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Genetic Diversity for Zinc, Calcium and Iron Content of Selected Little Millet Genotypes

Manimozhi Selvi V[1]*, Nirmalakumari A[2] and Senthil N[3]

[1]*Centre for Plant Breeding and Genetics, Tamil Nadu, India*
[2]*Centre of Excellence in Millets, Tamil Nadu, India*
[3]*Department of Plant Biotechnology, Tamil Nadu Agricultural University, Tamil Nadu, India*

Abstract

Little millet (*Panicum sumatrense* Roth. ex. Roem. and Schultz.) is an important indigenous small millets crop. The nutritional quality of little millet grain is superior to major cereals. The present experiment was carried out to identify the sources of zinc, iron and calcium rich genotypes. within this objectives 30 selected high yielding genotypes comprising of 26 germplasm accessions and four check varieties *viz.,* CO_2, CO_3, CO (Samai) 4 and OLM 203 were evaluated in a Randomized Complete Block Design (RCBD) with three replications during summer, 2013 (Jan-May) at Millets Breeding Station, Tamil Nadu Agricultural University, Coimbatore. All the 30 genotypes were subjected for grain nutrient analysis (zinc, iron and calcium) using Atomic Absorption Spectrophotometer. Nutrient analysis results revealed that zinc, iron and calcium contents in dehusked grains of little millet genotypes differed significantly among the genotypes. The zinc content was varied from 2.04 to 8.00 mg/g with a mean of 5.23 mg/g. Wide variation in iron content was observed and it ranged from 1.49 to 23.38 mg/g with a mean of 4.95 mg/g. The grain calcium content ranged from 1.14 to 13.15 mg/g with a mean of 3.90 mg/g. The genotypes TNPsu 25 (8.00 mg/g), TNPsu 23 (7.42 mg/g), TNPsu 21(6.95 mg/g) and TNPsu 9 (6.85 mg/g) had higher zinc content. Similarly the accessions TNPsu 23 (23.38 mg/g) and TNPsu 22 (19.22 mg/g) were superior in grain iron content. The CO_3 (13.15 mg/g), CO_2 (8.45 mg/g), TNPsu 141 (8.23 mg/g) and CO (Samai) 4 (6.52 mg/g) were some of the accessions which had significantly higher calcium content when compared to standard check varieties. A few of the genotypes like TNPsu 25, TNPsu 23 and TNPsu 22 were rich in zinc and iron contents and TNPsu 141 was rich in zinc and calcium contents.

Keywords: Little millet; Nutritional quality; Grain micronutrient content; Genetic diversity; Variability

Introduction

The gradual change in climatic conditions particularly rainfall receipt and distribution in tropical and subtropical regions of the world necessitates productivity enhancement of stress tolerant crops such as small millets as one option for food security. Little millet (*Panicum sumatrense* Roth. ex. Roem. and Schultz.) is an important indigenous small millets crop. It is well known for its drought tolerance and is considered as one of the least water demanding crops. Micronutrient malnutrition resulting from the consumption of diets deficient in minerals, vitamins and essential amino acids, affects more than one-half of the world's population especially women and children in developing countries [1]. The nutritional quality of little millet grain is superior to many other major cereals. It is also contains B vitamins, especially niacin, B6 and folic acid calcium, iron, potassium, phosphorus, magnesium and zinc [2]. Iron deficiency is the most common nutritional disorder in the world affecting over 4 billion people, with more than 2 billion people, mainly in developing countries, actually being anemic [3]. Zinc deficiency in humans reduces growth, sexual maturity and the immune defence system [4]. Whole grains of little millet may have health promoting effects equal to or even in higher amount than fruits and vegetables and have a protective effect against insulin resistance, heart diseases, diabetes, ischemic stroke, obesity, breast cancer, childhood asthma and premature death [5].

Very little efforts have been made from the green revolution time for the genetic enhancement of this crop although it contributes to the food security for the poor as well as tribal population. Wide spread reports on energy and micronutrient malnutrition in tribal population have raised concerns on the food and nutritional security. In the present climate changing scenario and in the context of micronutrient malnutrition, this crop has a large hidden potential as a promising crop of the future. This untapped potential should be properly exploited for our food and nutritional security in the coming years. The first pre requisite for initiating a breeding programme to develop micronutrient rich genotypes, is to screen the available germplasm and to identify the source of the genetic variation for the target trait which can be used in crosses, genetic variation, molecular marker development and to understand the basic enhancement of micronutrient. This study mainly focused to identify sources and improve zinc, iron and calcium contents in little millet which would be a pertinent approach to combat wide spread malnutrition.

