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# Assessment of Genetic diversity for grain macro and micro nutrients contents in mini-core germplasm collections of finger millet (*Eleusine coracana* (L) Gaertn.)

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***Abstract:*** *Intake of diets poor in iron, zinc and protein is the major cause for micronutrients and protein malnutrition in women and preschool children in Indian subcontinent. The most cost effective approach for mitigating micronutrients and protein malnutrition is to introduce finger millet varieties selected and/or bred for increased iron, zinc and protein contents. Assessing and exploitation of existing variability among germplasm accessions is the first principle of breeding micronutrients and protein-dense finger millet cultivars. Under this premise, a mini-core subset, which captures maximum variability of entire finger millet collection developed and maintained at International Crops Research Institute of Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India was evaluated for grain micronutrients and protein contents. The results revealed substantial variability for grain nutrient contents. Accessions contrasting for grain nutrients contents have been identified. These results are discussed in relation to breeding and selection strategies required for genetic enhancement of grain nutrients contents in finger millet.*

***Key words:*** *Finger millet, grain micronutrients, genetic diversity.*

## INTRODUCTION

Finger millet (*Eleusine coracana* Gaertn.) commonly known as ragi, birds foot millet, coracana and African millet, is grown under varied agroclimatic conditions, mostly in countries of Africa and Asia. Wide adaptability (Upadhyaya *et al.* 2007), higher nutritional quality (Gopalan *et al.* 2002) and high multiplication rate of ragi makes it one of the ideal crops for use as a staple food. Because of its excellent storability under ambient conditions (Iyengar *et al.* 1945), it is considered as an ideal famine reserves (Vietmeyer 1996). Because of its dual purpose (grain + dry fodder) nature, finger millet is an indispensable component crop in mixed crop-livestock system prevalent in Indian farming system. The dry fodder with high (61%) total digestible nutrients (Vietmeyer 1996) is the major source of dry matter to both draught and milch animals.

Assessing and exploitation of existing variability among germplasm accessions is the first principle of breeding micronutrients and protein-dense finger millet cultivars. Under this premise, a mini-core subset (89 accessions), which captures maximum variability of entire finger millet collection (5949 accessions) developed and maintained at International Crops Research Institute of Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India was evaluated for grain micronutrients and protein contents.

## MATERIAL AND METHODS

The material for the present study comprised of 89 mini core collections along with two checks, PR 202 and VR 708. These 89 mini core collections were developed and are being maintained at ICRISAT.

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While the grains of 89 mini- core accessions were procured from ICRISAT, Patancheru, those of two check varieties were procured from All India co-ordinated small millets improvement project, University of Agricultural Sciences (UAS), Gandhi Krishi Vignana Kendra (GKVK), Bengaluru, India. Macro nutrients such as nitrogen (N), potassium (K), crude protein and micronutrients such as calcium (Ca), zinc (Zn), magnesium (Mg) and manganese (Mn) were estimated in grains of 89 mini-core collections and two check varieties, PR 202 and VR 708. The analysis was carried out during the months of June-July 2009 at Soil Science and Agricultural Chemistry Laboratory, Krishi Vignana Kendra (KVK), Hassan, Karnataka, India.

**Estimation of grain nutrient contents:** Powdered grain samples (0.5 g) of each mini core accessions pre-digested using concentrated nitric acid and perchloric acid and nitric acid mixture in microwave oven except for nitrogen content analysis as described by Jackson (1973). Residue was extracted with dilute hydro chloric acid and preserved for further analysis after making known volume in double distilled water. For nitrogen content analysis, the samples were digested using Gerhardt Turbotherm digestion method (AOAC 1980). The digested samples were used for analysis of nutrients contents using standard AOAC (1980) procedure.

The nitrogen content of the digested samples was estimated using Micro-kjeldahl method (AOAC, 1980). The protein content was computed by multiplying the per cent nitrogen using the conversion factor 6.25 (AOAC, 1980).

### Calculation of (N %):

$$N(\%) = \frac{(Titre\ value \times Normality\ of\ acid \times 0.014 \times volume\ of\ digested\ sample \times 100)}{Weight\ of\ sample \times aliquot\ taken}$$

Potassium was estimated using Flame photometer method.

