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Comparative study of different millets with special reference to mineral elements

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Abstract: The aim of the present work is comparative study of different millets with special reference to mineral elements. In present study different millets like ragi, proso, rajgira, foxtail, kodo, and little millet were collected and analyzed with Atomic Absorption Spectrometer and Flame Photometer. *Eleusine coracana* showed highest concentration of iron (22.09mg/kg) and manganese (3.24 mg/kg). Highest concentration of copper was observed for *P. miliaceum* (0.122mg/kg), and lowest was observed for *P. sumatreance* (0.042mg/kg). It was observed that the highest concentration of zinc (0.91 mg/kg) and sodium (14.4mg/kg) was recorded for *P. miliaceum* and lowest sodium was found in *P. scrobiculatum* (10.2mg/kg). Highest concentration of potassium (41.84mg/kg) was observed for *A. cruentus* and lowest concentration of K was observed for *P. scrobiculatum* (00.78mg/kg). The highest amount of sodium, magnesium, copper and zinc was recorded for *Panicum miliaceum. Amaranthus cruentus* showed highest concentration of potassium. Chances of getting heart attack are very much minimized by proper intake of Potassium. *Panicum miliaceum* represents highest concentration of magnesium, is an important element which helps to control and maintain the insulin level in blood, and it is a supplementary element to the calcium. This indicates *E. coracana and P.miliaceum* are the best millets enriched in essential nutrients with highest concentration of selected mineral elements.

Index Terms **- Millets, nutrients, mineral elements, sodium, potassium**

I. INTRODUCTION

Millets are generic term used for small sized annual grasses family (Poaceae) from heterogeneous group that are cultivated as grain crops in hard environmental conditions (Singh and Raghuvanshi, 2012) and are referred as 'coarse cereals'. Millets are ranked sixth in agricultural production in the world having characteristics of drought-resistance, short growing seasons, resistant to pests and diseases (Devi, et al., 2014). They have easy storability under ordinary conditions and hence they are called as 'famine reserves' and due to their nutritional contribution they are referred as nutria-cereals/nutria-millets or nutricereals (Chhavi and Sarita, 2012). Millets are very good source of micronutrients such as calcium, iron, phosphorous, zinc and potassium, which can alleviate malnutrition in the developing countries. Millets are a good source of magnesium which reduces the severity of asthma, frequency of migraines, lowers high blood pressure and reduces the risk of heart attacks. These nutrients play important roles in human nutrition (Kumar et al, 2018).

The aim of this study is to introduce selected millets (Ragi, Proso, Rajgira, Foxtail, Kodo, and Little Millets) after evaluating their mineral elements as an alternative to cereals to alleviate the problem of malnutrition.

II. RESEARCH METHODOLOGY

All the standard solutions were prepared from analytical grade compounds of Merck Company. All the glassware used was of Borosil. Prior to all chemical analyses the reagent bottles, beakers and volumetric flasks were cleaned by soaking overnight in 2N hydrochloric acid, rinsed with water and oven dried at 60^{o}C. Nitric acid (65%Merck) and de-ionized water were used for sample preparation.Flame Photometer (MODEL1382) and Atomic Absorption Spectrometer (AA240-Varian) was used for analysis.

Sample collection and preparation: Millet samples (Ragi, Proso, Rajgira, Foxtail, Kodo and Little Millets) were collected from local grocery store at Raipur city and stored in the labeled polythene sampling pouches. They were brought to Central Laboratory Facility, CCOST, Raipur. All the samples were washed under tap water to remove any kind of deposition like soil or any other foreign particles. All the seeds of millets were then oven-dried and grounded into powdered form and then digested using wet digestion method.

Sample Analysis: After digestion samples were diluted up to 100 ml which was then filtered with whatman filter paper and ready for analysis. Sodium and potassium were analyzed using Flame Photometer. While iron, manganese, copper, zinc and magnesium were analyzed using Atomic Absorption Spectrophotometer.

III. RESULTS AND DISCUSSION

The results indicated that the samples had a variable concentration of mineral elements in selected millet samples. Table 1 represents concentration of selected elements in the analyzed samples of millets.

