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# Screening of higher mineral containing finger millet landraces from Maharashtra

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**Abstract**
Finger millet (*Eleusine coracana* L. Gaertn.) is one of the traditional and nutritionally most important crop. Sixty-four (64) landraces from Maharashtra were analyzed for 8 mineral elements Cu, Zn, Fe, Mn, K, Ca, Mg and Na by tri-acid digestion method. Obtained results showed substantial genetic variability for grain minerals among the landraces. Calcium (159.7-364.6mg/100gm) and Iron (10.2-424.16 mg/100gm) were the most concentrated nutrients, followed by potassium (26-184 mg/100gm) and sodium (107-268.23 mg/kg).Five best landraces containing higher amount of minerals were screen out. Collected landraces showed diversity in their morphological characters such as head weight, height, seed weight, tillers, extra fingers etc. Co-relation studies showed significant co-relation among K and Mn (0.648), Zn and Mg (0.551) Ca and Mg (0.476) and Fe and Ca (0.414). Obtained variability implies that the screened germplasm could serve as a source for breeding new varieties with improved nutritional traits or could be highly recommended to meet specific dietary requirements.

**Keywords:** *elusine corocana*, landraces, elements, correlation

## Introduction
Finger millet is a nutritious food grain crop with a fair amount of protein (7.3 g 100 g−1) (Malleshi and Klopfenstein, 1998), dietary fiber (15–20%) (Chethan and Malleshi, 2007) [3] and a rich source of calcium (344mg /100 gm) and iron (3.9mg) (Gopalan *et al*., 2002) [7]. As finger millet contains many valuable phyto-constituents and rich in minerals with highest calcium, it can be beneficial if blended with other dietary products. Finger millet is a promising source of micronutrients and protein (Malleshi and Klopfenstein, 1998). It can make a contribution to hidden-hunger' i. e. micronutrient and protein malnutrition which is affecting more than half of the world's population, especially women and preschool children in most countries of Africa and south-east Asia (Underwood, 2000) [27]. Malnutrition due to protein deficiency is also alarming in the Indian subcontinent (Chand *et al*., 2003; Prasad, 2010) [2]. Intake of diet poor in iron (Fe), zinc (Zn) and protein is the major cause for micronutrient and protein malnutrition. Protein deficiency causes retarded physical and mental growth, while Zn deficiency leads to diarrhoea, pneumonia and reduced immunity to diseases, and in pregnant women it leads to infant mortality (Gibson *et al*., 2008) [6]. More than 30 % of the world population suffers from anaemia, mostly caused by iron deficiency (WHO, 2015) [31]. More than 80 % of pregnant women in developing countries suffer from iron deficiency (Kruger *et al*., 2012) which results also in a variety of risks for both mother and infant, such as hemorrhage, maternal mortality, perinatal mortality, and low birth weight (WHO, 2001) [5, 32].

Besides iron deficiency, zinc deficiency is also an issue in the world. This deficiency is mostly associated with insufficient intake or absorption of zinc from the diet, but also losses of zinc during diarrhea can encourage zinc deficiency. In an estimation using food availability data, it is shown that one-third of the world population suffers from zinc deficiency. People with zinc deficiency have hypogonadism, impaired immune function, skin disorders, cognitive dysfunction, loss of appetite resulting in anorexia etc. (FAO & WHO, 2001) [5, 32]. Calcium deficiency leading to bone and teeth disorder, Fe deficiency leading to anemia can be overcome by introducing finger millet in our daily diet (Singh and Raghuvanshi, 2012) [17].

Finger mill *et al*so has medicinal attributes used by diverse communities for making special foods for diabetics, gluten-free food for people suffering from celiac disease and weaning foods for infants (Tylor *et al*., 2006) [8]. Starch fractions in finger millet are slow in digestion and absorption hence favorable in the diet pattern for metabolic disorders such as diabetes, hypertension, and obesity (Sharavathy *et al*., 2001) [20].