Materials and Methods

The experimental material consisted of 110 little millet genotypes having their origin from different geographical regions maintained at the Small Millets Germplasm Unit of Department of Millets, Tamil Nadu Agricultural University, and Coimbatore (Table 1). The 110 genotypes comprised of 105 germplasm accessions and five check varieties *viz.,* CO_2, CO_3, Paiyur 1, CO (Samai) 4 and OLM 203. They

***Corresponding author:** Manimozhi Selvi V, Centre for Plant Breeding and Genetics, Tamil Nadu, India, Tel: 0914226611215; E-mail: manimozhiagri2005@gmail.com

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S.No	Genotype	Origin
1	TNPsu 1/79	Tamil Nadu
2	TNPsu 2	Tamil Nadu
3	TNPsu 3	Tamil Nadu
4	TNPsu 4	Tamil Nadu
5	TNPsu 5	Tamil Nadu
6	TNPsu 6	Tamil Nadu
7	TNPsu 7	Tamil Nadu
8	TNPsu 7/79	Tamil Nadu
9	TNPsu 8	Tamil Nadu
10	TNPsu 8/78	Tamil Nadu
11	TNPsu 9	Tamil Nadu
12	TNPsu 10	Tamil Nadu
13	TNPsu 11	Tamil Nadu
14	TNPsu 12	Tamil Nadu
15	TNPsu 13	Tamil Nadu
16	TNPsu 14	Tamil Nadu
17	TNPsu 15	Tamil Nadu
18	TNPsu 16	Tamil Nadu
19	TNPsu 16/78	Tamil Nadu
20	TNPsu 17	Tamil Nadu
21	TNPsu 18	Tamil Nadu
22	TNPsu 19	Tamil Nadu
23	TNPsu 21	Tamil Nadu
24	TNPsu 22	Tamil Nadu
25	TNPsu 23	Tamil Nadu
26	TNPsu 24	Tamil Nadu
27	TNPsu 24/79	Tamil Nadu
28	TNPsu 25	Tamil Nadu
29	TNPsu 26	Tamil Nadu
30	TNPsu 27	Tamil Nadu
31	TNPsu 28	Tamil Nadu
32	TNPsu 29	Tamil Nadu
33	TNPsu 30	Tamil Nadu
34	TNPsu 31	Tamil Nadu
35	TNPsu 32	Tamil Nadu
36	TNPsu 33	Tamil Nadu
37	TNPsu 34	Tamil Nadu
38	TNPsu 35	Tamil Nadu
39	MS 108	Tamil Nadu
40	MS 109	Tamil Nadu
41	MS 110	Tamil Nadu
42	MS 115	Tamil Nadu
43	MS 509	Tamil Nadu
44	MS 662	Tamil Nadu
45	MS 1003/1	Tamil Nadu
46	MS 1211	Tamil Nadu
47	MS 1236	Tamil Nadu
48	MS 1826	Tamil Nadu
49	MS 3969	Tamil Nadu
50	MS 4527	Tamil Nadu
51	MS 4684	Tamil Nadu
52	MS 4700	Tamil Nadu
53	MS 4700/1	Tamil Nadu
54	MS 4725	Tamil Nadu
55	MS 4729	Tamil Nadu
56	MS 4735	Tamil Nadu
57	MS 4779	Tamil Nadu
58	MS 4784	Tamil Nadu
59	PM 29	Madhya Pradesh
60	PM 42	Bihar
61	PM 141	Madhya Pradesh
62	PM 143	Karnataka
63	PM 295	Andhra Pradesh
64	PM 295/1	Madhya Pradesh
65	PM 296	Bihar
66	PM 307	Andhra Pradesh
67	PM 410	Karnataka
68	IPM 59	Patancheru, Andhra Pradesh
69	IPM 115	Patancheru, Andhra Pradesh
70	IPM 118	Patancheru, Andhra Pradesh
71	IPM 221	Patancheru, Andhra Pradesh
72	IPM 221/A	Patancheru, Andhra Pradesh
73	IPM 226	Patancheru, Andhra Pradesh
74	IPM 231	Patancheru, Andhra Pradesh
75	IPM 232	Patancheru, Andhra Pradesh
76	IPM 272	Patancheru, Andhra Pradesh
77	IPM 838	Patancheru, Andhra Pradesh
78	IPM 884	Patancheru, Andhra Pradesh
79	IPM 895	Patancheru, Andhra Pradesh
80	IPmr 700	New Delhi
81	IPmr 709	New Delhi
82	IPmr 712	New Delhi
83	IPmr 712/1	New Delhi
84	IPmr 837	New Delhi
85	IPmr 838/1	New Delhi
86	IPmr 839	New Delhi
87	IPmr 841	New Delhi
88	IPmr 857	New Delhi
89	IPmr 859	New Delhi
90	IPmr 861	New Delhi
91	IPmr 862	New Delhi
92	IPmr 886	New Delhi
93	IPmr 889	New Delhi
94	IPmr 891	New Delhi
95	IPmr 1018	New Delhi
96	IPmr 1046	New Delhi
97	IPmr 1061	New Delhi
98	PMR 762	Banglore, Karnataka
99	RPM 8-1	Madhya Pradesh
100	RPM 11	Madhya Pradesh
101	ARP 9	Tamil Nadu
102	OLM 112	Odisha
103	OLM 114	Odisha

