

## Quantitative Estimation of Eight Essential Nutrients of Five Different Maize Hybrids and its Soil

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**Summary:** Various maize samples were collected from Maize and Millet Research Institute Yusaf wala, District Sahiwal, Punjab in Pakistan. The maize samples were analysed for eight essential elements (Na, K, Ca, Mg, Fe, Zn, Mn and Cu) by flame atomic absorption spectrophotometer. In general, the results showed that the variation in elemental uptake was observed in maize hybrids although they grow in the same agricultural plot. This may be due to its genetic characteristics. However, analysis of essential elements shows high level of Na in EV-5089, K, Mg and Mn in Gohar, Ca and Fe in EVS-10, Zn in hybrid 202 and Cu in Gohar hybrid.

### Introduction

Maize is one of the important food and is utilized in more diversified ways than any other. The chief use is as a food for live stock, about one-half the crop being used for this purpose. The grain is very nutritious, with a high percentage of easily digested carbohydrates, fats, proteins and very few deleterious substances. The pork industry in the United States is dependent almost entirely on maize and uses about 40% of the total amount raised. Cattle, horses and other domestic animals are also fed on maize.

Although there are many types of maize and their morphology and anatomy vary [1]. Reviews of the growth, structure, composition and utilization of each of the major grains can found in the monograph series published by the American Association of Cereal Chemists (AACC) [2]. Several parameters were compared between inbred of maize for the utilization of nutrient elements [3]. The effect of the cadmium on the yield and elemental content of Ca, Mn, Fe, Zn, Be, Pb, K and Cu etc. of maize was observed [4]. Element contents from the maize of Trabzon (Turkey) were determined [5]. Micro-nutrients i.e. Zn, Cu and Mn play an important role in plant growth, so that it is necessary that the availability of these should be determined in soil. Various workers tested and devised many methods under variable conditions for the determination of available content of any single micro-nutrient element [6]. Soil status and its micronutrient response became very much essential to know [7]. Since along

the macronutrients up take by plants, simultaneous removal of micronutrients from soil is effect, the soils thus gradually become deficient in micro-nutrient [8]. Intensive and specialized cropping systems are also conducive to micro nutrient deficiency in soil [9]. Transport of Zn and Mn to developing grains occurs via different pathways. Zinc was progressively transferred from the xylem to the phloem in the peduncle and rachis during transport to the grain, while Mn was not transferred into the phloem but remained in the metabolism and growth of plant [10]. Effect of the nutrients on the growth and yield of the maize [11-15] have already been reported in literature.

The purpose of this study is to examine the uptake of metal ions from the soil to seed and prepared a comparative data of metal content between collected/representative samples and a reference/certified samples.

### Results and Discussion

Table 1 gives the concentration of eight essential major and minor elements in five hybrids/cultivars of the maize; collected from MMRI Yusafwala, district Sahiwal (Punjab), Pakistan and analysed by atomic absorption spectrophotometric technique. t-test was conducted for collected and certified sample at 99.5% confidence limit for triplicate measurements in each case.

Table 1. Determination the concentration of essential elements present in five hybrids of the maize and their soil (mg/kg)

Elements	Name of varieties and their metallic concentrations including concentration of the soil					
	EVS-10	EV-5089	Hybrid 202	Gohar	OPV	Soil
Na	269.64±27.0	277.55±27.0	261.73±19.9	218.24±20.4	257.78±22.4	3968±456.1
K	2862.4±265	2816±207.3	2880±151.3	3288.4±235	2763.3±73.8	13427±413
Ca	3.54±0.17	3.25±0.55	2.34±0.63	2.25±0.14	1.78±0.35	3505±383.5
Mg	572.47±35.4	593.98±22	552.75±24.6	612±16.4	543.78±23.5	36295±2640
Fe	8.45±0.92	4.5±0.52	5.54±0.40	6.27±0.86	4.4±0.59	4414±517.3
Zn	25.44±1.41	25.44±2.24	34.22±3.71	26.63±1.33	18.12±1.59	66.3±7.22
Mn	6.2±0.98	6.16±0.67	4.60±0.28	17.08±1.61	4.45±1.31	522.1±47.2
Cu	1.5±0.15	1.55±0.31	1.05±0.23	1.95±0.23	0.6±0.15	16.18±2.05

