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# Micronutrient Composition, Antinutritional Factors and Bioaccessibility of Iron in Different Finger millet *(Eleusine coracana)* Genotypes

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**Abstract :**The present investigation was carried out to study the micronutrient composition, antinutritional factors and bioaccessibility of iron in finger millet. The different genotypes of finger millet selected for this study were ML-197, ML-553, ML-31, ML-426, ML-322, and ML-365. The results were compared with two check varieties, GPU-28 and Indaf-5. In these different genotypes, calcium was found to be in the range of 264-365 mg/100g, 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, whereas bioaccessibility of iron was more in ML-426 and ML-322 (12.01 and 12.06 respectively) and also they contain less tannins and phytates (0.30% and 0.34 mg/100g respectively). An antinutritional factor like phytate content was more in ML-197 (320 mg/g) and least in ML-365 (246 mg/g). The highest tannin content was found in ML-197 (0.54%) and least was found in ML-365 (0.20%). The bioaccessibility of iron appears to be associated with the high composition of antinutrients like phytates and tannin. The bioaccessibility of iron in ML-197 is very less due to the presence of more tannins and phytates.

**Key words:** Finger millet ,genotypes, bioaccessibility, micronutrients, antinutritional factors

## Introduction

Finger millet *(Eleusina coracana)*, typically a tropical crop, belongs to the group of minor cereals. It is mainly consumed in India and Africa. It is an important cereal because of its excellent storage properties of the grains and the nutritive value, which is higher than that of rice and equal to that of wheat. It is also a good source of micronutrients like Calcium, Iron, Phosphorus, Zinc and Potassium. Due to the presence of antinutrients in grains such as tannins and phytates, these micronutrients are less bioaccessable. These antinutritional factors modify the nutritional value of the individual grains. Among millets, finger millet was reported to contain high amounts of tannins (Ramachandra *et al*., 1977), ranging from 0.04 to 3.47 per cent (catachin equivalent). Poor iron availability (represented by low ionizable iron) in brown varieties is due to their high tannin content which adversely affect the nutritional quality of the grains (Udayasekhara *et al*., 1988).

Other group of antinutritional factor is phytate or phytic acid, a naturally occurring phosphorus compound significantly influences the functional and nutritional properties of foods. It is the main phosphorus store in mature seeds. Phytic acid has a strong binding capacity, readily forming complexes with multivalent cations and proteins. Most of the metal complexes are insoluble at physiological pH. Hence, phytate binding renders several minerals biologically unavailable to animals and humans. However, these antinutrients can be removed by processing techniques, germination, fermentation, dehulling etc. Sankara Rao and Deosthale (1983) observed that malting of the grain significantly reduced the phytin phosphorus in finger millet. This reduction was accompanied by significant increase in ionizable iron and soluble zinc, indicating the improved availability of these two elements. Keeping in view of these aspects, the investigation was carried out on new Indo African finger millet genotypes with the objective to study micronutrient composition, bioaccessibility of iron and also to study the antinutritional factors present in these different genotypes.

## Material and Methods

The different genotypes of Indo African finger millet like ML-197, ML-553, ML-31, ML-426, ML-322, and ML-365 were selected to study the bioaccessibility of iron and antinutritional factors in 2005.

Seeds of each finger millet genotype were milled to get fine flour. Nutrients like Calcium, Iron and phosphorous was analysed by following the standard procedure of AOAC (1980). Magnesium was estimated by Versanate titration method and the results were expressed as a percentage of the dry weight (mg/100g fresh weight basis or mg) (Jakson, 1973). Sodium / potassium in solution were estimated using flame photometer. Sodium / potassium in solution were atomized into an oxyhydrogen or oxyacetylene flame. The flame excites atoms of sodium / potassium causing them to emit radiations at specific wavelengths. The amount of radiation emitted is measured on a spectrophotometer. Under standard conditions, it is proportional to the concentration of sodium / potassium in solution. Sodium and potassium content of the sample was estimated from a standard curve prepared with standard sodium and potassium solution (range 0-150 ppm).

