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Millets Biofortification: A Sustainable Solution for Mitigating Malnutrition

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Abstract:

In world there are billions of people facing micronutrient deficiencies problem which is the main reason for malnutrition and severe health related problems in humans. These all happen due to poor quality of the diets or poor intake of vitamins and minerals especially affecting the women and preschool children of developing nations. So, to improve the quality of life many considerable global development efforts are underway to improve the health of poor people by breeding staple food crops enriched with essential micronutrient, so called bio fortification. We all know that now a days nutritional insecurity is a major threat to the world's population that is highly dependent on cereals-based diet, deficient in micronutrients. Millets are next to cereals, which act as primary sources of energy in the drought-prone regions and semi-arid tropics of Asia and Africa. They are nutritionally superior as their grains contain high amount of proteins, minerals, essential amino acids and vitamins. So, bio fortification of staple crops is proved to be an economically feasible approach to combat not only problem of malnutrition but also enhance the value of the food crops to provide micronutrient rich foods at low cost, sustainable and long term means of delivering the nutrients rich food to poor people in country. Harvest Plus program of CGIAR initiated the research on bio fortification of food crops and developed high iron pearl millet crop in India to tackle iron deficiency problem. In Proso millet, foxtail millet and barnyard millet the molecular basis of waxy starch has been identified to facilitate their use in infant foods. Millets have close genetic relatedness to cereals; comparative genomics has helped in deciphering genes and quantitative trait loci linked mainly to protein quality in finger millet. Recently, zinc transporters transgenic expression resulted in the development of high grain

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zinc and transcriptomics lead to discovery of calcium sensor genes leading calcium accumulation in finger millet. Biofortification in millets is still limited by the presence of antinutrients like phytic acid, polyphenols, and tannins.RNA interference and genome editing tools [zinc finger nucleases (ZFNs), transcription activator-like effect or nucleases (TALENs), and clustered regularly interspaced short palindromic repeats (CRISPR)] needs to be employed to reduce these antinutrients.

Introduction:

Millets are the important food crops in the developing countries. They give good productivity even in high temperature and less water conditions. So, there is a need to address not only bio fortification of major cereals but also nutrient rich millets. In India after green revolution large areas were replaced by wheat, paddy and commercial crops which lead to decrease in the cultivation of millets. Presently after realising the nutrient richness of millets again people started consuming, it now as at least one meal for a day. Realising this changes in food intake bio fortification of food crops has to be done to reduce micronutrient deficiencies among people. As millets are easy to grow in comparison to others, we need to focus mostly on bio fortification of millets.

Millets in India:

All types of millets major and minor millets are consumed in India. They represent a group of cereals. They are divided into major millets and minor millets. Major millets include sorghum and bajra and minor millets include Proso millet, foxtail millet, kodo millet, finger millet, little millet and barnyard millet.

Nutrients in millets:

Millets are the store house of the nutrients. They are many times nutritionally superior to the widely promoted wheat and rice in terms of minerals, proteins and vitamins. The foxtail millet and barnyard millet have highest mineral nutrient concentration even among millets. The finger millet is the richest source of calcium, magnesium, potassium and sodium. They are good source of antioxidants also. Chandrasekara and Shahidi (2010) have reported total flavonoid and phenol content of major millets for soluble and bound phenolic fractions. It is168 mg/100 g in pearl millet, 411–610 mg/ 100 g in finger millet and 140 mg/100 g in proso millet. The nutritive traits in millets have great variability, and it can be exploited for future nutrient thrust in people (Girish et al. 2014)

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Table 1 : Average nutrient composition of various millets (g/100 g)

Crop	Carbohydrates	Protein	Fiber	Fat	Minerals
Sorghum	72.6	11.3	5.4	1.9	1.6
Bajra	69.4	11.6	1.3	4.8	2.4
Finger millet	71.8	7.4	3.8	1.3	2.7
Foxtail millet	60.7	12.3	8.1	4.3	3.4
Proso millet	70.9	12.5	7.2	3.1	1.8
Kodo millet	65.5	8.2	9.2	1.5	2.6
Little millet	67.4	7.8	7.6	4.6	1.5
Barnyard millet	65.7	6.2	9.9	2.1	4.3

Table 2: Mineral composition of millets (mg/100 g of edible portion)