The most cost effective approach for mitigating micronutrient and protein malnutrition is to introduce improve Finger millet varieties or bred for increased mineral content through plant breeding. Attempts to breed finger millet for enhanced grain micronutrient contents are still in its infancy. Exploitation of existing variability for higher mineral content is the one of the important and short-term strategy for the development Finger millet with high mineral contents. In the present work landraces from Maharashtra were screened for higher mineral contents.

## Materials and Methods
The material for the study consisted of 64 landraces and 2 control cultivars, Dapoli 1 and Dapoli safed. The control cultivars Dapoli 1 and Dapoli safed are the high yielding cultivars developed and released by Kokan Krishi Vidyapith, Dapoli Maharashtra (India). The 64 landraces were collected from the part of western Ghat lies in Kolhapur, Pune, Sindhudurg, Ahmednagar and Nashik Dist. of Maharashtra during the year 2012-2013. Collected germplasm were sown to study morphological characters in rabbi season during 2014 at Nashik (India). Five representative plants were labeled in each plot for the study of 8 quantitative characters such as plant height, number of tillers, head weight, ear length, extra fingers,

number of grains, 1000 seed weight.

The grain samples of 64 landraces and 2 controls were evaluated for 8 mineral elements by the method Sahrawat *et al*. (2002) [18]. The grains samples were cleaned from foreign matters. One gram of sample (Powdered seeds) was taken in a conical flask, 15 ml of nitric acid $HNO_3$ and 5ml per-chloric acid $HClO_4$ was added. Samples were digested on hot plate till it become colorless. The digests were then dissolve in double distilled water and final volume was made to 100ml in volumetric flask. Mineral contents in the digests were determined by atomic absorption spectrophotometer (AAS). The experiment was replicated three times. For each of the nutrients, the best 5 accessions were selected and their agronomic diversity was assessed separately using descriptive statistics such as mean, range and variance. Each element was Co-related with morphological characters to understand relation among particular element and characters.

**Results and Discussions**

Finger millet is known for its adaptability to different environments, creating a wide range of morphological variability and variation in phytochemical contents. In the present studies most of the landraces showed variation in minerals contents due to differences in ecological conditions, genotype, origin and growing conditions from which the finger millet genotypes were originated. Lack of variability in mineral content among the genotypes of this study occurred possibly because few genotypes were originated from related genetic pool.

The result of analysis of variance showed a good amount of variability and significant differences for all the selected characters (Table 1). Differences in the characters attributed due to geographical variation and to some extent by genetic variability. Among the selected characters Tillers (71.36), Head weight (42.84) and Number of fingers (31.50) exhibited maximum variation (Table 1). Variability among indigenous and exotic finger millet germplasm were recorded by Satish (2003) [19], Kebere, (2006), Sonnad *et al*. (2008) [26] Shet *et al*. (2010) [21], Kumar and Gupta (2009), Ganapathy *et al*., (2011) and Upadhya *et al*., (2011).

**Table 1:** Mean, minimum and maximum values, standard deviation and coefficient of variation of agronomic traits of landraces.

| | Head weight | Height | 1000 Seed weight | Tillers | Ear length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|
| Minimum | 1.11 | 37.00 | 1.60 | 0.00 | 3.00 | 0.00 | 3.00 | 3.00 |
| maximum | 17.26 | 95.00 | 3.60 | 7.00 | 10.00 | 4.00 | 8.00 | 22.00 |
| mean | 6.40 | 66.63 | 2.36 | 1.59 | 6.40 | 0.67 | 5.12 | 6.76 |
| SD | 2.74 | 9.10 | 0.42 | 1.14 | 1.43 | 0.72 | 1.06 | 2.13 |
| CV | 42.84 | 13.66 | 17.88 | 71.36 | 22.33 | 107.02 | 20.67 | 31.50 |

All the collected landraces showed good amount of variation in their mineral content, few landraces exhibited significantly higher amount of minerals over to rest of the landraces.