### Calculations (K %)

$$K(ppm) = \frac{Graph\ ppm \times volume\ of\ digested\ sample \times volume\ made\ upto\ 10ml}{Weight\ of\ sample}$$

### Estimation of micronutrients

**Zinc and manganese:** Zinc and manganese were estimated by atomic absorption spectrophotometer (AAS) method. Suitable dilutions of digested samples were feed to AAS having appropriate hallow cathode lamps after getting values for standards (AOAC, 1980).

**Calcium and magnesium:** Calcium and magnesium were estimated by following Ethylene Diamine Tetra Acetic Acid (EDTA) titration method (Jakson, 1973).

**Statistical analysis:** The estimated values of the seven grain nutrient contents were subjected to statistical analysis.

Genetic diversity was assessed in 89 mini core germplasm accessions using principal components analysis as conceptualized by Pearson (1901) and described by Hotelling (1933). Adjusted, standardized and uncorrelated grain macro and micronutrients contents were used for principal component analysis. Based on first two major principal components which explained maximum variability among the accessions, a scatter graph was plotted. Based on the scatter plot, accessions were grouped into different clusters.

## RESULTS AND DISCUSSION

**Genetic diversity:** First two principal components explained 88.58 per cent of total variability among 89 mini core accessions **(Table 1)**. Based on the scatter plot (Fig. 1) of first two principal components, the 89 mini core accessions could be conveniently grouped in to 16 clusters suggesting wide differentiation among the accessions. The

**Table 1**
**Number of principal components and their Eigen values and contribution to total variability for 7 macro and micro nutrients contents in mini core finger millet germplasm accessions**

| *Principal components variation* | *Eigen value* | *% contribution to total* |
|---|---|---|
| 1 | 5838.23 | 68.32 |
| 2 | 1731.40 | 20.26 |
| 3 | 532.69 | 6.23 |
| 4 | 352.56 | 4.13 |
| 5 | 89.034 | 1.05 |
| 6 | 1.675 | 0.012 |
| 7 | 0.0048 | 5.62 |

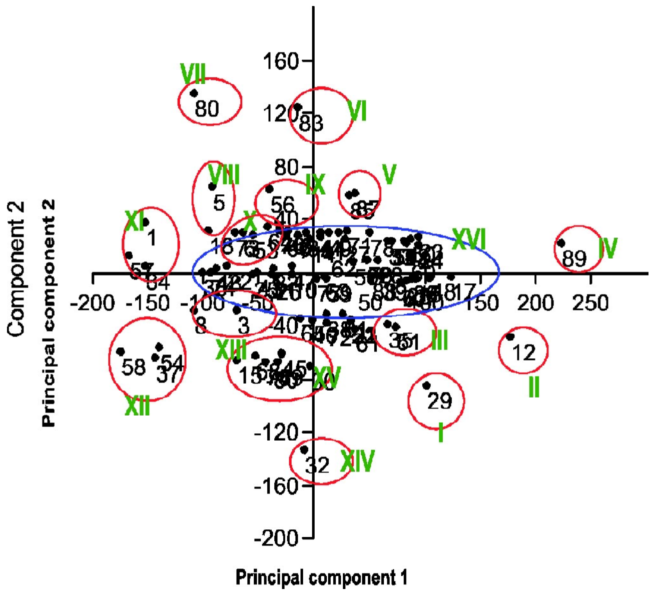


**Figure 1: Grouping of genotypes into different clusters based on first two principal components of macro and micro nutrients contents in minicore finger millet germplasm accessions.**

differentiation of the accessions was so much that about seven of the 16 accessions were solitary. The number of accessions in the remaining clusters varied from two in cluster No. III, V, VIII and XIII and three in X, XI and XII and four in XV to as many as 61 in cluster No. XVI. The substantial genetic diversity among the accessions could be attributed to differential natural selection pressure driven by agronomic advantages such as higher seedling vigour, disease resistance and water-use efficiency conferred by grain micronutrient contents to the accessions (Graham and Welch 1996). As finger millet has evolved in regions characterized by large biodiversity (Hilu and de Wet 1976) and spared to the regions with diverse climatic conditions due to anthropogenic activities, differential natural selection pressure must have occurred on accessions with different levels of grain micro nutrients contents. Critical examination of grain nutrient contents in accessions originating from different countries indicated lack of relationship between grain nutrient contents and geographical origin.

