International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 568-572

Received: 13-07-2019
Accepted: 15-08-2019

GK Pavan Kumar
P.G. Scholar, Dept. of Genetics and Plant Breeding, Agricultural College, Mahanandi, Andhra Pradesh, India

AVS Durga Prasad
Associate Professor, Dept. of Genetics and Plant Breeding, Agricultural College, Mahanandi, Andhra Pradesh, India

CV Chandra Mohan Reddy
Senior Scientist (Small millets) RARS, Nandyal, Andhra Pradesh, India

Correspondence
GK Pavan Kumar
P.G. Scholar, Dept. of Genetics and Plant Breeding, Agricultural College, Mahanandi, Andhra Pradesh, India

Nutritional composition of elite genetic resources of foxtail millet (*Setaria italica* (L.) Beauv)

GK Pavan Kumar, AVS Durga Prasad and CV Chandra Mohan Reddy

Abstract
Foxtail millet grains possess enormous nutrients content that enable to tackle lifestyle diseases including obesity, diabetes etc. The genetic resources studied exhibited highly significant differences for all the nutritional parameters *viz.,* protein, carbohydrate, calcium, magnesium, iron, zinc, copper and manganese. Large amount of variation was observed among the genotypes for protein content ranging from 10.50 to 18.38 percent with a mean value of 14.10 per cent. The mean value of carbohydrate content was 61.87 per cent and ranged from 50.05 and 76.42 per cent. The genotypes for calcium content ranged between 16.00 and 40.00 per cent and overall mean was 24.03 per cent. Considerable variation was also observed for magnesium per cent ranging from 4.80 to 31.20 with a mean value of 15.10. The overall mean value of iron content was 10.88 per cent and ranged from 4.42 and 32.50 per cent. The mean values for zinc ranged between 1.53 and 7.07 per cent and overall mean was 3.26 per cent. Considerable variation was also observed for copper per cent ranging from 0.86 to 2.76 with a mean value of 1.26. The mean values for manganese ranged between 1.31 and 4.12 per cent and overall mean was 2.33 per cent. Results indicated that ample scope is available to exploit nutrients for the health and therapeutic benefits of consumers. The most promising genotypes for nutritional characters may be chosen as 'donors' for utilization in biofortification programmes of this millet.

Keywords: Millet, foxtail millet Nutrition, Health, protein, carbohydrate, calcium, magnesium, iron, zinc, copper and manganese

Introduction
Millets are ancient Super grains that serve as a 'nutritional repositories' (nutri-cereals) for a better human health. They are the potential food cum fodder crops that are primarily grown in arid and semi-arid tracts of the globe. In the recent past, millets are rapidly gaining immense attention, owing to their demand from health-conscious consumers and their unique ability to adapt for climate-resilient agriculture. Judging any nutritional parameter, millets are miles ahead of rice and wheat in terms of their mineral content compared to rice and wheat (Gopalan *et al,* 2007) [1], (Kamatar, 2013) [3]. Healthy therapeutic foods and ready to eat food products can be prepared from millets for maintenance of good health (Kamatar, 2013) [3]. Realizing the importance of millets, the Government of India (GOI) had observed the year 2018 as 'National Year of Millets' to boost domestic production and achieve self-sufficiency. Besides the GOI went a step forward and even sent a proposal to U.N. Food and Agriculture Organization which after careful examination endorsed India's view and declared 2023 as the 'International Year of Millets'.

Among the small millets, foxtail millet (*Eleusine coarcana* (L.) Beauv), ranks second in economic importance, next to finger millet in terms of global production. It is fairly tolerant to drought and owing to its quick growing ability, it can be grown as a short term catch crop. Its grains are rich in protein (leucine and methionine), β carotene, minerals (Ca, Fe, K, Mg and Zn), antioxidants, dietary fibre, phytochemicals and vitamins - B_1, B_2 & B_3 (Rai, 2002) [5] and besides, possess low glycemic index, a requisite for healthy human diet (Murugan and Nirmalakumari, 2006) [4]. The grains with husk intact have long shelf life which is a preferable attribute (Ravi *et al,* 2010) [6]. A high intake of millet based dietary fiber, improves glycemic control, decreases hyperinsulinemia, and lowers plasma lipid concentrations in patients with type 2 diabetes in human beings (Jali *et al,* 2012) [4]. Besides, consumption of this millet may prevent cardiovascular disease through reduction of plasma triglycerides.