Results of minerals analysis showed that calcium and iron were the most concentrated nutrients in all studied landraces (159.7-364.6 mg/100gm and 10.2-424.16 mg/100gm respectively) followed by Magnesium (96.76-186.5 mg/100g), Potassium (26-184 mg/100g) and Sodium (107-268.23 mg/kg).

The calcium content of the studied landraces ranges from 159.7-364.6 mg/100gm (Table 3), higher content of calcium reported from the landraces of Rajabari (364.6 mg/100gram) and Karanjali (346.5 mg/100gram) from Nashik district. The control varieties Dapoli 1and Dapoli safed contain 290 mg/100gm and 234 mg/100gm of calcium respectively. Vadivoo, Joseph and Garesan (1998) results were the calcium content of 36 genotypes of finger millet ranged from 162 to 487 mg% with mean value of 320.8 mg%. Bhatt, Singh, Shrotria and Baskheti (2003) and Singh and Raghuvanshi (2012) [17] reported that the finger millets has the highest calcium content among all cereals (344 mg/100g).

Shibaior *et al.,* (2014) has determined Zn and Fe content of six finger millet genotypes to find out the differences in calcium, iron and Zinc but he could not find significance differences among the content. Singh and Raghuvanshi (2012) [17] has reported that the mineral composition of millet grains is highly variable and genetic factors and environmental conditions prevailing in growing region affect the mineral content of these food grains. Bacher *et al.* (2013) has reported significant variation among the mineral content of different accessions.

Obtained results showed wide range of variation in iron content (10.2-424.16 mg/100gm). In our analysis highest content of iron was reported from the landraces of Hattipada region of Nashik Dist. Maharashtra in red brown grains (424.16 mg/100gm) and white grains (352.78 mg/100gm), which are more than cultivar Dapoli 1(11.2 mg/100gm), Dapoli-safed (23.7 mg /100gm) and reported by Shobana *et al*., (2013) and Chandra *et al*., (2016) 3.9 %. Shashi *et al.* (2007) [22] studied micronutrient composition of 6 finger millet genotypes and found 264-365 mg/100g calcium, magnesium 66-130 mg/100g, iron 3.60-7.31 mg/ 100g, sodium 0.60-0.95 mg/100g and potassium 294-1160 mg/100g. Barbeau and Hillu (1993) [1] have reported significantly greater amount of Calcium (376 to 515 mg/100 g), and iron (3.7 to 6.8 mg/100 g) in two wild landraces than the cultivators. White grains showed good combination of calcium and iron (calcium-304.2 mg/100gm and Iron-352.7mg/100gm) over to red-brown (calcium-317 mg/100gm and Iron-59.41mg/100gm) in our studies. Both white and red-brown varieties contain higher amounts of calcium and iron, compared to other millets (FAO, 2016; Shobana *et al*., 2013; Singh & Raghuvanshi, 2012) [4, 17].

All the eight analyzed elements showed strong correlation amongst each other (Table 2). Co-relation studies showed significant co-relation among K and Mn (0.648), Zn and Mg (0.551) Ca and Mg (0.476) and Fe and Ca (0.414). Obtained results indicate co-relation of minerals with various agronomic characters (Table 3 – 9). Landraces rich in Cu content have significantly higher number of tillers (5.80) and higher content Mg and K have more number of fingers per head (18.80). The best 5 landraces rich in micronutrients viz. Iron, Zinc, Manganese exhibited more number of fingers and number of grains. Landraces containing high amount of Ca, Mg, Na and K co-related with the number of tillers, number of grains and number of fingers. (Table 3, 6) and landraces with high content of Zn have extra fingers (Table 10).