104	OLM 115	Odisha
105	TNPsu 141	Tamil Nadu
106	Paiyur 1	Tamil Nadu
107	CO 2	Tamil Nadu
108	CO 3	Tamil Nadu
109	CO(Samai) 4	Tamil Nadu
110	OLM 203	Odisha

Table 1: List of little millet genotypes used for evaluation.

were evaluated during *kharif,* 2012 and observations on 12 quantitative traits [days to 50 per cent flowering, plant height, basal tillers per plant, culm branches per plant, peduncle length (cm), panicle length (cm), panicle exertion (cm), flag leaf length (cm), flag leaf width (cm), thousand grain weight (g), single plant dry fodder yield (g) and single plant grain yield (g)] were recorded on five randomly selected competitive plants descriptor for *Panicum sumatrense* [6]. Based on the data for high single plant yield and bold seeds, 30 genotypes were selected. The 30 genotypes comprised of 26 germplasm accessions and four check varieties *viz.,* CO_2, CO_3, CO (Samai) 4 and OLM 203 and the experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications during summer, 2013 (Jan-May) at Millets Breeding Station, Tamil Nadu Agricultural University, Coimbatore. Recommended agronomic practices were followed to maintain a good crop stand. All the 30 genotypes were subjected to grain nutrient analysis (zinc, iron and calcium). Nutrient analysis was carried out in BRAIC-VFX-130 Atomic Absorption Spectrophotometer model with Iron Hallow cathode lamp at wavelength 248.3 nm. Nutrient analysis was carried out on triplicate ground samples of grains from individual plant by digestion with 9:4 diacid mixture (HNO_3: $HCLO_4$) followed by atomic absorption spectrometry (AAS) method using ECIL AAS (Perkin Elmer) as per the protocol described by [7,8].

Results and Discussion

Generally iron and zinc contents in major food crops range from 5 to 150 µg/g [9]. Nutrient analysis results revealed that zinc, iron and calcium contents in dehusked grains of little millet genotypes differed significantly among the genotypes (Table 2).

The zinc content varied from 2.04 to 8.00 mg/g with a mean of 5.23 mg/g (Figure 1). The genotypes TNPsu 25 had the highest grain zinc content of 8.00 mg/g followed by TNPsu 23 (7.42 mg/g), TNPsu 21(6.95 mg/g) and TNPsu 9 (6.85 mg/g) whereas the lowest zinc content was found in CO (Samai) 4 (2.04 mg/g).

Wide variation in iron content was observed and it ranged from 1.49 to 23.38 mg/g with a mean of 4.95 mg/g (Figure 2). Two of the little millet genotypes *viz.,* TNPsu 23 (23.38 mg/g) and TNPsu 22 (19.22 mg/g) had very high iron content genotypes that had not been reported earlier. In contrast MS 4700 had the lowest grain iron content (1.49 mg/g).

