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Comparison of Nutrients Uptake in Different Varieties of Rice in Pakistan

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Abstract: The objective of this research was to determine the uptake of different elements (K, Mg, Ca, Na, Fe, Co, Mn, Pb, Cu, Zn and Ni) which are used as nutrients by the rice crop. Different types of rice seeds KSK-282, KSK-134, BAS-515, IR6, BAS-2000, KSK-133 and super-BAS were collected from National Agricultural Research Centre (NARC) Islamabad Pakistan and grown in different plastic pots containing soil under the same condition. Ten days old immature plants of different varieties of rice were dried and their roots were separated from the whole plants. The dried roots were ground into fine powder followed by acid digestion (HNO_3, H_2SO_4 and $HClO_4$) solution in a ratio of (5:1:0.1) individually. After digestion the solutions were filtered and the filtrates were diluted by adding distilled water. The diluted solutions of all the above mentioned varieties of rice were analyzed by Atomic Absorption Spectrophotometer (AAS) for nutrients (K, Mg, Ca, Na, Fe, Co, Mn, Pb, Cu, Zn and Ni) concentration. The different values obtained from AAS had shown that some rice varieties had taken up nutrients (elements) in large amount (e.g., KSK-134 had taken up maximum Fe while KSK-133 had taken up minimum) as compared to other varieties. Similarly, several verities absorbed comparatively minimum concentration of elements. The results obtained in this research work clearly indicated that the absorption of these elements from the soil was dependent on the rice variety (e.g., BAS-2000 absorbed maximum Mg while minimum Super-BAS). Interestingly most of the rice vaities had absorbed the beneficial elements in large quantity as compared to other toxic elements.

Key words: Rice varities, nutrients uptake, essential elements, minimum, comparatively, spectrophotometer

INTRODUCTION

Rice (*Oryza sativa*) is the main source of carbohydrate as well as the source of staple nourishment of the 50% of the total world population (Ohtsubo *et al.*, 2005). Just like oats, barley and wheat, rice yields grains for nourishment and belongs to grass family Gramineae (Halliwell, 1997). In addition to small quantity of other micronutrients, rice also gives nutritionally important quantity of zinc, riboflavin, niacin and thiamin (Brown, 2007). According to Brown (2007) and Kennedy *et al.* (2002), rice has approximately 40 thousand verities all over the world. Minor amount of lipids are present in white rice prevailed by lengthy chain double or triple bond containing fats for example, linolenic and linoleic acids chain. In correlation, rice flour is rich in these double or triple bond containing fats and represent approximately 15/100 on dry weight basis (Wilson *et al.*, 2000). These unsaturated fatty acids could be degraded when store for extended period, lead in deterioration of flavor, loss of taste and also affect the quality of eating (Zhou *et al.*, 2003). In non-glutinous brown rice, lipid substances and unsaturated fats synthesis are influenced by day to day mean temperature at the time of ripening process (Taira and Maeshige, 1979).

Rice is most significant crop and is the main source of nourishment for half of the world (Zhu and Wu, 2008). More than 80% population in Asia alone use rice as their staple food. Similarly in Asia more than 90% of the world's rice is produced and consumed (Khush, 2005).

Rice in Pakistan both fragrant and nun-fragrant is cultivated on 2.62 mill ha (100 km^2) approximately which covers 12% of the total area under cultivation (Hussain *et al.*, 2011). Total 6.5 million tons of rice was

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Table 1: Methodology flow chart for the first phase of experiments

Samples collection and seeds preparation	Sprouting of seeds	Soil preparation and sowing of seeds
Seeds were collected from National Agricultural Research Centre (NARC)	The selected and disinfected twelve to fifteen seeds of seven varieties of rice were soaked with H_2O	Seven different plastic pots of size 15 inches cubic volume were taken and were labeled
↓ Seeds were sterilized	↓ In seven labeled different sterile disposable Petri plates (20×100 mm) of 25-30 mL callus induction medium	↓ The soils used for sowing of these were collected from same place Barakaho Islamabad Pakistan
↓ 71% ethanol for 65 sec	↓ The labeled seven different cultures were kept in a room temperature at 30±1°C for four days until sprouting was appeared	↓ The soil was dried crushed and passed through 2 mm sieveto remove the stones
Immersion in 52% (v/v) commercial bleach (5.20% $NaClO_4$)		↓ The sand was mixed to this soft soil in 1:3 ratios
↓ On a magnetic stirrer, nonstop stirring for 30-40 sec		↓ The sand was mixed in order to show good growth by the rice plants
↓ After sterilization, the seeds were washed 3-4 times withdistilled water		↓ The seven different sprouted rice seeds were sown at rate of 30/pot in seven special seedling raising labeled plastic pots
		↓ Tube well water was given until all the soil in pot was completely soaked
		↓ The next water was given after every 2 days
		↓ The sown seeds were kept at room temperature for 2 days