Although enormous health benefits are offered by foxtail millet, the crop remained as a neglected crop from the mainstream of crop improvement research, compared to cereals such

as maize, rice, wheat, sorghum, and pearl millet, mainly due to difficulties in processing (de-husking), farm operations (lack of suitable farm machinery) and Government policies benefitting fine-grained cereals. However in the recent past, this crop drew much attention mainly due to its amenability to climate-resilient agriculture and paradigm shift in Government policies encouraging millets on account of heavy market demand from consumers. Therefore, there is an urgent need to assess the foxtail millet genetic resources for their improvement in the grain, with respect to nutritive profile coupled with high yields. Keeping the aforesaid points in view, the present investigation was undertaken to assess the variability for nutrition parameters in germplasm of foxtail millet, so that highly nutritive genotypes can be exploited by the food industry and used in the ready to eat food products for the benefit of public health.

Material and Methods

Hundred foxtail millet genetic resources including four checks were laid in an Augmented randomized complete block design (ARCBD) during *Kharif*, 2018 in order to assess their nutritive profile. The experiment was carried out at an altitude of 211.3 m above mean sea level, latitude of 18.29°N and longitude of 78.29° E at Regional Agricultural Research Station, Nandyal, Andhra Pradesh, India. The net plot size was 40 x 3 m^2 with a recommended spacing of 22.5 cm x 10 cm. The experimental data was collected on five randomly selected plants per genetic resource for eight nutritional traits *viz.*, protein, carbohydrate, calcium, magnesium, iron, zinc, copper and manganese contents.

Dehulling

Harvested panicles seeds from this plot were collected cleaned and dehulled using pestle and mortar. The dehulled grains were used for analyzing nutritional characteristics.

Protein analysis

The nitrogen content of the grain was assessed by Kjeldahl method using Kelplus equipment. Protein content was calculated by multiplying with a factor 6.25.

$$\text{Protein (\%)} = \frac{\text{Titre value (X) x 14.007x 0.5(N of HCl) x 6.25}}{\text{Weight of sample (mg)}} \text{ X 100}$$

Carbohydrate analysis

The carbohydrate content was estimated as per procedure given by Sadasivam and Manickam (1997). Amount of carbohydrate present in 100 mg of the sample can be obtained using the following formula.

$$\text{Carbohydrate (mg/100g)} = \frac{\text{mg of glucose}}{\text{Volume of test sample}} \times 100$$

Minerals estimation:

The trace elements (iron, zinc, copper and manganese) were estimated by wet digestion using triacid mixture. A known aliquot of test sample was suitably diluted and micronutrients in the test sample (Iron, Zinc, Cu and Mn in mg/100) were determined using Atomic Absorption Spectrophotometer.

Estimation of mineral nutrients (Iron, Zinc, Cu and Mn in mg/100) by Di-acid mixture method

$$\text{Nutrient Conc. (ppm)} = \frac{\text{Graph ppm x Vol. of digested sample}}{\text{Weight of sample}}$$

Estimation of Calcium and Magnesium by titration method

$$\text{Ca (m.eq. /l)} = \frac{\text{T.V X Normality of EDTA X 1000}}{\text{Volume of Sample extract}}$$

$$\text{Mg (m.eq. /l)} = \frac{\text{T.V X Normality of EDTA X 1000}}{\text{Volume of Sample extract}}$$

Results and Discussion

The analysis of variance for nutritional quality parameters was carried out in 100 genetic resources of foxtail millet. The results are presented in Table 1. The genotypes exhibited highly significant differences for all the nutritional parameters *viz.*, protein, carbohydrate, calcium, magnesium, iron, zinc, copper and manganese. The *per se* performance of foxtail millet genotypes for nutritional traits is briefly presented in Table 2.

