RESEARCH ARTICLE

Variability of Mineral Composition of Rice Landraces Collected from Maharashtra, India

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ABSTRACT

Micronutrient malnutrition is one of the burning issues in the rice-based diet area throughout the world. The present study aimed at evaluation of the mineral composition of 77 rice landraces collected from various agro-climatic zones of Maharashtra. The hand-mill processed rice grains were analyzed for eight (Na, Mg, K, Ca, Mn, Fe, Co, Cu, and Zn) mineral content. Among the mineral contents, the iron content ranged from 2.05 to 12.2 mg/100g, calcium content from 39.2 to 238.47 mg/100g, manganese content from 1.53 to 7.54 mg/100g, copper content from 0.54 to 3.03 mg/100g and zinc content ranged from 2.65 to 11.62 mg/100g. The other minerals, like magnesium content in studied landraces, ranged from 81.72 to 278.56 mg/100g, sodium content from 4.73 to 274.34 mg/100g, and potassium content from 148.05 to 670.74 mg/100g. Most of the studied landraces had wide range of variation, rich in minerals and could be a valuable source for bio-fortification of minerals through the breeding method.

Keywords: Landraces, Malnutrition, Mineral content, Rice.

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INTRODUCTION

Rice (Oryza sativa L.) is the most important cereal in the world, cultivated in a large area. It is a staple food for nearly half of the world’s seven billion people (IRRI, 2013). Rice is low in fat and high in starchy carbohydrates, packed full of vitamins and minerals, and provides an excellent source of vitamin E, B vitamins (thiamine, niacin) and Potassium (Renuka et al., 2016). Unfortunately, rice is lacking many essential minerals as iron, zinc and vitamin A. Thus, a rice-based diet is the primary cause of micronutrient malnutrition throughout much of the developing world. Iron, zinc, and vitamin A deficiencies are common in rice-consuming regions (http://www.goldenrice.org/Content2-How/how6_mn.php). 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 (UNSCN, 2004, Datta et al., 2006). These deficiencies result in decreased work productivity, reduced mental capacity, stunting, blindness, increased child mortality, and elevated morbidity and mortality in general (http://www.goldenrice.org/Content2-How/how6_mn.php). One of the interventions against micronutrient malnutrition is the breeding of crops through conventional or genetic engineering to accumulate micronutrients in the edible portion (Stein, 2010). Various workers pointed out that the identification of genetic resources with high levels of targeted micronutrients is a necessary step to enhance micronutrient levels through conventional plant breeding (Ortiz-Monasterio et al., 2007; Bouis, 2000). The collection and characterization and screening for desirable characters become fundamental steps towards the genetic improvement of crops. The crop landraces are being served as a valuable gene pool as they contain locally adapted alleles and represent an irreplaceable bank of highly co-adapted genotypes (Qualset et al., 1997).

However, with the introduction of an industrial production system, crop diversity is the major victim. Therefore, conservation of this valuable gene pool is need of the hour. The objective of present work was to determine the mineral content of rice landraces collected from tribal areas of Maharashtra, India, which will reveal nutritive properties of these unexplored rice landraces and their possible use in breeding programs. Additionally, this study will contribute to the enrichment of food nutrition database.

MATERIALS AND METHODS

The 77 landraces of rice have been collected from native farmers in Jawhar (Palghar), Akole (Ahmednagar), Junner (Pune), and Etapalli (Gadchiroli) blocks in Maharashtra. The field experiments were conducted during Kharif 2017 at village level in-situ conservation centers of BAIF Development Research Foundation, and seed samples were collected at crop harvest. The hand-mill processed seed samples collected from these in-situ centers were used for analysis. Grain samples were analyzed at the National Agri-Food Biotechnology Institute (NABI), Mohali, Chandigarh. Samples of 0.1 g were digested with 10 mL of ICP-MS grade nitric
acid and diluted to 50 ml with MQ water. After digestion, the solution was examined for eight elements (Na, Mg, K, Ca, Mn, Fe, Cu, and Zn) content using Agilent 7700 series Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