Upadhyaya *et al*. (2011) found that finger millet core collection for grain nutrients and agronomic traits revealed a substantial genetic variability for grain Fe, Zn, calcium (Ca) and protein contents. Accessions rich in Zn content have significantly higher grain yield potential than those rich in Fe and protein content. Grain nutrient-specific accessions and those contrasting for nutrient contents were identified for use in the strategic research and cultivar development in finger millet. Mineral content of the finger millet has been studied by David *et al*., (2014), Komatkar *et al*., (2014). Kempanna and Kavallappa (1968) [9] and Shashi *et al*. (2007) [22]. It was reported that the landraces which are rich mineral contents exhibited high yield contributing characters e.g. number of fingers, 1000 seed weight.

**Table 2:** Correlation coefficients of mineral elements.

| | Ca | Fe | K | Mg | Zn | Cu | Mn | Na |
|---|---|---|---|---|---|---|---|---|
| Ca | 1 | .414* | .192 | .476** | .150 | -.221 | .172 | -.135 |
| Fe | | | .194 | .272 | -.096 | -.020 | .212 | -.075 |
| K | | | | .124 | .067 | -.124 | .648** | .072 |
| Mg | | | | | .551** | .035 | .094 | -.049 |
| Zn | | | | | | .052 | -.049 | -.122 |
| Cu | | | | | | | .105 | .154 |
| Mn | | | | | | | | -.265 |
| Na | | | | | | | | 1 |

* indicates 0.05 level of significance
** indicates 0.01 level of significance

**Table 3:** Best 5 landraces for the Macro Nutrient (Calcium) along with their morphological characters

| Landraces | Ca mg/100gm | Head weight | Height | 1000 Seed weight | Tillers | Head length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Rajbari | 364.6 | 5.48 | 5.48 | 3.46 | 2.60 | 6.00 | 1.00 | 5.00 | 6.40 |
| Karanjali-3 | 346.5 | 7.54 | 7.54 | 2.28 | 0.00 | 6.92 | 1.00 | 4.80 | 7.00 |
| Jamnespada | 323.4 | 3.65 | 3.65 | 2.16 | 1.00 | 7.82 | 0.00 | 4.20 | 5.60 |
| Kavthe | 317.1 | 3.96 | 3.96 | 2.08 | 1.40 | 7.66 | 1.60 | 3.60 | 6.40 |
| Hattipada-white | 304.2 | 4.32 | 4.32 | 2.02 | 0.20 | 4.50 | 0.00 | 4.20 | 5.60 |
| C.D | 30.06 | 1.97 | 1.97 | 0.75 | 1.30 | 1.70 | 0.87 | | 0.75 |
| Range | 159.7-364.6 | | | | | | | | |

**Table 4.** Best 5 landraces for the Macro Nutrient (Potassium) along with their morphological characters

| Landraces | K mg/100gm | Head Weight | Height | 1000 Seed weight | Tillers | Head length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Aadipada | 184 | 8.08 | 70.40 | 2.96 | 1.80 | 7.66 | 0.80 | 7.40 | 6.60 |
| Kengpada | 148 | 2.08 | 63.00 | 2.42 | 1.20 | 3.58 | 0.00 | 3.20 | 3.60 |
| Hattipada-White | 147 | 10.34 | 52.60 | 1.74 | 1.20 | 5.42 | 3.60 | 4.40 | 18.80 |
| Jamnespada | 146.4 | 7.46 | 61.40 | 2.44 | 3.40 | 6.02 | 0.60 | 6.20 | 6.20 |
| Hattipada-Red | 146 | 9.01 | 75.40 | 2.46 | 1.40 | 7.46 | 0.80 | 6.60 | 7.60 |
| CD | 20.68 | 3.93 | 10.89 | 0.54 | 1.15 | 2.07 | 1.74 | | 7.35 |
| Range | 26-184 | | | | | | | | |