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

Source of variation	d.f	Protein (g/100g)	Carbo hydrate (g/100g)	Calcium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Zinc (mg/100)	Copper (mg/100g)	Manganese (mg/100g)
		Mean sum of squares							
Block	7	0.588	0.546	0.122	0.16	0.104	0	0.001	0.027
Entries	99	2.922 **	57.173 **	34.524 **	43.080 **	42.754 **	1.437 **	0.452 **	0.233 **
Checks	3	5.320 **	4.716 **	336.718 **	311.224 **	250.694 **	0.726 **	1.195 **	0.784 **
Varieties	95	2.875 **	59.345 **	24.419 **	31.566 **	31.096 **	1.463 **	0.433 **	0.215 **
Checks vs. Varieties	1	0.202	8.184 **	87.879 **	332.457 **	526.524 **	1.184 **	0.062 **	0.214 **
Error	21	0.388	0.33	0.446	0.111	0.093	0	0.002	0.012

* Significant at 5% level
** Significant at 1% level

Table 2: *Per se* performance of 100 foxtail millet [*Setaria italica* (L.) Beauv.] genetic resources with respect to nutritional parameters

S. No.	Genotype	Protein (g/ 100g)	Carbo hydrate (g/ 100g)	Calcium (mg/ 100g)	Magnesium (mg/ 100g)	Iron (mg/ 100g)	Zinc (mg/ 100g)	Copper (mg/ 100g)	Manganese (mg/ 100g)
		1	2	3	4	5	6	7	8
1	SiA 3222	12.69	63.15	32.00	12.00	4.65	1.62	0.96	1.68
2	SiA 3323	16.63	58.94	28.00	12.00	12.45	2.84	1.04	2.13
3	SiA 3657	14.44	61.14	24.00	12.00	17.08	3.05	1.12	2.43
4	SiA 2745	12.25	63.51	24.00	12.00	13.08	3.24	1.05	2.33
5	SiA 2579	10.50	62.84	28.00	16.80	13.82	3.45	1.01	2.30
6	SiA 3627	14.44	61.21	24.00	21.60	13.96	3.50	0.98	2.63
7	SiA 4061	14.00	56.81	20.00	14.40	12.49	2.99	1.04	2.53
8	SiA 4036	14.00	62.96	32.00	16.80	16.63	2.92	0.90	2.35
9	SiA 2662	17.50	56.14	24.00	14.40	19.47	2.89	1.09	2.28
10	SiA 2737	13.56	50.93	16.00	19.20	9.38	3.50	0.89	2.06
11	SiA 3611	13.13	56.75	20.00	24.00	22.50	3.01	2.76	2.50
12	SiA 4155	15.31	53.34	24.00	19.20	11.72	2.93	1.23	2.30
13	SiA 2849	14.00	51.46	24.00	19.20	12.53	2.97	1.15	2.44
14	SiA 3577	14.88	61.29	24.00	21.60	14.79	3.02	1.23	2.49
15	SiA 3701	12.69	62.00	20.00	21.60	23.62	3.11	1.16	2.70
16	SiA 3559	13.13	57.96	24.00	7.20	6.55	2.71	1.13	4.12
17	SiA 3851	11.38	64.11	28.00	7.20	21.12	3.63	1.85	3.07
18	SiA 4016	12.69	76.42	24.00	9.60	13.72	3.28	2.76	2.20