The grain calcium content varied from 1.14 to 13.15 mg/g with a mean of 3.90 mg/g (Figure 3). The genotype CO_3 had the highest calcium content (13.15 mg/g) followed by CO_2 (8.45 mg/g), TNPsu 141 (8.23 mg/g) and CO (Samai) 4 (6.52 mg/g) while the genotypes *viz.,* TNPsu 28 (1.14 mg/g) and TNPsu 27 (1.35 mg/g) had the lowest calcium content.

The maximum grain calcium, iron and zinc contents in little millet grains were 13 mg/g, 9.3 mg/g and 3.7 mg/g respectively which was reported by FAO [10]. A few of the genotypes like TNPsu 25, TNPsu 23 and TNPsu 22 were rich in both zinc and iron contents and TNPsu 141wass rich in zinc and calcium content. Nambi et al. [11] also reported high iron and calcium contents in little millet. Past attempts by Shashi et al. [12] and Upadhyaya et al. [13] to detect and estimate wide genetic variability for grain nutrients (zinc, calcium and iron) in finger millet were based on a relatively fewer numbers of accessions. Basanti Brar et al. [14] reported wide range of iron and zinc contents in dehusked rice grains within 220 rice genotypes. These genotypes having high nutrient contents could possibly be used in breeding programmes, promotion of large scale cultivation and consumption. Under- utilized species like little millet is likely to be useful in fighting malnutrition and hidden hunger, both in areas of cultivation and outside.

The results implied that in general the little millet genotypes exhibited high variation for the grain nutrient contents *viz.,* iron, and zinc and calcium contents. This type of large genotypic variation especially for iron content in little millet has not been reported earlier. The large genotypic variation of iron, calcium and zinc in little millet grains could be due to tightly controlled homoeostatic mechanisms that regulate metal absorption, translocation and redistribution in plants allowing adequate, but non-toxic levels of these nutrients to accumulate in plant tissues [15]. Iron, zinc and calcium contents in edible portions also depend on the efficiency of translocation of minerals from root tissues to edible plant organs and accumulation thereof.

Genotypes	Grain nutrient content (mg/g)		
	Zinc	Iron	Calcium
TNPsu 1/79	6.36 ± 0.02	5.39 ± 0.14	2.66 ± 0.06
TNPsu 9	6.85 ± 0.04	4.67 ± 0.02	2.22 ± 0.04
TNPsu 12	4.91 ± 0.03	4.10 ± 0.04	2.00 ± 0.04
TNPsu 13	4.41 ± 0.23	3.15 ± 0.04	3.38 ± 0.01
TNPsu 17	4.67 ± 0.05	3.40 ± 0.02	1.68 ± 0.03
TNPsu 18	5.55 ± 0.03	3.20 ± 0.04	1.52 ± 0.02
TNPsu 19	5.86 ± 0.20	3.76 ± 0.07	1.59 ± 0.06
TNPsu 21	6.95 ± 0.08	5.88 ± 0.05	2.08 ± 0.02
TNPsu 22	4.66 ± 0.06	19.22 ± 0.16	3.22 ± 0.05
TNPsu 23	7.42 ± 0.08	23.38 ± 0.32	4.09 ± 0.06
TNPsu 25	8.00 ± 0.05	4.62 ± 0.09	1.68 ± 0.02
TNPsu 27	5.95 ± 0.01	3.85 ± 0.30	1.35 ± 0.08
TNPsu 28	4.63 ± 0.17	3.17 ± 0.04	1.14 ± 0.05
TNPsu 141	6.28 ± 0.03	4.32 ± 0.03	8.23 ± 0.03
MS 110	6.42 ± 0.03	4.32 ± 0.15	2.63 ± 0.05
MS 509	6.17 ± 0.06	4.00 ± 0.04	4.51 ± 0.01
MS 1003/1	5.03 ± 0.03	1.66 ± 0.03	2.89 ± 0.03
MS 1211	4.64 ± 0.03	2.02 ± 0.01	2.94 ± 0.05
MS 1236	5.67 ± 0.04	2.46 ± 0.02	5.18 ± 0.03
MS 1826	5.25 ± 0.05	2.24 ± 0.02	5.18 ± 0.03
MS 3969	5.25 ± 0.03	8.33 ± 0.03	4.77 ± 0.02
MS 4684	5.39 ± 0.02	1.93 ± 0.03	4.91 ± 0.02
MS 4700	4.37 ± 0.01	1.49 ± 0.01	5.34 ± 0.01
MS 4784	5.20 ± 0.04	2.57 ± 0.04	5.20 ± 0.05
PM 29	5.70 ± 0.04	4.29 ± 0.05	3.92 ± 0.03
IPmr 886	6.39 ± 0.03	3.00 ± 0.04	5.66 ± 0.04
CO 2	2.78 ± 0.01	4.07 ± 0.05	8.45 ± 0.06
CO 3	2.56 ± 0.03	4.40 ± 0.03	13.15 ± 0.04
CO (Samai) 4	2.04 ± 0.02	4.45 ± 0.05	6.52 ± 0.06
OLM 203	2.41 ± 0.0	5.22 ± 0.0	1.89 ± 0.0
Mean	5.25	2.24	5.18
CD	0.21	0.28	0.12
CV (%)	27.35	97.09	65.47

