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# MINERAL DIETARY STATUS OF SOME EXISTING DOMESTIC WHEAT GENOTYPES

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Mineral elements like Cu, Fe and Zn are very crucial for human health and play a key role in various biochemical processes. The daily dietary requirement of a young adult ranges from 10-60 mg for Fe, 2-3 mg for Cu and 15 mg per day for Zn. Intake less than these values can slower physiological processes. The information on the reserves of these elements in staple foods like wheat is scarce. The present study was undertaken to collect such information for wheat and 78 genotypes were analyzed for these nutrients. The results revealed that Zn concentration in seed ranged between 30.4 to 55.5 µg $g^{-1}$ in 31 genotypes, from 21.08 to 29.8 in 37 genotype and from 12.72 to 19.08 in 10 genotypes. Of the different genotypes, 38 were recorded as poor in Zn and ranged from 0.41 to 1.06 µg Zn/seed. Rests of the genotypes were either medium or rich in Zn. Considerable variations in Fe and Cu concentrations were also observed in seed of different genotypes. Iron concentration ranged from 13.03 to 52.43 µg $g^{-1}$ while Cu concentration averaged between 2.66 and 6.10 µg $g^{-1}$.

**Keywords:** Dietary, Micronutrients, Wheat, Genotypes, Zinc, Mineral.

## 1. Introduction

Mineral elements like Cu, Fe and Zn are as essential for human health as of organic compounds such as carbohydrates, fats, proteins and vitamins. An element is considered to be essential if it is always present in the body with a particular organ, tissue, cell or enzyme and forms a rational basis of action [1]. Although these elements are minute part of whole diet, but play a key role in various biochemical processes [2-3]. Daily intake of Fe, Cu, Zn for a young adult ranges from 10-60 mg, 2-3 mg and 15 mg per day respectively [4]. Intake less than these values can slower physiological processes and body becomes vulnerable to different diseases due to deficiency of these elements.

Mineral nutrient reserves in seed must also be adequate to sustain plant growth until root system takes over the nutrient supply function. During early establishment phase, the mineral nutrients are partly supplied by the soil. Therefore, information on mineral nutrient reserves in seed should be perfect from agricultural point of view as well. It could provide an insight into these genotypes, which are high mineral element accumulators, and can best be utilized for human consumption as well as agricultural production. In the absence of systematic data it would be very difficult to determine the adequacy of our diet with respect to minerals. Keeping in view their importance in human diet, the seeds of 78 wheat genotypes were analysed for Fe, Cu, and Zn so that information on mineral reserves in seed of domestic genotypes can be generated.

## 2. Materials and Methods

### *2.1 Collection of seeds*

The seeds of 78 wheat genotypes were collected from different research organizations with specific reference to NIA Tando Jam, NIFA Peshawar, NARC Islamabad, ARI Tando Jam and CCRI Pirsabak (Table-1). The seed was cleaned from any of unwanted foreign materials like stone, dust and wheat straw and stored at 4 °C in refrigerator before further processing. Prior to chemical analysis, the seed of each genotype was dried in forced draft oven at 80 $^{0}$C and then ground in IKA FM-10 grinding mill to pass through 0.5 mesh sieve.

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Table 1. Concentration of mineral nutrients in seed of different wheat genotypes.

