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Evaluation of foxtail millet (*Setaria italica* (L.) Beauv.) Germplasm for folic acid content

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Abstract
Foxtail millet (*Setaria italica* (L.) Beauv.) is a potential climate resilient, C4 Panicoid crop. It is commonly known as Italian millet and is staple food crop grown in some parts of China, India and Japan. Nutrient composition of millets is higher than the average nutrient composition in major cereals (Muthamilarasan and Prasad, 2015). Research studies are lagging behind in nutrient profiling of millets. Hence, an experiment was done with one hundred genotypes of foxtail millet procured from ICRISAT mini core collection (Upadhyaya *et al.* 2011) for folic acid content. The range of values for these parameters ranged from 3.2-17.48mg/g. ISe 1767 recorded least amount of folic acid (3.2mg/g) whereas ISe 1387 recorded highest amount of it. The study also reveals great variability among the collection of foxtail millet accessions for folic acid that can be exploited to improve cultivars to meet the nutritional requirements of humans.

Keywords: Foxtail millet, vitamins, folic acid, germplasm, millets

Introduction
Nutrient superiority of millets in terms of its non-gluten protein, high fibre content, minerals, vitamins and antioxidants is firmly established over non-millet cereals, and hence these are popularized as 'nutricereals'. Foxtail millet (*Setaria italica* (L.) Beauv.) is a good source of micro and macronutrients with elevated levels of nutrient and antioxidant properties. It contains good amount of proteins, dietary fibers, vitamins, minerals, anti-oxidants and non-starchy polysaccharides with low glycemic index, when compared to major cereals (Taylor *et al.*, 2006; Amadou *et al.*, 2013; Muthamilarasan and Prasad, 2015;) [4, 5, 6]. It is a valuable model to exploit phytonutrient pathways of millets. 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) [7]. Even after knowing all these health benefits farmers are hindering from its cultivation due to the limited availability of improved varieties with best agronomic and nutrient traits. This study helps in identifying the genotypes with advanced micronutrient quality for their exploitation to improve the cultivars and thus making its cultivation remunerative to the farmers.

Materials and Methods
Folic acid was determined in exactly 2.5 g foxtail millet grain sample. This was weighed into 25 ml of 0.1 mol L^{-1} potassium dihydrogen phosphate and incubated in a 50 °C. thermostat water bath for 8 h. The sample was centrifuged in a high-speed refrigerated centrifuge at 5000 rpm for 10 min. The supernatant was collected, followed by the addition of 0.5 g aniline-treated activated C. The mixture was thoroughly vortexed and then heated to boiling in a water bath for 10 min. The sample was filtered and the supernatant was discarded. The residue was washed five times with 7 ml of 3% ammonia: 70% ethanol. The eluate was evaporated and concentrated to 5 ml, followed by addition of 1 ml 2% glacial acetic acid. Thereafter, 0.04% potassium permanganate was added drop wise until the color of the solution no longer changed. Furthermore, 3% hydrogen peroxide was added until the color of potassium permanganate faded. The solution was diluted to a volume of 10 ml. The fluorescence intensity was measured using a fluorescence spectrophotometer at 370 nm and 443 nm (Shao *et al.*, 2014) [3].

Results and Discussion

The present work profiled one hundred germplasm accessions of foxtail millet for folic acid content. The analysis of variance unveiled significant differences for the studied trait (Table 1). The mean values, SD, Range obtained and the genotypes with Mean + SD for all the observed quality parameters are presented in Table 2. The range of values obtained on analysis is 3.2mg to 17.48mg of folic acid per 100g of defatted flour with the mean value of 9.84mg/100g. Genotype Ise 1387 recorded highest amount of folic acid (17.48mg) and ISe 1767 has the least amount (3.2mg) of it. The analysis also showed that there are 17 genotypes which are above mean+SD values for folic acid that can be exploited for crop improvement and direct supplementation with other cereal based foods. The mean value of each genotype for this parameter is given in Table 3.

Table 1: Analysis of variance for folic acid in foxtail millet [*Setaria italica* (L.) Beauv.]

Sources of variations	d.f	Folic acid (mg/100g)
		Mean sum of squares
Treatment	103	11.69 **
Treatment: Check	3	21.32 **
Treatment: Test vs. Check	1	80.58 **
Treatment: Test	99	10.7 **
Blocks	3	3.32 **
Error	9	0.17

* Significant at 5% level

** Significant at 1% level

Table 2: Mean Performance, Range, SD, SE, CV% and the genotypes with high Mean+SD for folic acid

S. No.	Parametre	Mean	Range	Std. Deviation	Std. Error	CV%	Number & identified Genotypes	
							No. of genotypes	Best Genotypes High i.e>(Mean+SD)
1	Folic acid(mg/100g)	9.84	3.2-17.48	3.26	0.32	33.10	17	ISe 748, ISe 1181, ISe 1227, ISe 1258, ISe 1286, ISe 1547, ISe 1704, Ise 751, Ise 34, Ise 1137, Ise 1187, Ise 201, Ise 1387, Ise 1581, Ise 1610, Ise 1638, C4(Ise 375).