$$\text{Sodium / Potassium (mg/100g)} = \frac{\text{ppm according to standard} \times \text{volume} \times \text{dilution made up if any} \times 100}{\text{Weight of the sample} \times 1000}$$

Zinc was estimated using atomic absorption spectrophotometer (model AAS-2-6100).

$$\text{Element concentration (mg/g)} = \frac{\text{AAS readings (ppm)} \times \text{volume made up} \times \text{dilution (if any)}}{\text{Weight of the sample}}$$

Bioaccessibility of iron was estimated by *in vitro* dialysability method (Rao and Prabhavathi, 1978). Tannin was estimated colorimetrically based on the measurement of blue colour formed by the reduction of phosphotungstomolybdate acid in alkali solution (AOAC, 1975). The estimation of phytic acid was based on the principle that the phytate is extracted with trichloroacetic acid and precipitated as ferric salt. The iron content calculated from this value assuming a constant 4 Fe: 6 molecular ratios in the precipitate. Phytates were estimated as phytic acid and the phytate phosphorus was obtained (AOAC, 1980). The phytate phosphorus was calculated by the following formula.

$$\text{Phytate phosphorus (mg/100g sample)} = \frac{\text{ug Iron} \times 15}{\text{Weight of sample}} \times \frac{1}{100}$$

## Results and Discussion

The results pertaining to calcium (mg/100) indicates that the maximum content was in the genotype ML-365 (365), followed by ML-197 (359), ML-553 (346) and the least was found in ML-31 (264). The composition of calcium was comparable to that of control (Gopalan *et al*., 2000). Phosphorus (mg/100g) was found to be highest in ML-31 (292), followed by ML-322 (280), ML-365 (255) and then the check GPU-28 (250). The Phosphorus content of ML-197 (248), ML-553 (240) and the least was in the check Indaf-5 (Table 1). Estimated values of iron (mg) showed that ML-553 scored the maximum of 7.31, followed by ML-365 (5.52) and then the checks GPU-28 (6.35) and Indaf-5 (4.44), followed by ML-97 (4.43), ML-426 (4.00), ML-322 (3.84) and the least in ML-31 (3.60). Iron content of both experimental genotypes and the checks were found to be significantly higher except for ML-31. Highest content of magnesium (mg/100g) was found to be in the check varieties similar to the control values of Gopalan *et al*.(2000) i.e.137. Whereas, ML-426 had 99, followed by ML-553 (96), ML-197 (90), Ml-31 (85), ML-365 (80) and the least was found in ML-322 (66), which are in lower range as compared to check and control values. Zinc (mg/100g) was high in the check variety of Indaf-5 (2.31), followed by the reported values 2.30 and then followed by other check GPU-28 (2.26). ML-553 and ML-426 had the same zinc content of 2.14 mg followed by ML-31 (1.96), ML-322 (1.87) and least in ML-197 (1.83). Highest sodium content was found in control (Gopalan *et al*., 2000) i.e. 11.0, followed by both checks GPU-28 (0.95) and Indaf-5 (0.90). ML-31 had 0.09 mg of sodium followed by ML-426 (0.85), ML-197 and ML-365 (0.70) with similar values and the least in ML-322 (0.60). Maximum potassium content (mg/100g) was found in both the check varieties GPU-28 (1160.00) and Indaf-5 (1070.00) respectively followed by the control. ML-426 scored highest among the genotypes with 360, followed by ML-553 (350), ML-365 (334), ML-197 (328) and the least in ML-322 (294). Bioaccessability of iron (mg/100g) was more in ML-322 (12.06), then the check followed by GPU-28 (12.02), then ML-31 (11.23), ML-365 (11.14) and other check Indaf-5 (10.98) and ML-553 scored 10.59, the least bioaccessability of iron was found in the genotype ML-197 (9.28) (Table 2). The highest tannin content (%) was found in ML-197 (0.54) followed by ML-31 (0.44), ML-553 (0.44) and the check Indaf-5 (0.40), followed by ML-322 (0.34) and then the other check GPU-28 (0.32), which was followed by ML-426 (0.30) and least was found in ML-365 (0.20). The maximum phytate content was found in ML-197 (320) followed by ML-31 (301.50) and then the two checks GPU-28 (275) and Indaf-5 (260) followed by ML-553 (250), ML-426 (246), ML-322 (242), ML-365 (240) had least phytate among the genotypes. Whereas the control values (Gopalan *et a*l., 2000) values were the least when compared to that of genotypes and check. Finger millet contains many micronutrients like calcium (Ca), phosphorus (P), iron (Fe), magnesium (Mg), zinc (Zn), sodium (Na) and potassium (K). Calcium in cereal and millet based diets is unavailable due to the presence of phytate and oxalic acid which bind Ca to form insoluble calcium oxalates and thus render Ca unavailable to the body. The results obtained in this study are comparable with that of Gopalan *et al*., (2000). Iron and sodium was found to be highest in the analysis made compared to the reported values. Ca and Fe content are on par with that of Barbean and Hilu (1993) values. Ca, K, Na, P, Mg and Fe content have almost similar to those of Samontray *et a*l., (1989). Finger millet is a very good source of micronutrients, which could alleviate the wide spread micronutrient malnutrition in the vulnerable segments in the developing country like India. However, the bioavailbility is crucial due to the presence of antinutritional factors. The genetic modification through breeding efforts largely did not effect the micronutrient composition of finger millet genotypes. Iron bioavailability of genotypes is found to be less than that of values reported by Reddy (1985). It may be mainly because of not subjecting these genotypes to any kind of processing. It was found that germination increased the bioavailbility of Fe in finger millet in the study reported. Results obtained for bioaccessibility of iron are higher than that of Pushpanjali and Khokhar (1996) studies on Indian vegetarian diet which consisted of mainly cereals and legumes. It was concluded that poor availability could be related to the composition of the diet and high amounts of phytates as well as fiber. Thus, the percentage bioavailbility of iron appears to be associated with the high compositional factors such as antinutritional factors present that is phytates, tannin and fiber which prevent the iron absorption to a great extent. Tannin content obtained in the study was on par with the range obtained by Ramachandra *et al*., (1977), where as tannin content