Table 2: Variability for grain nutrient content in selected 30 littlemillet genotypes.

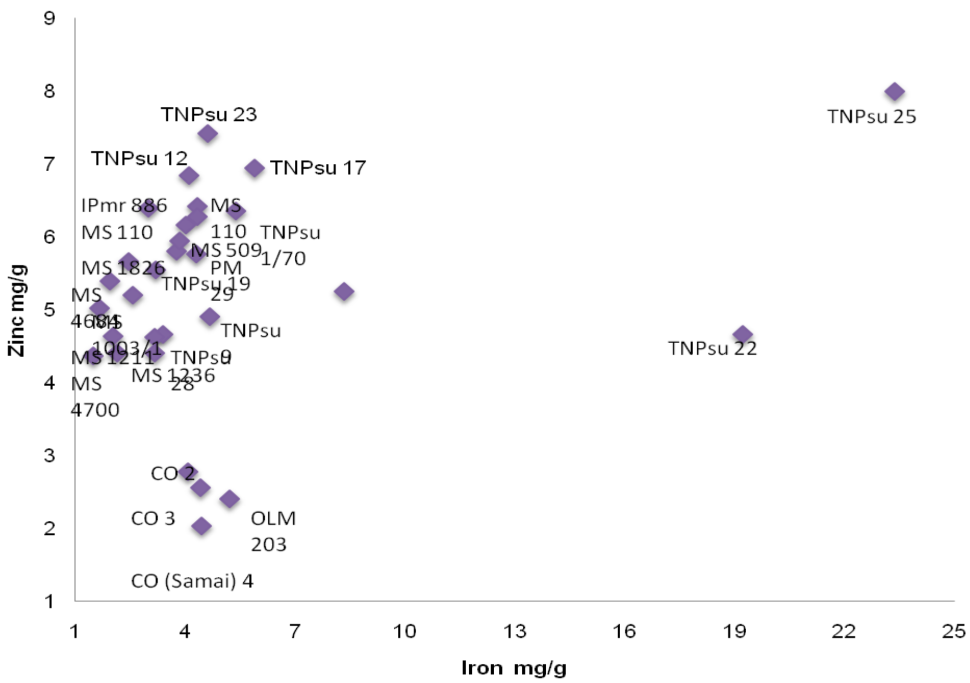

Figure 1: Variation for iron and zinc contents in littlemillet genotypes.