| Genotypes | Zn | Fe | Cu | Genotypes | Zn | Fe | Cu |
|---|---|---|---|---|---|---|---|
| | μg $g^{-1}$ | | | | μg $g^{-1}$ | | |
| SD-4 | 18.13 | 17.63 | 3.63 | Indus-66 | 21.70 | 39.89 | 3.30 |
| M-172 | 17.09 | 31.30 | 3.32 | CM-24/87 | 24.40 | 26.23 | 3.27 |
| Uqab | 14.13 | 19.47 | 2.66 | Anmole | 42.87 | 30.03 | 3.27 |
| WL-711 | 17.22 | 15.40 | 3.13 | Pavan | 31.87 | 23.50 | 2.90 |
| 7- 03 | 17.40 | 20.27 | 3.93 | RWM-9313 | 24.03 | 17.67 | 3.20 |
| Zardana | 19.01 | 18.63 | 3.38 | M-233 | 24.70 | 27.03 | 3.40 |
| Sonalika | 28.21 | 16.00 | 2.95 | A-4 | 24.37 | 39.93 | 4.17 |
| Maxipak | 12.72 | 17.57 | 3.77 | A-7 | 32.53 | 27.83 | 3.23 |
| Juhar –78 | 27.27 | 18.50 | 3.30 | V-7001 | 22.80 | 52.43 | 3.37 |
| SI- 99-257 | 21.08 | 16.27 | 3.79 | V-7002 | 43.93 | 33.93 | 4.07 |
| SI-99-77 | 22.66 | 18.40 | 3.91 | V-7003 | 34.40 | 32.57 | 4.33 |
| Soghat –90 | 18.22 | 14.03 | 3.44 | V-7004 | 32.60 | 30.50 | 3.43 |
| SI-97-71 | 31.37 | 18.17 | 3.83 | V-7005 | 35.50 | 29.60 | 4.27 |
| SI-99-261 | 42.23 | 29.23 | 3.40 | V-7010 | 27.80 | 23.13 | 4.30 |
| SI-97-151 | 40.90 | 31.03 | 3.60 | V-7012 | 32.10 | 24.90 | 3.67 |
| SI-99-76 | 43.13 | 32.30 | 3.45 | V-7014 | 41.07 | 18.20 | 4.43 |
| Abadgar | 27.30 | 13.03 | 5.80 | V-7015 | 32.30 | 23.07 | 3.13 |
| Sindh-81 | 30.40 | 18.70 | 3.20 | V-8001 | 36.07 | 24.53 | 3.17 |
| SI-99-15 | 46.70 | 38.27 | 3.63 | V-8003 | 32.97 | 19.92 | 3.37 |
| ESW-9525 | 26.87 | 14.93 | 3.20 | V-8004 | 35.13 | 22.10 | 3.10 |
| Inqulab-91 | 25.37 | 14.23 | 4.00 | V-8006 | 35.93 | 23.47 | 3.10 |
| ESW-9639 | 25.67 | 25.43 | 4.30 | IBW-96079 | 29.37 | 21.07 | 3.27 |
| T.J-83 | 41.33 | 17.50 | 3.87 | IBW-97170 | 22.47 | 17.37 | 3.00 |
| 15-10 | 41.73 | 37.50 | 2.93 | CT-99186 | 31.83 | 25.37 | 3.23 |
| Bakhtawar | 33.20 | 18.27 | 4.20 | CT-00054 | 28.33 | 21.03 | 3.37 |
| SI-99-85 | 24.50 | 13.03 | 5.20 | CT-97177 | 27.87 | 40.87 | 3.23 |
| SI-99-50 | 26.50 | 15.60 | 4.17 | IDA-97107 | 25.33 | 19.27 | 3.37 |
| SI-99-239 | 45.30 | 20.47 | 3.40 | Fakhr-e- Sarhad | 28.53 | 26.20 | 3.63 |
| SI-99-65 | 55.50 | 28.23 | 6.10 | CT-0067 | 30.97 | 30.93 | 3.80 |
| Iqbal | 38.50 | 24.93 | 4.47 | WS10 | 31.13 | 27.77 | 3.83 |
| Kiran-95 | 28.07 | 23.10 | 4.67 | IDA-97082 | 15.50 | 15.50 | 3.53 |
| Khirman | 26.07 | 21.80 | 4.07 | IBW99110 | 24.97 | 25.67 | 3.47 |
| SD-1200/1 | 28.45 | 16.60 | 4.07 | IBW97249 | 25.67 | 21.74 | 3.90 |
| ZA-77 | 31.93 | 32.67 | 3.07 | CT-00231 | 23.73 | 30.50 | 3.57 |
| Mangla | 34.33 | 17.27 | 4.13 | CT-00108 | 27.80 | 34.93 | 4.10 |
| Sarsabz | 29.07 | 15.33 | 3.13 | IBW-97057 | 14.20 | 23.93 | 3.70 |
| SI-99-50 | 28.47 | 13.47 | 5.10 | IBW-96390 | 26.70 | 34.33 | 4.23 |
| Yecora | 24.57 | 13.27 | 4.27 | IBW-96405 | 25.47 | 15.17 | 4.27 |
| ESW-9650 | 29.33 | 24.33 | 3.33 | CT-00019 | 29.80 | 38.93 | 3.90 |
| CV (%) | 11.37 | 11.25 | 10.92 | | | | |
| LSD | 5.33 | 4.36 | 0.654 | | | | |