Table 3: Mean performance of 100 foxtail millet [*Setaria italica* (L.) Beauv.] genotypes for folic acid content

S. No.	Genotype	Folic acid(mg/100g)	S. No.	Genotype	Folic acid(mg/100g)
1	Ise237	8.25	53	Ise 267	8.31
2	ISe 403	6.5	54	Ise 289	6.2
3	ISe 710	7.42	55	Ise 388	5.66
4	ISe 735	11.15	56	Ise 398	5.15
5	ISe 748	13.39	57	Ise 480	6.56
6	ISe 783	6.68	58	Ise 663	6.97
7	ISe 792	5.93	59	Ise 717	11.4
8	ISe 827	8.16	60	Ise 719	7.13
9	ISe 914	5.15	61	Ise 746	6.76
10	ISe 963	6.9	62	Ise 751	15.1
11	ISe 1067	12.46	63	Ise 758	11.75
12	ISe 1136	11.4	64	Ise 771	12.44
13	ISe 1161	12.68	65	Ise 828	10.67
14	ISe 1163	11.13	66	Ise 842	9.48
15	ISe 1177	6.46	67	Ise 846	10.13
16	ISe 1181	14.48	68	Ise 900	7.65
17	ISe 1227	15.47	69	Ise 969	9.34
18	ISe 1234	9.1	70	Ise 999	10.46
19	ISe 1258	14.52	71	Ise 1009	10.64
20	ISe 1286	14.9	72	Ise 1037	11.11
21	ISe 1302	6.35	73	Ise 1118	12.71
22	ISe 1305	7.77	74	Ise 1119	7.24
23	ISe 1332	8.18	75	Ise 1129	8.15
24	ISe 1338	5.58	76	Ise 1134	13.16
25	ISe 1460	6.12	77	Ise 1137	17.45
26	ISe 1474	12.42	78	Ise 1151	10.24
27	ISe 1547	13.57	79	Ise 1162	10.42
28	ISe 1575	12.23	80	Ise 1187	16.27
29	ISe 1597	10.11	81	Ise 1201	15.58
30	ISe 869	11.35	82	Ise 1209	4.43
31	ISe 1666	9.67	83	Ise 1251	6.17
32	ISe 1674	11.03	84	Ise 1254	12.55
33	ISe 1685	12.45	85	Ise 1299	9.04

34	ISe 1704	16.02	86	Ise 1312	8.58
35	ISe 1725	11.28	87	Ise 1320	12.94
36	ISe 1736	8.02	88	Ise 1335	12.55
37	ISe 1745	9.4	89	Ise 1387	17.48
38	ISe 1762	7.35	90	Ise 1400	6.52
39	ISe 1767	3.2	91	Ise 1454	12.17
40	ISe 1773	4.68	92	Ise 1458	11.45
41	ISe 1789	11.26	93	Ise 1511	10.16
42	ISe 1808	5.53	94	Ise 1563	8.75
43	ISe 1858	5.28	95	Ise 1581	13.59
44	ISe 1859	9.33	96	Ise 1610	13.95
45	Ise 1888	7.02	97	Ise 1638	13.6
46	Ise 2	8.37	98	Ise 1647	12.46
47	Ise 18	8.91	99	Ise 1655	11.77
48	Ise 49	5.25	100	Ise 1664	8.58
49	Ise 90	5.71		Korra local (C1)	12.65
50	Ise 96	5.92		Prasad (C2)	11.42
51	Ise 156	6.77		Suryanandi (C3)	8.53
52	Ise 238	7.66		C4(Ise 375)	14.44

Conclusion

Healthy growth of human body and its functioning is the result of good nutrition (Branca *et al.* 2015) [2]. Shao *et al.*, (2014) [3] evaluated folic acid (vitamin B9) content in 245 varieties of China showing wide genetic variations (0.37–2.37 mg/g). Their study resulted in identifying 24 varieties with higher folic acid content with Jingu 21 being first one recording 2mg/g.

Our results revealed ISe 748, ISe 1181, ISe 1227, ISe 1258, ISe 1286, ISe 1547, ISe 1704, Ise 751, Ise 34, Ise 1137, Ise 1187, Ise 201, Ise 1387, Ise 1581, Ise 1610, Ise 1638 and C4(Ise 375) as nutritionally superior genotypes. This study prompts for selecting enriched varieties for household consumption. Industries can attempt to explore the recognized varieties to supplement this micronutrient in preparation and development of products. Millets identified with high nutritive values can be used as parental lines in breeding programmes to generate biofortified cultivars.

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