19	SiA 4179	14.44	50.11	20.00	14.40	7.06	2.36	1.07	2.04
20	SiA 3498	14.88	58.57	20.00	21.60	13.70	2.43	2.75	2.05
21	SiA 4107	14.88	52.99	20.00	19.20	14.54	2.36	1.06	2.01
22	SiA 2674	14.00	74.16	24.00	14.40	12.65	2.35	1.11	1.99
23	SiA 2697	16.63	73.40	28.00	9.60	14.94	2.41	2.75	1.75
24	SiA 3516	12.69	57.18	36.00	19.20	16.69	3.08	2.74	1.94
25	SiA 3496	11.38	54.18	16.00	19.20	9.72	3.65	1.12	1.82
26	SiA 3580	15.31	52.30	24.00	21.60	29.00	4.04	2.74	2.61
27	SiA 3971	16.19	53.61	24.00	19.20	13.38	3.81	1.01	2.12
28	SiA 3038	13.56	66.25	40.00	4.80	9.21	3.03	2.40	2.16
29	SiA 3588	14.88	66.99	20.00	21.60	8.54	3.54	1.67	2.31
30	SiA 3737	14.88	59.55	24.00	14.40	14.74	3.14	0.90	2.04
31	SiA 3462	15.75	61.94	20.00	16.80	9.61	3.47	1.30	2.32
32	SiA 2671	14.00	72.83	24.00	14.40	7.85	3.00	1.05	1.91
33	SiA 3492	14.00	55.57	24.00	21.60	8.18	3.53	0.91	2.22
34	SiA 3429	12.25	54.14	28.00	14.40	23.60	3.35	0.90	2.05
35	SiA 4063	14.88	57.36	24.00	9.60	5.74	2.39	1.63	2.10
36	SiA 3793	17.06	65.82	24.00	9.60	7.19	2.65	0.91	2.23
37	SiA 805	13.13	51.34	16.00	24.00	6.59	2.40	0.89	2.20
38	SiA 3855	16.19	64.86	20.00	9.60	10.05	2.53	2.70	2.26
39	SiA 3420	14.00	57.36	24.00	9.60	6.52	2.31	0.91	2.26
40	SiA 4167	15.31	51.20	24.00	7.20	5.99	2.39	2.72	2.29
41	SiA 2864	14.44	75.67	24.00	12.00	7.88	2.32	0.90	2.08
42	SiA 3409	12.25	56.26	24.00	7.20	6.19	2.47	0.89	2.30
43	SiA 4027	12.25	52.03	20.00	31.20	11.03	2.40	2.73	2.36
44	SiA 3423	14.88	57.51	24.00	14.40	10.47	2.55	0.90	2.16
45	SiA 4181	15.75	63.39	24.00	16.80	8.28	3.12	2.75	2.11
46	SiA 1244	11.81	57.96	20.00	9.60	6.33	2.72	2.73	2.19
47	SiA 4044	13.56	51.20	40.00	21.60	23.36	2.68	0.89	2.70
48	SiA 3643	16.19	52.97	20.00	12.00	8.68	2.68	2.73	2.19
49	SiA 2713	11.81	68.19	20.00	14.40	7.70	2.57	0.91	2.19
50	SiA 2757	12.69	76.38	20.00	14.40	9.54	2.53	2.74	2.14
51	SiA 2681	14.00	55.26	20.00	12.00	9.40	2.61	2.74	1.99
52	SiA 3511	14.44	55.65	20.00	9.60	32.50	2.24	1.76	2.47
53	SiA 3674	13.13	59.45	32.00	21.60	18.40	3.94	0.89	2.40
54	SiA 3827	11.38	66.72	24.00	9.60	5.37	2.24	0.86	1.58
55	SiA 3908	14.00	64.27	16.00	14.40	4.45	1.97	0.86	1.31
56	SiA 3697	12.25	68.07	24.00	21.60	7.96	3.49	0.89	2.31