Table 1: Concentration (mg/kg) of various mineral elements in selected millet samples

S.N.	Common name of samples	Botanical Name of Samples	Mineral Elements (mg/l)						
			Iron	Manganese	Copper	Zinc	Magnesium	Sodium	Potassium
1.	Ragi	*Eleusine coracana*	22.02	3.24	0.074	0.52	11.52	11.6	30.40
2.	Chena	*Panicum miliaceum*	0.39	0.15	0.122	0.91	11.56	14.4	19.82
3.	Rajgira	*Amaranthus cruentus*	1.02	0.28	0.062	0.56	07.32	10.4	41.84
4.	Kangni	*Setaria italic*	0.17	0.14	0.066	0.55	08.48	11.6	18.61
5.	Kodo	*Paspalum scrobiculatum*	0.17	0.01	0.076	0.33	06.86	10.2	00.78
6.	Kutki	*Panicum sumatreance*	0.11	0.08	0.042	0.43	08.60	10.4	12.86

Magnesium (Mg) concentration ranges from 11.56 to 6.86mg/kg, it is an important element which helps to control and maintain the insulin level in blood. The other important element Potassium (K) concentration was the highest of all the analyzed metals in all samples. Its mean concentration ranges from 2.3260 to 5.6510 mg/L, the chances of getting heart attack are very much minimized. Similarly, the elements such as iron, copper, manganese and zinc was observed in low concentration and are the supplementary elements which help the formation of hemoglobin content in blood.

The trend of the analyzed metal concentration determined in all millet samples was almost K > Na > Mg >Fe>Zn>Mn> Cu. The probable reasons for the variation of these metal concentrations in all three types of millet samples may be due to their genetic potential to absorb and accumulate these elements from the soil, the availability of the minerals in the soil that exist in usable forms, the use of different types of fertilizers, pesticides, herbicides and other chemicals, etc. (Chandravanshi and Feleke, 2015; Yohannes and Chandravanshi, 2015).

Iron status: The *Eleusine coracana* showed highest concentration (22.09mg/kg) and *Panicum sumatreance* showed lowest concentration (0.11mg/kg) of iron. The result (22.09 to 0.11mg/kg) of Fe in this study was not agreed with the value (156±18 mg/L to 775.3±42 mg/L) reported by Birhanu et al (2015) and Hemamalini et al (2020). According to the permissible limit adopted by FAO (2010), almost all of the millet samples were below the safe limit (3.6 to 6.4 mg/L) except *E. coracana*. The finding of this study is in contrast to recommend the value of FAO (2010). Therefore, According to the present study and Vijayakumari (2003) *E. coracana*/ finger millet are the richest source of iron. Iron deficiency leads to anemia, which can be overcome by introducing finger millet and other food items that can be rich in iron to our daily diet.Fe is considered as the second most abundant metal and as such anessential element necessary for the synthesis of blood pigments and other essential cell processes (Reilly, 2002).

Manganese status: Highest concentration of manganese was observed for *E.coracana*/finger millet (3.24mg/kg) while lowest (0.01mg/kg) was recorded for *P. scrobiculatum* /Kodo millet. The result was not agreed with the value (52±3mg/L to75.3± 0.3 mg/L) reported by Desta and Bhagwan(2014) but in accordance to the findings of Fetene et al (2023). According to the safe limit adopted by FAO (2010), almost all of the millet samples were below the safe limit (2 mg/L) with the exception of *E. coracana* (3.24mg/kg). The daily intake amount of these metals differs from person to person based on the developmental levels, sex and the standards of the different countries they set. Therefore, According to U.S.A. standards, the R.D.I. of Mn is (2.3 mg/day) for matured adults and (2.6 mg/day) for lactating females, respectively. Because of the mean concentration of Mn in this study as compared to the FAO standard, all the millet samples are safe for consumption.

Copper status: Highest concentration of copper was observed for *P. miliaceum* (0.122mg/kg) and lowest was observed for *P. sumatreance* (0.042mg/kg). The result is not agreed with the safe limit value of (30 mg/L) reported by FAO (2010) but very similar to the findings of Fetene et al (2023). According to U.S.A. standards, R.D.I. of Cu is (0.9 mg/day) for matured adults and (1.3 mg/day) for lactating females respectively. Copper is an essential micronutrient which functions as a biocatalyst, required for body pigmentation in addition to iron, maintain a healthy central nervous system, prevents anemia and inter-related with the function of zinc and iron in the body (Kalagbor and Diri, 2004).