Crop	Phosphorus	Potassium	Calcium	Magnesium	Sulphur	Iron	Sodium
Sorghum	5.6	130	27	138	55	1.6	7.2
Bajra	14.1	32	38	122	149	4.8	10.4
Finger millet	17.2	406	346	405	155	2.6	12.0
Foxtail millet	12.9	246	32	124	168	2.8	4.8
Proso millet	11.3	111	14	74	151	1.5	0.8
Kodo millet	30.8	141	29	110	133	0.5	4.8
Little millet	10.2	126	18	61	124	2.3	7.9
Barnyard millet	2.9	-	18	-	-	6.7	-

Different bio fortified millet crops:

Pearl millet is the first cheapest energy source among the millets and is well adapted to low moisture and poor fertile soils. In addition, its grains are rich in protein especially

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gluten-free and micronutrient concentration. The ICTP8203 Fe-10-2 is the first high-iron-containing pearl millet variety was evolved through conventional breeding using variation of iron concentration by the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) as part of the Harvest Plus program. Another pearl millet variety, Dhanshakti, was also developed in the course of bio fortification by the ICRISAT in association with Harvest Plus. The high-quality pearl millet hybrids developed recently in India are PKV-Raj, CO- 9, HHB 226, PAC 909,KBH 108, GHB 905, Nandi-72, MPMH 17, HHB 234, Kaveri, Bio 70, Bio 448, Pratap, RHB 173, RHB 177, GHB 732, GHB 719,HHB 223, RHB 154,PB 180and RHB 121.

Sorghum is the second cheapest energy source crop after bajra. In post rainy sorghum agronomic biofortification (increasing the grain Fe and Zn status through application of Fe and Zn containing fertilizers) is one of the low-cost options to reduce the problem of hidden hunger in predominantly sorghum-eating populations of semiarid tropics. Phule and Maulee sorghum cultivars can be used for producing iron and zinc rich post rainy sorghum with soil application of $ZnSO_4$+ $FeSO_4$ each at 50 kg/ha followed by foliar application (0.50 % + 1.0 %) at 45 DAS along with recommended dose of NPK is used for producing iron and zincrich post-rainy sorghum varieties.

The minor millets have been the last priority crops as far as their encouragement and development are concerned. Finger millet among the minor millets is given more attention when compared to other millets than the rest. Finger millet is given importance after pearl millet and sorghum. Its grains are the richest source of calcium, potassium, sodium and magnesium. The important varieties of finger millet which are recently developed are VL 324, PR 202, Divya, Indaf 7, KMR 301, VL 149, Godavari, Indaf 9,GPU 45, GPU 48, VR 708, Marua2, RAU-8,HR 374, CO-14, CO-13,Phule nachani,GPU 67, GPU 66, GPU 28, Birasa, and Hima.

The foxtail varieties most commonly grown in India are Srilakshmi, SiA 3085 and PS 4. The improved varieties of barnyard millet which are most extensively cultivated are CO 2,VL 207 and RAU 11for barnyard millet; The varieties of kodo millet are JK 13, JK 48, JK 98,CO 3 and JK 439;The varieties of little millet are CO 4, JK 8, GV 2, and Sukshema; and the varieties of prosomillet are TNAU 151, TNAU 164, and TNAU 202.In addition to nutrition richness, minor millets offer another advantage of suitability to grow as rainfed with

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multicropping system along with legumes and oilseeds (Pradhan *et al.* 2010).Under rainfed conditions the grain yield of little millet was significantly increased by 30–40 % under rainfed conditions with nutrient fertilization (Shashidhar *et al.* 1998; Yargattikar *et al*. 2004)

Conclusion:

Micronutrient deficiency is the major problem faced by many developing countries. We all know that millets are the good source of proteins, vitamins, minerals. Only antinutritional factors has to be reduced in it or novel promoters should be used. Millets are more nutrient rich than cereals and can tolerate harsh climatic conditions, low cost of cultivation are the major reasons why millets are most preferable for combating the micronutrient deficiencies in the people across the world. Food fortification is costly and can't be met by poor people,so bio fortification of already nutrient rich food crops offers all macro and micronutrients necessary for body in single diet which affords less cost and can prevent malnutrition problem among poor people. Omics information on millets should be advanced as cereals to enhance their nutrition in the fight against micronutrient malnutrition. By using all breeding technologies and biotechnology bio fortified crops can be developed in millets then solving this malnutrition problem will become miracle in agriculture.