Table 2. Mineral nutrients contents in grains of wheat genotypes.

| Genotypes | Zn | Fe | Cu | Genotypes | Zn | Fe | Cu |
|---|---|---|---|---|---|---|---|
| | μg $g^{-1}$ $seed^{-1}$ | | | | μg $g^{-1}$ $Seed^{-1}$ | | |
| SD-4 | 0.83 | 0.80 | 0.17 | Indus-66 | 0.75 | 1.37 | 0.11 |
| M-172 | 0.77 | 1.40 | 0.15 | CM-24/87 | 1.07 | 1.15 | 0.14 |
| Uqab | 0.41 | 0.56 | 0.08 | Anmole | 1.92 | 1.35 | 0.15 |
| WL-711 | 0.84 | 0.75 | 0.15 | Pavan | 1.03 | 0.76 | 0.09 |
| 7- 03 | 0.70 | 0.82 | 0.16 | RWM-9313 | 0.85 | 0.62 | 0.11 |
| Zardana | 0.79 | 0.78 | 0.14 | M-233 | 1.32 | 1.45 | 0.18 |
| Sonalika | 1.56 | 0.88 | 0.16 | A-4 | 1.03 | 1.69 | 0.18 |
| Maxipak | 0.49 | 0.68 | 0.15 | A-7 | 0.91 | 0.78 | 0.09 |
| Juhar -78 | 0.96 | 0.65 | 0.12 | V-7001 | 0.94 | 2.16 | 0.14 |
| SI- 99-257 | 0.78 | 0.60 | 0.14 | V-7002 | 1.93 | 1.49 | 0.18 |
| SI-99-77 | 0.88 | 0.71 | 0.15 | V-7003 | 1.27 | 1.20 | 0.16 |
| Soghat -90 | 0.63 | 0.48 | 0.12 | V-7004 | 1.28 | 1.20 | 0.13 |
| SI-97-71 | 1.13 | 0.65 | 0.14 | V-7005 | 1.26 | 1.05 | 0.15 |
| SI-99-261 | 1.25 | 0.87 | 0.10 | V-7010 | 1.07 | 0.89 | 0.17 |
| SI-97-151 | 1.55 | 1.18 | 0.14 | V-7012 | 1.23 | 0.96 | 0.14 |
| SI-99-76 | 1.52 | 1.14 | 0.12 | V-7014 | 1.63 | 0.72 | 0.18 |
| Abadgar | 1.19 | 0.57 | 0.25 | V-7015 | 1.33 | 0.95 | 0.13 |
| Sindh-81 | 1.24 | 0.76 | 0.13 | V-8001 | 1.31 | 0.89 | 0.12 |
| SI-99-15 | 1.76 | 1.44 | 0.14 | V-8003 | 1.15 | 0.69 | 0.12 |
| ESW-9525 | 0.95 | 0.53 | 0.11 | V-8004 | 1.04 | 0.65 | 0.09 |
| Inqulab-91 | 1.39 | 0.78 | 0.22 | V-8006 | 1.28 | 0.84 | 0.11 |
| ESW-9639 | 1.07 | 1.06 | 0.18 | IBW-96079 | 1.01 | 0.72 | 0.11 |
| T.J-83 | 1.42 | 0.60 | 0.13 | IBW-97170 | 0.83 | 0.64 | 0.11 |
| 15-10 | 1.45 | 1.31 | 0.10 | CT-99186 | 1.11 | 0.88 | 0.11 |
| Bakhtawar | 0.94 | 0.52 | 0.12 | CT-00054 | 1.07 | 0.79 | 0.13 |
| SI-99-85 | 0.75 | 0.40 | 0.16 | CT-97177 | 0.98 | 1.44 | 0.11 |
| SI-99-50 | 1.05 | 0.62 | 0.17 | IDA-97107 | 0.87 | 0.66 | 0.12 |
| SI-99-239 | 1.67 | 0.75 | 0.13 | Fakhr-e- Sarhad | 0.89 | 0.82 | 0.11 |
| SI-99-65 | 2.09 | 1.06 | 0.23 | CT-0067 | 0.98 | 0.98 | 0.12 |
| Iqbal | 1.28 | 0.83 | 0.15 | WS10 | 1.22 | 1.09 | 0.15 |
| Kiran-95 | 1.19 | 0.98 | 0.20 | IDA-97082 | 0.46 | 0.46 | 0.10 |
| Khirman | 1.27 | 1.06 | 0.20 | IBW99110 | 1.11 | 1.14 | 0.15 |
| SD-1200/1 | 1.24 | 0.72 | 0.18 | IBW97249 | 0.82 | 0.70 | 0.12 |
| ZA-77 | 1.24 | 1.27 | 0.12 | CT-00231 | 0.99 | 1.27 | 0.15 |
| Mangla | 1.32 | 0.66 | 0.16 | CT-00108 | 1.06 | 1.33 | 0.16 |
| Sarsabz | 1.34 | 0.71 | 0.14 | IBW-97057 | 0.74 | 0.83 | 0.13 |
| SI-99-50 | 1.24 | 0.59 | 0.22 | IBW-96390 | 0.94 | 1.21 | 0.15 |
| Yecora | 0.98 | 0.53 | 0.17 | IBW-96405 | 0.85 | 0.50 | 0.14 |
| ESW-9650 | 1.48 | 1.23 | 0.17 | CT-00019 | 1.07 | 1.40 | 0.14 |
| CV (%) | 11.51 | 11.389 | 10.59 | | | | |
| LSD | 0.21 | 0.169 | 0.024 | | | | |