**RESULTS AND DISCUSSIONS**

Results of the present study on eight mineral contents in 77 rice landraces showed that many rice landraces are with a wide range of minerals; the result of the analysis is given in Annexure 1. Figure 1 shows the landraces with higher levels of Fe (5 to 12.51 mg/100g), Na (50 to 274.34 mg/100g), Mg (140 to 278 mg/100g), K (350 to 670 mg/100g), Ca (85 to 238.47 mg/100g), Mn (4 to 7.53 mg/100g), Cu (1 to 3 mg/100g) and Zn (5 to 11.62 mg/100g) among studied 77 landraces.

The calcium content in studied landraces ranged from 81.72 to 278.56 mg/100g. The landraces showed that most of the studied landraces are superior in the matter of iron content.

The copper content in studied landraces ranged from 0.54 to 3.03 mg/100g. The 45 landraces contained more than 1 mg/100 g copper. Sonphal (3.03 mg/100g), Hali kolpi (2.52 mg/100g), Raibhog (2.06 mg/100g), Kalbhat (2.05 mg/100g) and Garikolapi (1.95 mg/100g) landraces found with highest copper content. Renuka et al. (2016) reported vast variation in 39 rice varieties in respect to zinc content (25µg/g to165 µg/g). The zinc content in studied landraces ranged from 2.65 to 11.62 mg/100g. Khadkya (11.62 mg/100g), Noon (10.57 mg/100g), Sonphal 9.57 mg/100g, Kirtibhat (9.32 mg/100g) and Varangal (7.68 mg/100g) landraces found with highest zinc content. The 49 landraces contained more than 5 mg/100 g zinc. Deb et al., (2015) reported 2.4 to 44.9 mg/kg (0.24 to 4.49 mg/100g) zinc content in 130 rice landraces except for Garibsaal, which is known for its medicinal properties in gastro-intestinal ailments, contains extraordinary amount (155 mg/kg) of zinc. In the present study, also few landraces like Khadkya (11.62 mg/100g) Noon (10.57 mg/100g) and Sonphal (9.57 mg/100g) contain higher zinc. The rice landraces with overall higher mineral contents are depicted in Table 1. Tulshya and Khadkya contain an overall

![Figure 1: Number of rice landraces with high levels of minerals in grains](Image)
Variability of Mineral Composition of Rice Landraces Collected from Maharashtra, India

Table 1: Selected rice landraces with highest mineral contents in studied samples (mg/100g)

| Landraces      | Iron | Sodium | Magnesium | Potassium | Calcium | Manganese | Copper | Zinc |
|----------------|------|--------|-----------|-----------|---------|-----------|--------|------|
| Ambemohar      | 7.24 | 156.81 | 253.52    | 624.45    | 109.55  | 6.14      | 1.61   | 6.50 |
| Hali Kolamba   | 5.90 | 136.74 | 268.94    | 560.47    | 102.80  | 5.00      | 1.80   | 7.08 |
| Kiritbhut      | 5.16 | 172.10 | 198.52    | 476.46    | 138.24  | 6.65      | 1.58   | 9.32 |
| Sonphal        | 7.73 | 21.84  | 237.76    | 531.05    | 79.18   | 3.50      | 3.03   | 9.57 |
| Tulshya        | 8.08 | 144.28 | 278.56    | 670.74    | 94.88   | 7.43      | 1.79   | 7.25 |
| Khadkya        | 11.51| 274.34 | 228.51    | 517.83    | 238.47  | 5.30      | 1.87   | 11.62|
| Kalbhat        | 12.21| 125.21 | 205.80    | 524.31    | 92.94   | 5.16      | 1.70   | 5.45 |
| Varangal       | 4.20 | 170.46 | 169.30    | 311.38    | 179.92  | 3.90      | 1.72   | 7.68 |
| Malghudya      | 8.52 | 137.67 | 147.51    | 290.64    | 139.41  | 2.54      | 0.93   | 5.23 |
| Kalbhat        | 12.21| 125.21 | 205.80    | 524.31    | 92.94   | 5.16      | 1.70   | 5.45 |

higher amount of most of the minerals among the studied landraces.

