1	Ise-31	12.99	3.31	70.46	8.56	0.27	15.88
2	Ise-144	12.76	2.89	67.26	13.24	0.22	18.55
3	Ise-160	9.34	3.65	50.78	3.27	0.22	13.57
4	Ise-179	15.36	3.62	65.64	9.51	0.40	25.21
5	Ise-195	14.42	4.00	67.85	5.96	0.14	27.88
6	Ise-200	11.88	2.68	67.76	13.20	0.14	16.24
7	Ise-254	12.47	3.56	65.28	23.00	0.28	21.21
8	Ise-362	6.01	2.77	67.00	9.76	0.38	20.24
9	Ise-364	14.77	3.08	65.94	25.68	0.39	13.21
10	Ise-375	8.12	3.21	64.05	13.65	0.24	15.88
11	Ise-458	11.09	2.59	57.79	15.09	0.26	13.57
12	Ise-507	12.50	3.45	67.46	17.62	0.26	11.88
13	Ise-525	11.18	2.99	62.35	10.39	0.40	16.24
14	Ise-745	10.98	2.96	67.81	25.46	0.34	9.21
15	Ise-769	9.61	2.76	60.53	3.42	0.31	15.88
16	Ise-785	8.01	5.26	52.07	15.20	0.33	21.21
17	Ise-795	9.69	4.04	67.00	8.07	0.37	17.57

18	Ise-796	12.32	5.42	64.11	17.06	0.29	15.88
19	Ise-813	9.87	4.42	58.14	9.25	0.24	19.88
20	Ise-838	19.56	5.50	62.72	24.50	0.30	18.55
21	Ise-840	16.60	4.44	67.03	1.22	0.16	17.57
22	Ise-869	14.60	5.03	64.50	11.80	0.28	13.21
23	Ise-907	12.21	4.84	64.60	6.88	0.27	30.55
24	Ise-909	12.05	3.57	65.98	8.90	0.32	5.57
25	Ise-931	11.33	3.67	65.73	17.52	0.39	14.55
26	Ise-936	13.11	3.62	61.85	5.90	0.20	11.88
27	Ise-985	14.06	2.96	63.59	15.27	0.39	17.57
28	Ise-995	13.02	1.81	64.08	23.87	0.16	9.21
29	Ise-1000	9.84	1.97	67.36	1.62	0.15	14.55
30	Ise-1026	6.36	1.97	52.32	19.91	0.11	6.91
31	Ise-1059	9.49	2.39	66.80	14.43	0.31	30.55
32	Ise-1269	11.86	5.62	66.10	1.40	0.29	29.21
33	Ise-1354	14.57	3.49	65.70	27.73	0.33	11.88
34	Ise-1402	14.68	2.83	66.80	10.65	0.31	17.57
35	Ise-1406	9.78	3.77	66.36	14.33	0.30	11.88
36	Ise-1408	10.28	3.26	63.14	14.32	0.31	9.21
37	Ise-1419	9.60	3.51	49.78	3.57	0.29	8.24
38	Ise-1593	10.13	2.69	63.99	15.67	0.27	30.55
39	Ise-1605	14.06	2.39	73.00	15.25	0.27	16.24
40	Ise-1629	12.23	2.20	66.72	14.73	0.27	13.57
41	Ise-1687	11.36	3.92	60.98	21.39	0.38	13.21
42	Ise-1780	9.60	5.22	65.22	14.17	0.43	17.57
43	Ise-1805	12.82	5.25	68.04	4.39	0.29	10.55
44	Ise-1806	6.55	2.78	67.49	6.64	0.36	11.88
45	Ise-1820	8.29	2.64	67.67	1.61	0.23	8.24
46	Ise-1846	11.51	2.88	64.97	17.92	0.28	11.88
47	Ise-1851	9.96	3.01	67.38	3.69	0.23	13.21
48	Ise-1881	16.14	3.31	70.46	12.36	0.25	18.55
49	Ise-1892	11.59	3.20	68.35	15.14	0.17	11.88
50	Ise-1900	11.00	3.20	67.67	12.91	0.39	24.24
51	Korra local (C1)	10.58	5.03	64.64	12.20	0.27	16.22
52	Prasad (C2)	8.07	4.25	67.45	14.00	0.25	16.75
53	Suryanandi (C3)	13.57	3.79	62.92	11.26	0.23	14.00

Conclusion

Among the selected 50 genotypes of foxtail millet, the highest seed protein and fat content were recorded in genotypes Ise-838 and Ise-1269, whereas the other genotypes *viz*., Ise-1605, Ise-1354, Ise-1780 and Ise-907 were found to possess maximum carbohydrate, iron, phosphorous and calcium contents. However, the genotypes Ise-1780 and Ise-907 were found to be nutritionally superior in almost all the parameters *viz*., seed fat, carbohydrate, iron, phosphorous and protein contents, followed by the genotypes Ise-838 and Ise-1881, thereby inferring that these genotypes could be further utilised in breeding programmes for bio-fortification.

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