Sodium, potassium, calcium and magnesium are macronutrient elements. The statistically data shows that the distribution of the essential nutrient elements was not uniform in all varieties of maize. The maximum concentration of sodium was found ( $277.55 \pm 27.01$  and  $269.64 \pm 27.01$  mg/kg) in EV-5089 and EVS-10 respectively and the minimum concentration ( $261.73 \pm 19.9$ ,  $218.24 \pm 20.42$  and  $257.78 \pm 22.37$  mg/kg) was recorded in hybrids 202, Gohar and OPV cultivars respectively. Soil concentration of the sodium was estimated  $3968 \pm 456.1$  mg/kg. The higher concentration of the potassium was found ( $3288.4 \pm 235.32$ ) in Gohar and lower concentration ( $2763.3 \pm 73.80$  mg/kg) was observed in OPV hybrid as compared to rest of the hybrids, whereas its soil possess  $13426.7 \pm 412.7$  mg/kg of the potassium. Maximum concentration of calcium was found ( $3.54 \pm 0.17$ ) in EVS-10 and minimum ( $1.78 \pm 0.35$ ) in OPV hybrids. Rest of the three hybrids lying between both of these ranges and its soil accumulate  $3504.5 \pm 383.5$  mg/kg of the calcium. The level of calcium was very low, and the maize alone not provide the essential nutrient calcium, which is necessary for the normal physiology of humans as well as animals. The high content of magnesium ( $611.91 \pm 16.40$  mg/kg) present in the Gohar cultivar, whereas the low content of the magnesium ( $543.78 \pm 23.49$  mg/kg) was found in OPV hybrid. The soil of this specific plot occupy  $36295.4 \pm 2639.5$  mg/kg of the magnesium.

Iron, zinc, manganese and copper are essential microelements present in maize varieties at different concentrations. Average high value of the iron ( $8.45 \pm 0.92$  mg/kg) was found in EVS-10 hybrid and low value ( $4.50 \pm 0.52$  and  $4.40 \pm 0.59$  mg/kg) were observed in EV-5089 and OPV cultivar respectively, whereas the concentration of iron was found  $4413.5 \pm 517.3$  mg/kg in the soil of MMRI Yusafwala. The highest concentration of zinc ( $34.22 \pm 3.71$  mg/kg) was found in Hybrids 202 and the lowest concentra-

tion was found ( $18.12 \pm 1.59$  mg/kg) in OPV, Zinc accumulation was detected  $66.30 \pm 7.22$  mg/kg in its soil.

The data indicated in (Table 1) shows that manganese concentration was higher in Gohar than the others maize hybrids and the lower concentration of the manganese ( $4.60 \pm 0.28$  and  $4.45 \pm 1.31$  mg/kg) was shown in Hybrid 202 and OPV which are very closed to each other. The soil of this specific plot contain  $522.1 \pm 47.21$  mg/kg. Copper is one of the essential elements in trace quantity, which is present in a trace level as compared to all other mentioned elements. Maximum uptake of copper ( $1.95 \pm 0.23$  mg/kg) was detected in Gohar and its minimum uptake was found ( $0.60 \pm 0.15$  mg/kg) in OPV cultivar, whereas the level of copper  $16.18 \pm 2.05$  mg/kg was estimated in its soil where these hybrids were grown.

## Experimental

### Sampling and Sample Preparations

Five samples of maize were randomly collected from Maize and Millets Research Institute Yusafwala, District Sahiwal, Punjab, Pakistan. As well as the reference samples were obtained from the office of Federal Seed Certification and Registration Department Sahiwal.

Maize varieties i.e. EVS-10, EV-5089, Hybrid 202, Gohar and OPV were collected at the time of harvesting during the month of September 2000. Same varieties of the same location were obtained from FSC & RD Sahiwal. Samples of maize were washed with distill/deionized water and were oven dried at  $105^{\circ}\text{C}$  to constant weight [16].

### Soil Samples

Composite soil samples (0-15 cm depth) were collected randomly from agricultural plot where these

**Table 2. Instrumental conditions for the FAAS measurement of Na, K, Ca, Mg, Fe, Zn, Mn and Cu.**

Elements	Wave length (nm)	Slit width (nm)	Lamp current (mA)	Fuel flow (acetylene) (l/min)	Flow rate (Air) (l/min)	Burner Height (mm)	Oxidant (Air) kg/cm <sup>2</sup>	Fuel (Acetylene) kg/cm <sup>2</sup>	Signal out put
Na	590	0.4	9.5	2.21	9.4	7.5	1.60	0.25	100%
K	766.8	2.6	9.5	2.3	9.4	7.5	1.60	0.3	
Ca	422.2	2.6	7.3	2.6	9.4	12.5	1.60	0.4	100%
Mg	285.5	2.6	7.0	2.0	9.4	7.5	1.60	0.2	100%
Fe	248.3	0.2	9.5	2.30	9.4	7.5	1.60	0.3	100%
Zn	214.0	1.3	9.5	2.0	9.4	7.5	1.60	0.2	100%
Mn	279.8	0.4	9.5	2.0	9.4	7.5	1.60	0.2	100%
Cu	325.0	1.3	9.5	2.0	9.4	7.5	1.60	0.2	100%