Several traditional rice varieties are considered in folk medicine to have high nutritive and therapeutic value and found rich in minerals (Deb et al., 2015). The indigenous traditional knowledge indicated that collected landraces are being utilized for various purposes like diet for nursing mothers (Malghudya, Raigudya, Dhavul), fracture recovery (Mahadi), weakness recovery (Dangi-red, Kasbai) etc. However, these community claims need to be scientifically validated.

Conclusions

The present study reported a wide range of mineral accumulation, including Cu, Fe, Mn, Zn and Mg in hand-milled seeds of 77 rice landrace. This has indicated that there is a good scope to locate and promote such high mineral-rich varieties for cultivation and human consumption. The outcome of the study will also facilitate plant breeders to choose desired parents for a breeding program to articulate the nutrient-rich varieties and address the malnutrition aspect in regards to most of the cereal crops.

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## Annexure 1: Mineral contents in studied rice landrace samples (mg/100g)

| Landrace name          | Fe   | Na   | Mg    | K     | Ca    | Mn   | Cu   | Zn   |
|------------------------|------|------|-------|-------|-------|------|------|------|
| Chimansal              | 3.10 | 9.75 | 119.08| 252.42| 42.83 | 4.62 | 0.73 | 2.65 |
| Zini (midlate)         | 2.73 | 52.35| 100.31| 213.97| 76.19 | 2.26 | 0.67 | 3.10 |
| Zini early             | 3.95 | 58.35| 83.93 | 148.05| 96.70 | 1.65 | 0.76 | 3.43 |
| Ehawani                | 3.85 | 5.20 | 121.20| 334.02| 42.05 | 2.52 | 0.60 | 3.61 |
| Sapari                 | 3.54 | 6.06 | 93.11 | 359.61| 49.19 | 1.95 | 0.94 | 3.66 |
| DRK-1                  | 3.73 | 7.09 | 101.34| 296.45| 64.64 | 3.13 | 0.76 | 3.81 |
| Kasbai                 | 5.22 | 7.83 | 141.28| 329.71| 71.00 | 4.39 | 0.94 | 3.89 |
| DRK-2                  | 4.40 | 12.23| 184.97| 596.42| 61.26 | 5.58 | 0.92 | 3.89 |
| Yeremalunchi           | 3.60 | 7.53 | 110.79| 455.25| 48.41 | 3.37 | 0.71 | 4.07 |
| Katewanji              | 4.31 | 5.69 | 139.65| 446.14| 39.20 | 1.08 | 0.90 | 4.18 |
| Kasvel                 | 3.64 | 33.37| 123.22| 240.57| 75.54 | 4.43 | 0.90 | 4.18 |
| DRK-1                  | 4.40 | 12.23| 184.97| 596.42| 61.26 | 5.58 | 0.92 | 3.89 |
| Yeremalunchi           | 3.60 | 7.53 | 110.79| 455.25| 48.41 | 3.37 | 0.71 | 4.07 |
| Katewanji              | 4.31 | 5.69 | 139.65| 446.14| 39.20 | 1.08 | 0.90 | 4.18 |
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| DRK-2                  | 4.40 | 12.23| 184.97| 596.42| 61.26 | 5.58 | 0.92 | 3.89 |
| Yeremalunchi           | 3.60 | 7.53 | 110.79| 455.25| 48.41 | 3.37 | 0.71 | 4.07 |