S. No.	Genotype	Protein (g/ 100g)	Carbo hydrate (g/ 100g)	Calcium (mg/ 100g)	Magnesium (mg/ 100g)	Iron (mg/ 100g)	Zinc (mg/ 100g)	Copper (mg/ 100g)	Manganese (mg/ 100g)
		1	2	3	4	5	6	7	8
57	SiA 4009	14.44	67.82	20.00	16.80	6.83	3.00	0.87	1.78
58	SiA 3965	13.56	61.39	28.00	19.20	5.40	3.81	0.89	2.64
59	SiA 3972	15.75	61.21	32.00	14.40	5.41	4.03	0.91	2.55
60	SiA 3756	14.00	50.07	24.00	14.40	12.44	2.50	0.88	2.35
61	SiA 4013	16.19	64.62	24.00	26.40	24.00	4.26	0.90	2.44
62	SiA 3754	17.94	53.97	36.00	14.40	7.48	3.80	0.88	2.34
63	SiA 3413	14.00	55.10	24.00	21.60	10.36	3.75	0.88	2.18
64	SiA 3435	14.00	56.59	24.00	21.60	8.31	3.81	0.88	2.40
65	SiA 4045	15.75	51.66	20.00	12.00	8.43	2.44	0.89	2.48
66	SiA 3499	15.31	56.28	20.00	12.00	7.61	2.56	0.88	2.05
67	SiA 3436	14.88	73.34	28.00	14.40	8.17	2.75	0.88	2.31
68	SiA 3560	16.19	69.46	24.00	26.40	7.40	4.21	0.90	2.44
69	SiA 4114	15.31	75.20	24.00	9.60	6.14	2.80	0.87	2.26
70	SiA 3419	14.44	50.05	16.00	9.60	5.90	2.59	0.87	2.09
71	SiA 3465	13.13	74.10	20.00	12.00	5.97	2.17	0.87	2.19
72	SiA 4068	15.31	67.27	24.00	12.00	6.06	2.39	0.87	2.38
73	SiA 3749	15.75	71.38	32.00	4.80	6.12	2.62	0.88	2.09
74	SiA 4141	15.75	63.58	28.00	9.60	5.63	2.38	0.87	2.21
75	SiA 2667	13.13	70.50	32.00	9.60	5.10	2.48	0.87	1.79
76	SiA 3422	15.31	57.12	28.00	7.20	5.61	3.06	0.88	2.03
77	SiA 3894	14.88	51.56	20.00	14.40	7.29	2.76	0.87	1.66
78	SiA 3282	11.38	72.13	20.00	12.00	6.41	2.26	0.88	1.77
79	SiA 3639	10.94	68.36	20.00	12.00	11.27	1.76	0.86	1.84
80	SiA 2856	14.44	62.33	20.00	16.80	5.76	2.62	0.87	1.92
81	SiA 3291	16.19	53.05	20.00	9.60	6.81	2.58	0.88	2.23
82	SiA 3430	12.69	61.08	24.00	7.20	4.42	2.68	0.86	2.02
83	SiA 4020	10.94	75.04	24.00	12.00	5.77	2.76	0.87	2.15
84	SiA 2663	10.94	73.40	24.00	14.40	6.17	1.53	0.87	2.13
85	SiA 3554	15.31	66.88	28.00	14.40	11.90	7.07	1.12	2.94
86	SiA 3753	14.88	67.35	20.00	12.00	12.08	7.05	1.19	3.30
87	SiA 2844	12.69	53.81	24.00	14.40	9.69	6.42	1.04	2.93
88	SiA 4180	18.38	68.87	20.00	12.00	11.67	4.22	0.91	3.40
89	SiA 4005	15.75	52.97	20.00	28.80	8.73	5.26	0.89	2.79
90	SiA 2850	14.88	74.53	24.00	26.40	6.19	5.84	0.88	2.65
91	SiA 3513	13.56	68.42	20.00	14.40	7.86	5.74	0.90	3.07
92	SiA 3469	13.56	62.04	28.00	24.00	11.22	5.22	0.90	3.11
93	SiA 3281	14.44	67.42	20.00	14.40	10.35	6.64	0.90	3.52
94	SiA 1266	13.56	73.40	36.00	24.00	8.53	6.14	0.90	3.16
95	SiA 4182	10.50	72.99	20.00	12.00	10.55	6.27	0.89	3.46
96	SiA 3969	11.38	67.17	24.00	12.00	12.84	6.21	0.89	3.68
97	Prasad (C)	15.29	62.52	23.88	12.02	11.95	2.81	1.86	2.35
98	SiA 3085 (C)	14.14	63.34	20.64	16.79	21.64	3.11	1.14	2.41
99	SiA 3156 (C)	13.32	61.46	23.63	14.37	9.54	2.82	1.26	1.78
100	Suryanandi (C)	14.02	62.40	35.35	12.54	18.37	3.45	0.97	2.44
	Minimm	10.50	50.05	16.00	4.80	4.42	1.53	0.86	1.31
	Maximum	18.38	76.42	40.00	31.20	32.50	7.07	2.76	4.12
	Mean	14.10	61.87	24.03	15.10	10.88	3.26	1.26	2.33
	Std. Error	0.17	0.75	0.50	0.55	0.56	0.12	0.06	0.05
	Std. Deviation	1.67	7.55	4.98	5.52	5.62	1.19	0.65	0.46