produced in the years 2005-2006 with the increase of 2.12 tons/ha. To meet every day metabolic requirements, individuals need twenty three element components that micro and macro nutrients are included and are obtained from foods dietary. Being the staple nourishment for more than a large portion of the world population, rice meets 20% of protein and 27% of caloric supply in developed countries (Tollens, 2007). In Asia, where 95% of the world's rice yield is used, 40-80% of the caloric ingestion originates from rice and its items. Even though the grains of rice are deficient in essential nutritional substances, 50% of these elements are found in the bran (i.e., seed coat, nucellus, seed coat, aleurone layer and pericarp) and 10% in the embryo and process of milling gives us 28%t of the grain in polished rice by removing the bran and embryo. The large use of rice grain is in the form of milled (white) rice. The process of polishing (milling) removes both embryo and bran of rice. The milling process leaves only 28% of elements in the white rice (Hunt *et al*., 2002). Internationally the malnutrition of the micronutrients produces learning disabilities in children, raises the rate of mortality and morbidity and diminishes the work efficiencies which decline the nation economic development (Welch and Graham, 2004). Almost 66% of the children death is mainly linked with deficiencies of these micronutrients (Caballero, 2003).

Mineral components most regularly deficient in human body eating regimens are Zn and Fe, at the same time, different components for example Selenium (Se), Iodine (I), Copper (Cu), Magnesium (Mg) and Calcium (Ca) can be not enough in the diet of a few populations (Welch and Graham, 2004). Around three billion individuals of the world suffered from the effects of micronutrient insufficiencies, especially of Fe and Zn and the said proportion is as yet rising (Caballero, 2003; Mason and Garcia, 1993; Nestel *et al*., 2006; Welch *et al*., 1997). Billions of individuals are at danger of Zinc in-sufficiency and it is positioned as the 5th driving danger variable for diseases for example, loose motions and pneumonia in youngsters Virk. These insufficiencies are produced by continual eating habitual of the same diet (over-reliance on a single staple sustenance), circumstances of nourishment inadequacy where populaces don't have enough to eat, low eating of main sources of elements such as fruits, vegetables and products of fish and animals (FAO, 2001). The majority of those harrowed with micronutrient malnourishment are subject to staple products like rice. The approaches on food to accomplish the requirement of micronutrients to human beings have worldwide strong support (Halliwell, 1997; FAO/WHO, 1996) (Table 1).

MATERIALS AND METHODS

The seven verities of rice seeds which were collected are KSK-282, KSK-134, BAS-515, IR6, BAS-2000, KSK-133 and super-BAS. The chemicals that were used are Tap H_2O, 71% Ethanol, Nitric acid (HNO_3), Sulfuric acid (H_2SO_4) and Perchloric acid ($HClO_4$). All the chemicals were of Merck Company. The equipment's that were used are sieve (2 mm), Incubator (Shemadso), Petri plats (20×100 mm), flasks (50 and 80 mL), hot plate, filter