Contd....
| Landrace          | Variability | Mineral Composition | Variability | Mineral Composition | Variability | Mineral Composition | Variability | Mineral Composition | Variability | Mineral Composition |
|------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|
| Jaymahadev       | 4.27        | 10.81               | 151.16      | 452.47              | 60.75       | 5.62                | 0.98        | 5.90                |
| Jirvel           | 7.90        | 135.33              | 165.38      | 434.71              | 111.50      | 2.50                | 1.69        | 5.97                |
| Sodui            | 4.15        | 15.58               | 182.79      | 411.74              | 66.07       | 4.00                | 0.96        | 6.14                |
| Kamal bhat       | 5.45        | 140.60              | 156.97      | 396.10              | 83.20       | 3.96                | 1.53        | 6.16                |
| Kamod            | 4.35        | 173.48              | 181.68      | 411.51              | 91.25       | 4.10                | 1.39        | 6.19                |
| Sadhana bhat     | 3.52        | 124.49              | 134.48      | 325.73              | 62.69       | 3.58                | 1.52        | 6.22                |
| Mahadi (midlate) | 6.00        | 44.66               | 139.44      | 262.61              | 197.05      | 4.20                | 1.27        | 6.27                |
| Dula-2           | 4.74        | 24.85               | 150.93      | 362.58              | 91.25       | 4.10                | 1.39        | 6.28                |
| Nanded-92        | 4.49        | 15.90               | 128.21      | 382.08              | 91.38       | 4.24                | 1.16        | 6.30                |
| Vijay Nanded     | 4.37        | 16.79               | 121.47      | 324.14              | 78.14       | 3.73                | 1.04        | 6.35                |
| Goti             | 7.20        | 7.34                | 212.83      | 517.56              | 69.96       | 4.97                | 1.27        | 6.42                |
| Ambemohar        | 7.24        | 156.81              | 253.52      | 624.45              | 109.55      | 6.14                | 1.61        | 6.50                |
| Gandha           | 4.57        | 7.00                | 239.12      | 564.77              | 61.78       | 5.87                | 1.36        | 6.57                |
| Dangi (red)      | 3.00        | 136.99              | 143.90      | 293.41              | 180.82      | 4.46                | 1.33        | 6.59                |
| Lalkabara        | 6.60        | 5.12                | 269.87      | 577.55              | 50.88       | 6.06                | 1.18        | 6.63                |
| Salbhat          | 8.91        | 10.03               | 185.27      | 409.15              | 54.12       | 6.57                | 1.18        | 6.76                |
| Namoku           | 6.14        | 5.99                | 210.69      | 608.12              | 71.13       | 5.43                | 1.23        | 6.78                |
| Pacheki          | 6.52        | 125.20              | 185.85      | 316.66              | 146.94      | 3.84                | 0.97        | 7.00                |
| Pitris           | 5.12        | 6.95                | 221.42      | 496.03              | 80.61       | 7.52                | 1.20        | 7.02                |
| Hali kolamba     | 5.90        | 136.74              | 268.94      | 560.47              | 102.80      | 5.00                | 1.80        | 7.08                |
| Tulshya          | 8.08        | 144.28              | 278.56      | 670.74              | 94.88       | 7.43                | 1.79        | 7.25                |
| Jayshriram       | 11.37       | 40.18               | 189.98      | 481.45              | 136.17      | 5.67                | 1.12        | 7.39                |
| Hari kolpi       | 5.26        | 117.41              | 187.46      | 385.69              | 194.98      | 2.75                | 2.25        | 7.58                |
| Varangal         | 4.20        | 170.46              | 169.30      | 311.38              | 179.92      | 3.90                | 1.72        | 7.68                |
| Kirtibhat        | 5.16        | 172.10              | 198.52      | 476.46              | 138.24      | 6.65                | 1.58        | 9.32                |
| Sonphal          | 7.73        | 21.84               | 237.76      | 531.05              | 79.18       | 3.50                | 3.03        | 9.57                |
| Noon             | 7.73        | 7.03                | 204.11      | 487.97              | 88.52       | 7.54                | 1.18        | 10.57               |
| Khadkya          | 11.51       | 274.34              | 228.51      | 517.83              | 238.47      | 5.30                | 1.87        | 11.62               |
| Range            | 2.05        | 4.73                | 81.71       | 39.19               | 1.53        | 0.53                | 2.65        |                    |
|                  | -12.21      | 274.00              | 278.00      | 148.04-670.00       | 238.47      | 7.53                | 3.03        | 11.62               |