*2.2. Seed analysis*

Samples of ground material (0.500 ± 0.01 g) were weighed and transferred into an acid washed 100 ml Kjeldahl digestion tube. 10 ml of concentrated AnalaR nitric acid (69 %) was added to each tube and thoroughly mixed. The petri dish was placed on each tube and the samples were left overnight in the fume hood. On the next day, the tubes were placed in digestion block and heated continuously for 1 hour at 60 $^0$C. The temperature was gradually increased and digested for further 6 hours at 110 $^0$C. The tubes were removed from the block, allowed to cool and then filtered in acid washed 100 ml volumetric flasks through a filter paper (Whatman 40). Successive rinsing of tubes was done with deionised water and thus the volume of the flask was made upto mark. The concentrations of Fe, Cu and Zn were determined by Atomic Absorption spectrophotometer (AAS) following the method of single acid digestion as described by Westerman (1990) (19). Co-efficient of variation (cv) and Least Significant Difference (lsd) were computed from difference in mean (x) using MStatc programme.

## 3. Results

*3.1. Zinc concentrations*

Zinc concentration in the seeds of different wheat genotypes ranged from 12.7 to 55.50 µg g$^{-1}$, when determined on oven dry weight basis (Table-1). The genotype SI-99-65 showed the highest accumulation of Zn (55.50 µg g$^{-1}$) whereas the lowest Zn concentration was recorded in Maxi Pak (12.70 µg g$^{-1}$). It was further observed that out of 78 genotypes under investigation, the Zn concentration ranged between 30.4 to 55.5 µg g$^{-1}$ in 31 genotype, from 21.08 to 29.8 in 37 genotype and from 12.72 to 19.08 in 10 genotypes. Likely variations in different wheat genotypes for Zn accumulations have been reported by Qureshi *et al. (*1990), Imtiaz *et al.* (2003) [2, 7].