Table 1: Micronutrient composition of finger millet genotypes (mg/100g)

| Genotypes | Calcium | Phosphorus | Iron | Magnesium | Zinc | Sodium | Potassium |
|---|---|---|---|---|---|---|---|
| Indaf-5 | 293.00 | 234.00 | 4.44 | 110.00 | 2.31 | 0.90 | 1070.00 |
| GPU-28 | 298.00 | 250.00 | 6.35 | 130.00 | 2.26 | 0.95 | 1160.00 |
| ML-197 | 359.00 | 248.00 | 4.43 | 90.00 | 1.83 | 0.70 | 328.00 |
| ML-365 | 365.00 | 259.00 | 5.52 | 80.00 | 1.76 | 0.70 | 328.00 |
| ML-553 | 346.00 | 240.00 | 7.31 | 96.00 | 2.14 | 0.95 | 350.00 |
| ML-426 | 327.00 | 285.00 | 4.00 | 99.00 | 2.14 | 0.85 | 360.00 |
| ML-31 | 264.00 | 292.00 | 3.60 | 84.65 | 1.96 | 0.90 | 334.00 |
| ML-322 | 281.00 | 280.00 | 3.84 | 66.00 | 1.87 | 0.60 | 294.00 |
| F-value | 261.01 * | 62.99* | 273.61* | 59.53* | 4.37* | 1.84 NS | 265.22 |
| SEm +_ | 3.317 | 3.899 | 0.114 | 3.578 | 0.139 | 0.139 | 31.51 |
| CD at 5% | 10.817 | 12.715 | 0.372 | 11.668 | 0.453 | - | 102.76 |
| Control** | 344 | 283 | 3.9 | 137 | 2.3 | 11.0 | 408 |