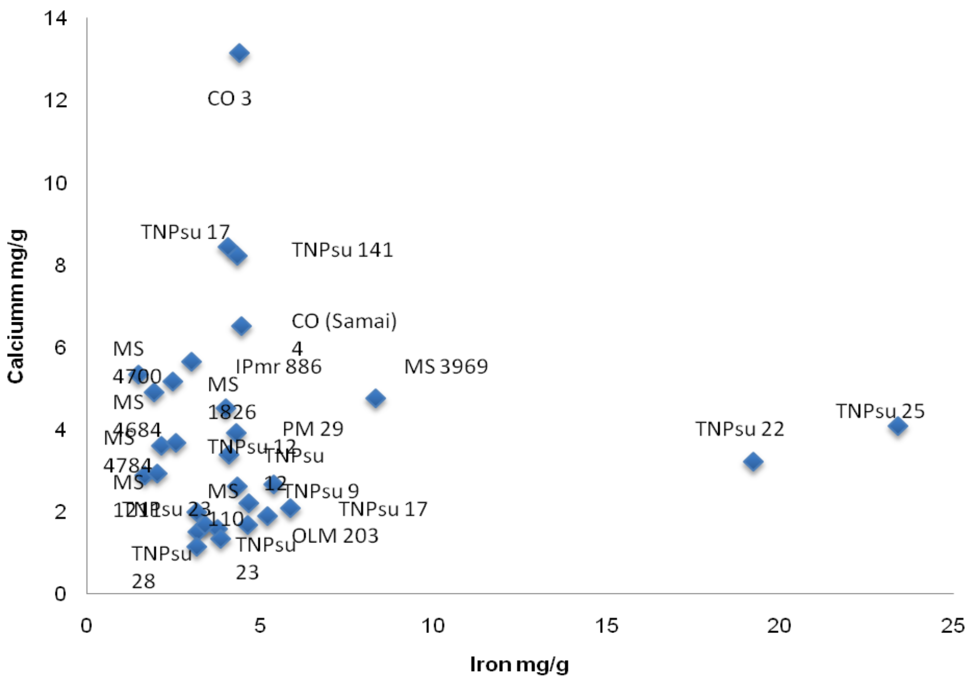

Figure 2: Variation for iron and calcium contents in littlemillet genotypes.

Conclusion

Zinc, iron and calcium rich genotypes *viz.,* TNPsu 25, TNPsu 23, TNPsu 22 and TNPsu 141 could be involved in hybridization with agronomically superior accessions / breeding lines to combine grain nutrients (zinc, iron and calcium) and grain yield. Genotypes with poor content of nutrients *viz.,* TNPsu 28, TNPsu 27, MS 4700 and MS 1003/1 identified in this study could be an ideal material for molecular understanding of the metal homeostasis in little millet. Even though some of the genotypes had lower calcium content than that of the the standard check varieties but those genotypes were superior in zinc and iron contents. Thus little millet could be a good source of nutrients

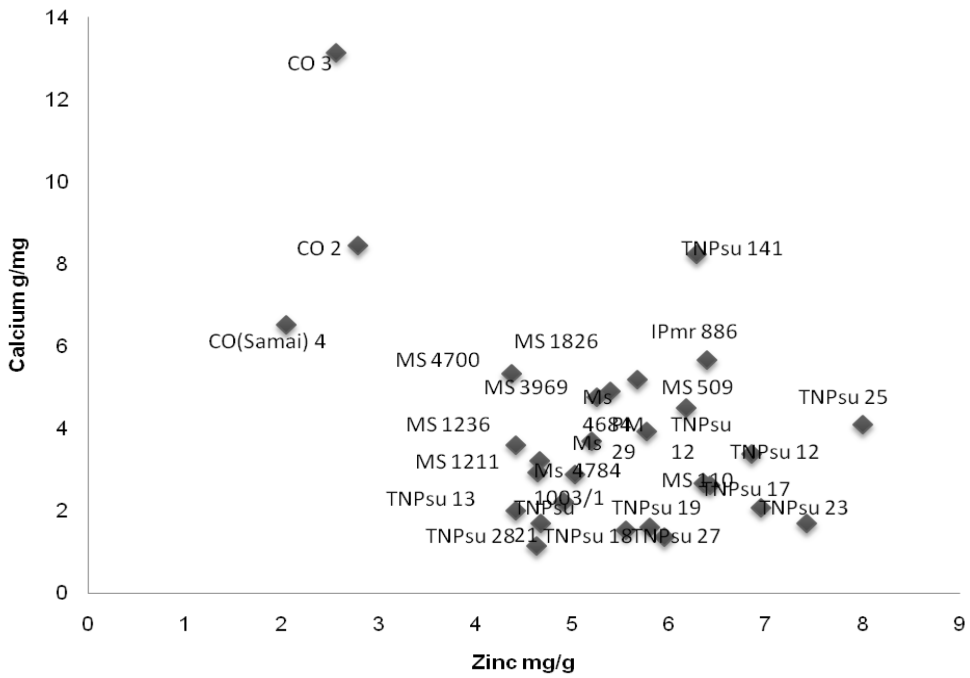

Figure 3: Variation for zinc and calcium contents in littlemillet genotypes.

which need to be exploited properly. This research findings could help in promoting the little millet consumption and thereby nutritional intake of the consumers significantly. This would also contribute to the food basket of the nation in addressing the food security.

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