Zinc status: The highest concentration of Zn was recorded for *P. miliaceum* (0.91 mg/kg) and lowest zinc was reported for *P. scrobiculatum* (0.33mg/kg). The result was not agreed with the value (15±3 to 24±3 mg/L) reported by Birhanu et al (2015) and Hemamalini et al (2020).The present values of Zn are slightly below finding of Fetene et al (2023) i.e. 0.336 to 0.561 mg/L. The permissible limit of Zn is 27.4 mg/L and the average daily intake of zinc is 7-16.3 mg per day, the recommended dietary allowance is 15 mg per day for men and 12 mg per day for women, almost all millet samples were found to be below the safe limit. As it falls below the safety limit, selected millets which contains Zn can be consumed in addition to other types of food which include Zn to obtain all of the following importance of Zn. which is essential in wound healing, nervous system, reproductive and immune systems, metabolic function, malaria treatment and as well as the treatment of diabetes Mellitus's (Djama et al., 2011).

Magnesium status: The present result of Mg (7.32 to 11.56mg/kg) is slightly higher than the report (2.53 to 6.38mg/100gm) of Sanusi et al. (2019) and Prasanna et al., (2015) for finger millet with the range of 0.28 to 0.31 percent.Magnesium content of finger millet germplasm reported by Hiremath et al (2018) ranged from143.24-192.94 mg/100 g with little variation and by Bachar et al., (2013) where the range reported to be 84.71 to 567.45 mg/100gare not consistent with the present report.

Sodium status: Highest concentration of sodium was found in *P.*miliaceum (14.4mg/kg) and lowest was found in *P. scrobiculatum* (10.2mg/kg). These values are slightly lower than the values (3.70 to 5.10mg/100gm) observed by Sanusi et al (2019). The study by Bachar et al (2013) revealed that sodium content varied from 13.73 to 42.47 mg/100g which is slightly higher in comparison to the present result. The concentration of sodium by Birhanu et al (2015) was found in the range 2.73±0.06 ppm to 10.73 ±0.16 ppm at trace level that is slightly lower than the present result.

Biologically, sodium is important for maintaining acid-base equilibrium in human body and also acts as electrolyte in transmitting nerve impulse and in relaxing muscles of human body (Lokhande and Olaiyea 2010). The excess or deficiency of Na intake in human body could be subjected to water retention, high blood pressure, stomach ulcer and cancer, confusion, weakness, seizures, coma and even death.

Potassium status: Highest concentration of K (41.84mg/kg) was observed for *A. cruentus* and lowest concentration of K was observed for *P. scrobiculatum* (00.78mg/kg). The present values are very close to the result (24.13 to 35.19mg/100gm) reported by Sanusi et al (2019). The study by Bachar et al (2013) revealed that potassium content varied from 11.24 to 284.7 mg/100g and this is very high in comparison to the present result. Hassan et al (2020) studied that K was the amplest mineral found in the millet grains ranging from 3864.6 to 4899.3 mg/kg. This is not consistent with the present values of K. The concentration of K by Birhanu et al (2015) was found 592 to 2407 ppm in finger millet. That is very high in comparison to the present values.

IV. CONCLUSION

The results obtained from this work showed that the selected millet varieties are all good sources of essential nutrients which could make substantial contribution to the intakes of some minerals. Highest concentration of iron and manganese was observed in *Eleusine coracana* and second highest amount of sodium, potassium and magnesium was also found in *E.coracana.* The highest amount of sodium, magnesium, copper and zinc was recorded for *Panicum miliaceum. Amaranthus cruentus* showed highest concentration of potassium. Chances of getting heart attack are very much minimized by proper intake of Potassium. *Panicum miliaceum* represents highest concentration of magnesium, is an important element which helps to control and maintain the insulin level in blood, and it is a supplementary element to the calcium. This indicates *E. coracana and P.miliaceum* are the best millets enriched in essential nutrients with highest concentration of selected mineral elements.

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