*3.2. Zinc contents*

Zinc contents (on single seed basis) have been presented in Table 2. The data revealed that genotypes exhibited significant variations in Zn contents of their seed and ranged from 0.41 to 2.09 µg/seed. The maximum Zn content of 2.09 µg/seed was recorded in genotype SS-99-65 and the lowest (0.41 µg/seed) in Uqab. The genotype, V-7002, Anmol and SI-99-15 were also found Zn rich genotypes as their Zn contents were found to be, 1.93, 1.92 and 1.76 µg/seed (Table 2). Of the different genotypes, 38 were recorded as poor in Zn and ranged from 0.41 to 1.06 µg Zn/seed. These results are in accordance with those of Imtiaz (1999) [7].

*3.3 Iron concentrations*

Similar to Zn concentration, Fe concentration, within the seed of different genotypes varied considerably. Maximum Fe concentration of 52.43 µg g$^{-1}$ was observed in genotype V-7001 where as minimum concentration (13.03 µg g$^{-1}$) was recorded in SI-99-85 (Table-1) these results are similar to those of Graham Welch, (1997) [8].

*3.4 Iron contents*

The results revealed that average Fe contents (2.16 µg g$^{-1}$) of genotype V-7001 were significantly higher as compared with the contents of other genotypes (Table 2). The lowest Fe contents of 0.40 µg/seed were recorded in genotype SI-99-85. These results are in agreement with those of Imtiaz et al; (2005). [7].

*3.5 Copper concentration*

The concentrations of Cu also varied significantly from variety to variety. Compared to Fe and Zn, the concentration of Cu was quite low and ranged from 2.66 to 6.10 µg g$^{-1}$ (Table-1) The wheat genotype SI-99-65 had the higher Cu concentration (6.10 µg g$^{-1}$), which were significantly different from rest of the genotypes. The cultivar Uqab was found to be the poorest in Cu with a concentration of 2.66 µg g$^{-1}$only. These results are similar to those of Graham and Welch, (1997) [8].

*3.6 Copper contents*

The results revealed that Cu contents in all the genotypes under study ranged from 0.08 to 0.25 µg/seed. Genotype Abadgar accumulated the highest contents of Cu (0.25 µg/seed) where as the Cu reserves of the Uqab were only 0.08 µg/seed. Imtiaz *et al.*, (2003) [7] also reported the similar findings while studying the wheat genotypes for micronutrient status.

## 4. Discussion

Seed size and seed quality are important determinant of dietary nutrition seedling vigor and growth of cereals [9]. Large seeds produce improved crop stand, which outyield the crop derived from small seeds and gather bigger reserves of food [10]. The seed quality expressed as higher seed content results in better human nutrition [11] vegetative growth and grain yield [12].

The present study showed a large variation in acquisition of these mineral elements, which substantiate the earlier findings of those reported by Imtiaz et al., (2003); Ahmed et al., (1998); Takkar and Walker, (1993) [7,13,14]. Variation in acquisition of these elements by different genotypes can be attributed to genetic makeup [8], agro-climatic conditions in which cereals are grown and the fertility of the soil, which is more important [15]. In general the heavier seeds of genotypes have higher mineral contents (Fe, Cu, Zn), however, dilution in concentration was noticed in certain genotypes [4].

Balanced human nutrition consists of a proper diet in terms of carbohydrate, lipids and proteins. Apart from these organic nutrients, ample amounts of inorganic nutrients must also be part of human diet. The deficiencies of these inorganic nutrients (Fe, Zn and Cu) can affect brain and immune functions [16-17]. Globally, about two billion people in more than hundred countries are victims of multiple micronutrient deficiencies [18-19]. More than 90% of pregnant women and pre-school children in developing countries show signs of Fe deficiency, anemia and other related orders. Iron, Zn and Ca are also required at maximum level during adolescent stage. Element malnutrition in much of the human population has been dealt by fortifying the cereals with a plant and animal product, which increases the cost of production of these commodities. Due to wide availability of staples, their share in malnourished food is always higher. In present study concentration was focused on large number of wheat genotypes to disseminate information about their elemental nutrition. The researchers involved in biofortification of wheat can have prebasic status of Fe, Zn and Cu in existing domestic genotypes. The wheat genotypes like Anmol, V-7002, SI-99-15 and V-7001, which have higher concentration of these mineral elements, can be included in breeding programme to enhance the amount of these elements for human consumption and overcome the problem of deficiencies of these elements in human and soil.


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