**Grain nutrient-specific accessions:** Breeding for grain nutrient-rich finger millet cultivars is still in its infancy. Detection and quantification of genetic variability, unravelling the inheritance pattern and genotype by environment interaction for grain nutrients contents is the major goal of most finger millet breeding programmes. Identification of accessions contrasting for one or more grain nutrients contents is a prerequisite for inheritance and genotype by environment interaction studies and developing mapping populations. The accessions such as IE 2093, IE 2457, IE 501, IE 518, IE2296 (with >1.42% nitrogen content) and IE 3973, IE 3543, IE 2589, IE 2437, IE 2619 (with < 0.73% nitrogen content); IE 3614, IE 3045, IE 2217, IE 3077, IE 6221 (with > 47 ppm zinc content) and IE 3134, IE 2322, IE 4759, IE4425, IE 7320 (with <16.6 ppm zinc content); IE 6059, IE 5736, 6514, IE6350, IE 2034 (with > 384 mg 100 $g^{-1}$ calcium content) and IE4565, IE 4121, 2710, IE4329, IE 4734 (with < 256 mg 100 $g^{-1}$ calcium content) **(Table 2)** are useful for such studies. The information thus obtained is useful for designing suitable strategies to develop grain nutrient-dense finger millet cultivars.

**Table 2**
**Accessions with contrasting expressions for different macro and micro nutrients contents in finger millet mini core germplasm**

| *Sl. No.* | *Nutrients* | *Accessions with lowest performance* | *Mean value* | *Accession with highest performance* | *Mean value* |
|---|---|---|---|---|---|
| 1 | Nitrogen (%) | 3973 | 0.674 | 2296 | 1.420 |
| 2 | | 3543 | 0.680 | 518 | 1.470 |
| 3 | | 2589 | 0.696 | 501 | 1.570 |
| 4 | | 2437 | 0.720 | 2457 | 1.571 |
| 5 | | 2619 | 0.729 | 2093 | 1.750 |
| 1 | Crudeprotein (%) | 4073 | 4.22 | 4795 | 8.89 |
| 2 | | 4414 | 4.25 | 3543 | 9.18 |

*contd. table 2*

| *Sl. No.* | *Nutrients* | *Accessions with lowest performance* | *Mean value* | *Accession with highest performance* | *Mean value* |
|---|---|---|---|---|---|
| 3 | | 4121 | 4.35 | 3973 | 9.80 |
| 4 | | 2821 | 4.52 | 3077 | 9.82 |
| 5 | | 4565 | 4.56 | 4545 | 10.93 |
| 1 | Potassium (ppm) | 4329 | 2320. 0 | 4816 | 5040. 0 |
| 2 | | 2042 | 2360. 0 | 5066 | 5060. 0 |
| 3 | | 501 | 2480. 0 | 6154 | 5240. 0 |
| 4 | | 680 | 2480. 0 | 2606 | 5800. 0 |
| 5 | | 2312 | 2620. 0 | 5091 | 6220. 0 |
| 1 | Calcium(mg 100 $g^{-1}$) | 4565 | 192 | 2034 | 384 |
| 2 | | 4121 | 240 | 6350 | 384 |
| 3 | | 2710 | 256 | 6514 | 384 |
| 4 | | 4329 | 256 | 5736 | 448 |
| 5 | | 4734 | 256 | 6059 | 448 |
| 1 | Magnesium(mg 100 $g^{-1}$) | 4565 | 76.8 | 3317 | 172.8 |
| 2 | | 4121 | 96.0 | 5106 | 172.8 |
| 3 | | 5870 | 99.9 | 2790 | 172.8 |
| 4 | | 5201 | 100.1 | 3721 | 192.0 |
| 5 | | 5066 | 106.0 | 2322 | 192.0 |
| 1 | Manganese(ppm) | 5736 | 41.220 | 4491 | 114.300 |
| 2 | | 7018 | 42.120 | 3614 | 115.020 |
| 3 | | 2322 | 42.300 | 2457 | 120.780 |
| 4 | | 5817 | 42.840 | 4734 | 125.820 |
| 5 | | 2871 | 45.360 | 2790 | 130.500 |
| 1 | Zinc (ppm) | 3134 | 13.200 | 6221 | 47.000 |
| 2 | | 2322 | 15.000 | 3077 | 47.616 |
| 3 | | 4759 | 15.600 | 2217 | 47.740 |
| 4 | | 4425 | 16.200 | 3045 | 47.988 |
| 5 | | 7320 | 16.600 | 3614 | 55.552 |

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