maize hybrids were grown, to evaluate the level of macro and micronutrients in agricultural soil and monitor the variation in uptake of different elements in different varieties of maize. 1.0 kg of the soils from each site was taken in the plastic bags. The samples were air dried, ground with a wooden pestle in a mortar to a fine powder and stored for various analyses.

#### Procedure

Five replicate 2g samples of each variety in whole grains and 1g of the soil were weighed into 100ml conical flasks and treated with 5ml of nitric acid. The flasks were covered with watch glasses, and their contents were heated to reflux gently on an electric hot plate. After refluxing for one hour the contents of flasks were treated with 5ml of nitric acid, 2ml of 35% hydrogen peroxide, and the heating at gentle reflux was continued for another hour. The watch glasses were removed from the flasks, and the heating was continued until the volumes of their contents were reduced to 2-3 ml. The contents of flask were cooled, diluted with high purity water, and filtered through Whatman # 42 papers into 25ml volumetric flasks. A duplicate blank was prepared similarly under identical condition [17].

The contents of the flasks were brought to volume with high purity water and analysed by flame atomic absorption spectrometry for their sodium, potassium, calcium, magnesium, iron, zinc, manganese and copper contents. The results of these measurements are presented in Table-1.

#### Instrumentation

The FAAS analyses were performed with an atomic absorption spectrophotometer of Hitachi; Japan, Model 180-50 and equipped with a graphite furnace, a microprocessor and built in printer. Hollow cathode lamps (made by Meltorika Com-

pany) of sodium, potassium, calcium, magnesium, iron, zinc, manganese and copper was used as radiation source. Air-acetylene flame was used during atomization step of Na, K, Ca, Mg, Fe, Zn, Mn and Cu as oxidant. The instrumental conditions used for the determination of essential elements are given in Table 2. Sample injection was done automatically using an auto sampler. Signal evaluation was based exclusively on integrated absorbance value.

#### Reagents and Calibration

Standard solutions 1000 mg/litre multi element solution (ICP Multi element standard iv, Merck, Darmstadt.) of Na, K, Ca, Mg, Fe, Zn, Mn and Cu were prepared by diluting with appropriate amounts of deionized water. Calibration was obtained with external standards. Stock and standard solutions were made in 0.02 N HNO<sub>3</sub>. Distilled deionized water was used throughout this work. Glassware was cleaned by overnight soaking in nitric acid (1+1) followed by multiple rinses with distilled and double distilled water. Analytical reagent grade hydrogen peroxide (35%w/v) and distilled nitric acid (65% w/v, specific gravity 1.41kg) were used for digestion of the samples.

The statistical data for standards are given in table 3.

**Table 3. Statistical data for standards of elements**

Elements	Concentration range ppm (x)	Absorbance	Statistical calculation $y = mx + c$		
			m	c	r <sup>2</sup>
Na	0 - 1	0 - 0.395	0.3952	-0.0013	0.9990
K	0 - 1	0 - 2680	0.2678	0.0016	0.9997
Ca	0 - 1	0 - 0.1850	0.1852	0.0001	0.9998
Mg	0 - 0.2	0 - 0.352	1.743	0.0036	0.9993
Fe	0 - 1	0 - 0.300	0.3011	0.0004	0.9997
Zn	0 - 1	0 - 0.235	0.2349	0.0027	0.9989
Mn	0 - 1	0 - 0.1350	0.1328	0.0021	0.9983
Cu	0 - 0.5	0 - 0.035	0.0691	0.0030	0.9994

### Conclusions

It was observed that out of five hybrids of the maize, only one hybrid i.e. EV-5089 retained maximum concentration of sodium, where as minimum uptake of the sodium was detected in Gohar. Higher level of potassium, magnesium, manganese and copper was found in Gohar hybrid. The uptake of calcium in all hybrids was low, so the any variety of maize not provide this essential element as recommended by WHO. Maximum absorption of iron and zinc was detected in EVS-10 and hybrid 202 respectively

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