**Table 5:** Best 5 landraces for the Macro Nutrient (Magnessium) along with their morphological characters

| Landraces | Mg mg/100gm | Head weight | Height | 1000 Seed weight | Tillers | Head length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Kavthe | 186.5 | 5.48 | 5.48 | 3.46 | 2.60 | 6.00 | 1.00 | 5.00 | 6.40 |
| Hattipada-White | 160.9 | 3.20 | 3.20 | 2.46 | 3.60 | 7.06 | 1.00 | 4.00 | 5.80 |
| Karanjali-3 | 156.39 | 3.96 | 3.96 | 2.08 | 1.40 | 7.66 | 1.60 | 3.60 | 6.40 |
| Karanjali-5 | 145.68 | 5.22 | 5.22 | 2.76 | 2.40 | 4.78 | 1.00 | 6.00 | 5.40 |
| Jamnespada | 143.85 | 10.34 | 10.34 | 1.74 | 1.20 | 5.42 | 3.60 | 4.40 | 18.80 |
| CD | 21.29 | 3.46 | 3.46 | 0.82 | 1.21 | 1.46 | 1.40 | 1.17 | 7.14 |
| range | 96.76-186.5 | | | | | | | | |

**Table 6:** Best 5 landraces for the Macro Nutrient (Sodium) along with their morphological characters

| Landraces | Na mg/kg | Head weight | Height | 1000 Seed weight | Tillers | Head length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Chadvel-1 | 268.23 | 8.08 | 70.40 | 2.96 | 1.80 | 7.66 | 0.80 | 7.40 | 6.60 |
| Jamnespada | 268.07 | 5.27 | 72.40 | 2.08 | 1.60 | 8.46 | 0.00 | 4.80 | 6.80 |
| Karanjali-3 | 265.04 | 3.20 | 59.60 | 2.46 | 3.60 | 7.06 | 1.00 | 4.00 | 5.80 |
| Mesmad | 247.62 | 5.22 | 64.60 | 2.76 | 2.40 | 4.78 | 1.00 | 6.00 | 5.40 |
| T32 | 245.65 | 6.69 | 72.00 | 2.36 | 0.80 | 6.96 | 2.00 | 4.20 | 6.20 |
| CD | 14.06 | 2.27 | 6.90 | 0.43 | 1.30 | 1.70 | 0.89 | | 0.71 |
| Range | 107-268.23 | | | | | | | | |

**Table 7:** Best 5 landraces for the Micro Nutrient (Iron) along with their morphological characters

| Landraces | Fe mg/100gm | Head weight | Height | 1000 Seed weight | Tillers | Head length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Hattipada-Red | 424.16 | 10.04 | 72.40 | 2.48 | 0.80 | 7.92 | 1.40 | 5.20 | 9.80 |
| Hattipada-White | 352.78 | 3.92 | 58.20 | 2.08 | 0.40 | 6.94 | 0.60 | 4.20 | 5.40 |
| Vangni | 168.155 | 4.96 | 73.20 | 1.88 | 0.60 | 5.22 | 1.00 | 5.20 | 6.60 |
| Jawle | 156.232 | 9.01 | 75.40 | 2.46 | 1.40 | 7.46 | 0.80 | 6.60 | 7.60 |
| Manejdeja | 128.17 | 7.25 | 67.80 | 2.24 | 2.20 | 7.38 | 0.80 | 5.60 | 6.80 |
| CD | 127.25 | 3.23 | 8.51 | 0.32 | 0.91 | 1.30 | 0.38 | | 2.03 |
| Range | 10.2-424.16 | | | | | | | | |