Protein (g/100g)

Millets are high in protein content than rice which is a staple food of south India. The protein content of millets when compared to rice it is twice higher. As per WHO standards, the recommended dietary allowance of protein per day, for men and women are 60 g and 50 g, respectively. It is fulfilled by consuming 600 g of millets instead of 1000 g of rice. The protein content ranged from 10.50 g (SiA 2579 and SiA 4182) to 18.38 g (SiA 4180) with a mean of 14.10 g. Moderate PCV (10.88) and low GCV (9.94) recorded for this trait indicated less variation among the test genotypes studied.

Carbohydrate (g/100g)

Carbohydrates provide quick energy to the body. Usually millets contain ample quantity of carbohydrates in their grains but comparatively they have low proportion of carbohydrates than rice and wheat. Lower carbohydrates and high fiber content in food is desired for maintenance of good health, especially for diabetics and cardiovascular patients. The carbohydrate in 100 g of seed ranged from 50.05 g (SiA 3419) to 76.42 g (SiA 4016) with a mean of 61.87 g.

Calcium (mg/100g)
Plant-based sources for calcium are good for strengthening bones of human body. They provide an easily absorbable source of calcium. The calcium content in 100 g of seed ranged from 16.00 mg (SiA 2737, SiA 3496, SiA 805, SiA 3908 and SiA 3419) to 40.00 mg (SiA 3038 and SiA 4044) with a mean of 24.03 mg.

Magnesium (mg/100g)
Magnesium acts as a co-factor for more than 300 enzymes, including enzymes involved in the body's use of glucose and insulin secretion. The magnesium content in 100 g of seed varied from 4.80 mg (SiA 3038 and SiA 3749) to 31.20 mg (SiA 4027) with a mean of 15.10 mg.

Iron (mg/100g)
Natural **Iron** is readily available in plants and their consumption helps in recovery from anaemia. The iron content in 100 g of seed ranged from 4.42 mg (SiA 3430) to 32.50 mg (SiA 3511) with a mean of 10.88 mg.

Zinc (mg/100g)
Zinc is needed for the proper growth and maintenance of the human body. It is found in several systems and biological reactions, and it is needed for immune function, wound healing, blood clotting, thyroid function, and much more. The zinc content in 100 g of seed varied from 1.53 mg (SiA 2663) to 7.07 mg (SiA 3554) with a mean of 3.26 mg.

Copper (mg/100g)
Copper is an essential nutrient for the body. Together with iron, it enables the body to form red blood cells. It helps to maintain healthy bones, blood vessels, nerves, and immune function, and it contributes to iron absorption. Sufficient copper in the diet may help prevent cardiovascular disease and osteoporosis, too. The copper content in 100 g of seed ranged from 0.86 mg (SiA 3827, SiA 3908, SiA 3639 and SiA 3430) to 2.76 mg (SiA 3611 and SiA 4016) with a mean of 1.26 mg.

Manganese (mg/100g)
Manganese improves bone health in combination with other nutrients. Strong antioxidant properties may reduce disease risk. It helps reduce inflammation, particularly in combination with glucosamine and chondroitin. Besides, it plays a vital role in blood sugar regulation. The manganese content in 100g of seed ranged from 1.31 mg (SiA 3908) to 4.12 mg (SiA 3559) with a mean of 2.33 mg.
In a nutshell, the study of 100 foxtail millet genetic resources for the nutrient composition revealed existence of sufficient availability for nutritional traits and this in turn offers ample opportunities to the farmers and food industry towards their exploitation for therapeutic benefits and better human health.

References

1. Gopalan C, Ramasastri BV, Balasubramanian SC. Nutritive value of Indian foods. National Institute of Nutrition, ICMR, Hyderabad, 2007.
2. Jali MV, Kamatar MY, Jali SM, Hiremath MB, Naik RK, Efficacy of value added foxtail millet therapeutic food in the management of diabetes and dyslipidamea in type 2 diabetic patients. Recent Research in Science and Technology, 2012; 4(7):03-04.
3. Kamatar MY. Noble Millet Food Products for Quality Life ofAll Walks of Life and Age Groups (in) International Symposium onRTE Foods: Innovations in Ready-to-Eat Products: Drivers, Trends and Emerging Technologies held during 24-25 Sept 2013 at Mumbai, Maharastra, India. 2013, 24-26.
4. Murugan R, Nirmala Kumari A. Genetic divergence in foxtail millet. (*Setaria italica* (L.) Beauv). Indian Journal of Genetics. 2006; 66(4):339-340.
5. Rai M, Nutritive cereals. In: Survey of Indian Agriculture. The Hindu, Chennai, Tamil Nadu, India, 2002, 59-62.
6. Ravi SB, Hrideek TK, Kumar ATK, Prabhakaran TR, Mal B, Padulosi S. Mobilizing neglected and underutilized crops to strengthen food security and alleviate poverty in India. Indian J Plant Genet. Reso. 2010; 23:117-121.