* Significant at 5% ** Gopalan *et al*. 2000 NS – Non significant

Table 2: Bioaccessibility of iron of finger millet genotypes (mg/100g)

| Genotypes | Bioaccessibility |
|---|---|
| Indaf-5 | 10.98 |
| GPU-28 | 12.02 |
| ML-197 | 9.92 |
| ML-365 | 11.14 |
| ML-553 | 10.59 |
| ML-426 | 12.01 |
| ML-31 | 11.23 |
| ML-322 | 12.06 |
| F-value | 87.28* |
| SEm +_ | 0.118 |
| CD at 5% | 0.385 |

Significant at 5%

Table 3: Antinutritional composition of finger millet genotypes

| Genotypes | Tannins (%) | Phytates (mg/100g) |
|---|---|---|
| Indaf-5 | 0.40 | 260.00 |
| GPU-28 | 0.32 | 275.00 |
| ML-197 | 0.54 | 320.00 |
| ML-365 | 0.20 | 240.00 |
| ML-553 | 0.44 | 250.00 |
| ML-426 | 0.30 | 246.00 |
| ML-31 | 0.44 | 301.50 |
| ML-322 | 0.34 | 242.00 |
| F-value | 59.22 | 171.66 |
| SEm +_ | 1.375 | 3.209 |
| CD at 5% | 4.484 | 10.465 |
| Control** | - | 209.00 |

* Significant at 5% ** Gopalan *et al.*, 2000

varied from 0.03-3.42%. The results of Rao (1994) showed that germination decreased the tannin and phytin content. Thus, as discussed earlier, the higher percent of tannins and phytates in the finger millet genotypes are a cause for concern in the utilization of proteins, calcium, iron and zinc. However, application of processing techniques would bring down their interference.

**References**


ANONYMOUS, 1975, *Official methods of Analysis,* 11th edition. Association of official agricultural chemists, Washington, D.C., 2004.

ANONYMOUS, 1980, Official methods of Analysis, 13th edition. Association of official agricultural chemists, Washington, D.C. 2004.

ANONYMOUS (AAS-2-6100), 1997, *Analysis of Polarized Zeeman Atomic Absorption Spectrophotometry Hitachi,* Ltd., pp.122-131.

BARBEAU, W.E., and HILU, K.W., 1993, Protein, calcium, iron and amino acid content of selected wild and domesticated cultivar of finger millet. *Plant Foods Human Nutrition,* **43**: 97-104.

GOPALAN,C., RAMA SASTRI, B.V. AND BALASUBRA MANIAN, S.C., 2000**,** Nutritive value of Indian Foods. National Institute of Nutrition*,* ICMR, Hyderabad.

JACKSON, M.L., 1973, Soil Chemical Analysis, Pretice Hall, New Delhi, pp.1-485.

PUSHPANJALI AND KHOKHAR, S., 1996, Invitro availability of iron and zinc from some Indian vegetarian diets: Correlations with dietary fibre and phytate**.** *Food Chemistry,* **56**: 111-114.

RAMACHANDRA, G., VIRUPAKSHA, T.K. AND SHADAKSHA RASWAMY, M., 1977, Relationship between tannin levels and in vitro proteindigestability in finger millet (*Eleusina coracana* Gaertn). *Journal of Agriculture Food Chemistry,* **25**: 1101-1104

RAO, N. AND PRABHAVATHI, T., 1978. An in vitro method for predicting the bioavailability of iron from foods. *American Journal Clinical Nutrition***, 31** : 169-175.

RAO, P.U., 1994, EVALUATION of protein quality of brown and white ragi (*Eleusina coracana*) before and after malting. *Food Chemistry***, 51**: 433-436

SAMANTRAY, G.T., MISRA, P.K. AND PATNAIK,K.K., 1989, Mineral composition of ragi. *Indian Journal of Nutrition* and *Dietetics*, **26** : 113-116

SANKARA RAO, D.S. & DEOSTHALE, Y.G. 1983. Mineral composition, ionizable iron and soluble zinc in malted grains of pearl millet and ragi. *Food Chemistry,* **11**: 217-223.

UDAYASEKHARA RAO, P. & DEOSTHALE, Y.G., 1988, In vitro availability of iron and zinc in white and coloured ragi (*Eleusine coracana*): role of tannin and phytate. *Plant Foods Human Nutrition*, **38**: 35-41.