**Table 8:** Best 5 landraces for the Micro Nutrient (Mangnese) along with their morphological characters

| Landraces | Mn Mg/Kg | Head weight | Height | 1000 Seed weight | Tillers | Head length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Hattipada -Red | 291.62 | 4.60 | 58.80 | 1.98 | 1.00 | 4.82 | 0.00 | 3.60 | 6.60 |
| Jale | 289.54 | 5.57 | 66.00 | 2.28 | 0.80 | 6.70 | 0.00 | 4.00 | 6.40 |
| Kolhapur | 263.45 | 3.49 | 61.40 | 2.76 | 2.40 | 7.16 | 0.00 | 4.20 | 5.40 |
| Hattipada-White | 250 | 5.68 | 68.40 | 2.28 | 1.60 | 7.26 | 0.00 | 5.20 | 6.40 |
| Rajbari | 248.7 | 4.32 | 57.40 | 2.02 | 0.20 | 4.50 | 0.00 | 4.20 | 5.60 |
| CD | 25.91 | 1.13 | 5.83 | 0.39 | 1.04 | 1.65 | - | 0.73 | 0.67 |
| Range | 24.29-291.62 | | | | | | | | |

**Table 9:** Best 5 landraces for the Micro Nutrient (Copper) along with their morphological characters

| Landraces | Cu Mg/Kg | Head weight (gm) | Height (cm) | 1000 Seed weight (gm) | Tillers | Head length (cm) | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Kuher | 37.68 | 5.48 | 71.00 | 3.46 | 2.60 | 6.00 | 1.00 | 5.00 | 6.40 |
| Jamnespada | 34.97 | 4.81 | 67.60 | 1.98 | 1.40 | 7.72 | 0.00 | 4.20 | 6.20 |
| Karanjali-6 | 23.5 | 10.33 | 50.60 | 3.02 | 3.00 | 7.48 | 0.80 | 5.80 | 9.20 |
| Karanjali-5 | 20.87 | 7.38 | 73.20 | 3.04 | 5.80 | 4.34 | 0.00 | 5.80 | 6.80 |
| Karanjali-1 | 16.54 | 4.13 | 64.80 | 2.18 | 1.60 | 5.96 | 0.80 | 3.80 | 5.40 |
| CD | 11.40 | 3.10 | 11.06 | 0.78 | 2.19 | 1.70 | 0.60 | | 1.78 |
| Range | 6.52-37.6 | | | | | | | | |

**Table 10:** Best 5 landraces for the Micro Nutrient (Zinc) along with their morphological characters

| Landraces | Zn Mg/Kg | Head weight | Height | 1000 Seed weight | Tillers | Head length | Extra fingers | Number of grains | Number of fingers |
|---|---|---|---|---|---|---|---|---|---|
| Kavthe | 44.47 | 10.34 | 52.60 | 1.74 | 1.20 | 5.42 | 3.60 | 4.40 | 18.80 |
| Chadvel-2 | 38.04 | 7.38 | 78.00 | 2.58 | 1.60 | 4.30 | 1.60 | 4.80 | 8.80 |
| Aadipada | 33.94 | 6.92 | 68.60 | 2.74 | 1.60 | 6.88 | 0.80 | 4.80 | 6.20 |
| Karanjali-4 | 33.9 | 8.01 | 79.00 | 2.52 | 2.20 | 7.28 | 0.80 | 5.80 | 7.60 |
| Hattipada-Red | 33.19 | 5.48 | 71.00 | 3.46 | 2.60 | 6.00 | 1.00 | 5.00 | 6.40 |
| CD | 5.90 | 2.21 | 13.20 | 0.76 | 0.69 | 1.48 | 1.48 | | 6.55 |
| Range | 20.38-44.47 | | | | | | | | |

## Conclusion

Finger millet is one of the natural and important source of mineral elements specifically calcium and iron. Morphological variation and variation in amount of elements could be due to differences in ecological conditions, genotype, origin and growing conditions. Conservation and multiplication of mineral rich landraces could be highly recommended to meet specific dietary requirements. Substantial variability for all the eight grain nutrient minerals observed in the finger millet landraces suggest ample scope for the selection of nutrient-rich accessions for use in the breeding programs and will be useful to find out genetic diversity among the finger millet and can be used for analysis of crop diversity and its evolution.

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