Table 2: Methodology flow chart for the second phase of experiments

Green house	Drying	Elemental analysis
Plastic pots were shifted to green house and were kept under in plastic sheets ↓	The grown plants the roots of plants were washed by tube well H_2O and were kept on new labeled and cleaned study sheets ↓	100 ppm of stock solution of the K, Mg, Ca, Na, Fe, Co, Mn, Cu, Zn, Pb and Ni were prepared by dissolving required amount of salts in distilled water ↓
Plastic pots were kept for 60 days at ↓	The roots of plants were washed by tube well H_2O and were kept on new labeled and cleaned paper sheets ↓	HNO_3, H_2SO_4 and $HClO_4$ were taken in three room temperature sterilized different 50 mL flasks ↓
After the completion of growth duration the plastic sheet was removed ↓	The roots were washed 3-4 time through sterilized distilled water ↓	Were mixed in ratio of 5:1:0.1, respectively ↓
The roots were washed 3-4 time through plants for 8 days at room temperature sterilized distilled water	Plants were kept for 8 days at room temperature ↓	From the mixed acids solution 6.5 mL solutions were kept were taken in sterilized seven different 50 mL flasks ↓
	The roots were separated (i.e., Removed) from plants and were kept in different sterile disposable Petri plates (20×100 mm) containing 25-30 mL callus induction medium ↓	Flasks were labeled as KSK-282, KSK-134, BAS-515, IR6, BAS-2000, KSK-133 and Super-BAS ↓
	Petri plates were shifted to incubator for further drying ↓	The powder form roots rice were poured in the respective labeled flasks ↓
	The roots were incubated for 3 days at 37°C ↓	Flask was kept on hot plateand boiled ↓
	The separated dried roots of each variety of rice were weighed 0.5g by analytical balance separately ↓	During boiling process colored fumes were emerged from flask ↓
	The labeled dried roots were milled into powder with electrical grinder ↓	Sample was boiled for 50 min and colorless fumes were emerged from flask this indicates that digestion is completed ↓
	Stored in airtight bottles before analysis ↓	
	Determination of mentioned macro and micro nutrients were done by Perchloric-acid digestion procedure	Few drops of distilled H_2O were added and were allowed to cool at room temperature ↓
		Make up the volume up to 50 mL by adding distilled H_2O in every flask ↓
		The solution of digested roots, three acids solution and distilled H_2O were filtered through whatmann filter paper No. 42 and was collected in plastic bottles ↓
		The concentration of macro and micro nutrients (K, Mg, Ca, Na, Fe, Co, Mn, Cu, Cr, Pb, Zn and Ni) weredetermined by atomic absorption Spectrophotometer

paper (Whatmann No. 42), funnel and Atomic Absorption Spectrophotometer (Shimadzu aa-6300) (Table 2).

Erythematic formula: The AAS values were converted by using the following equation:

$$OD \div W \times \text{Dilution factor}$$

Where:

OD = Optical density (that is given by AAS)
W = Weight of dry plant
Dilution factor = 50 mL
W = The 0.5 g (weight of dried root of each rice type was 0.5 g)

RESULTS AND DISCUSSION

Grain, vegetables and fruits provide high amount of minerals, vitamins and other natural nutrients. These substances function as antioxidant (Allen, 1974). Researchers have studied that people who eat lots of fruits and veggies have lower rates of cancer and heart disease (Miller, 2016).

After the analysis of roots of grown different varieties of immature rice by atomic absorption spectrophotometer, following different nutrients in different concentration were founded such as under (Table 3 and 4).

Rice is mostly consumed as staple food source from different soils with different composition. Investigation of heavy metals and trace elements in the rice is important

Table 3: Comparisons of Mg, Ca, Na, K, Cr and Ni Quantity up take by different varieties of immature rice plant roots

Rice varieties	Mg contents (mg/kg)	Ca contents (mg/kg)	Na contents (mg/kg)	K contents (mg/kg)	Cr contents (mg/kg)	Ni contents (mg/kg)
KSK-282	2700.20	2097.52	1326.10	457.624	1.712	7.44
KSK-134	3444.36	2179.20	1593.74	702.840	0.648	13.36
BAS-515	3364.32	989.84	1249.40	698.552	0.816	11.52
IR-6	3076.04	430.16	1108.39	942.056	5.064	18.64
BAS-2000	3720.50	946.72	1633.00	876.056	8.560	20.16
KSK-133	2233.11	1159.76	1660.40	546.152	9.496	14.80
Super-BAS	2117.93	2063.84	1808.60	554.976	12.128	10.96

Table 4: Comparisons of Mn, Fe, Zn, Cu and Pb Quantity were taken up by different varieties of immature rice plant roots

Rice varieties	Mn contents (mg/kg)	Fe contents (mg/kg)	Zn contents (mg/kg)	Cu contents (mg/kg)	Pb contents (mg/kg)
KSK-282	12.240	3024.48	79.9600	12.80	20.0
KSK-134	132.24	3632.48	29.9200	2.640	25.6
BAS-515	73.040	3014.32	41.3600	10.32	35.2
IR-6	83.600	3118.48	41.5840	10.08	17.6
BAS-2000	76.800	2972.48	55.4320	12.48	24.0
KSK-133	46.080	1586.64	50.4000	3.920	28.8
Super-BAS	104.96	1657.76	102.168	6.400	27.2

because soil might be contaminated. On December 16, 2002, UNGA introduced concept “Rice is Life” and also called ‘2004’ as the year of rice because rice is recognized as primary food source for more than half world’s population (FAO and M.H.I. FOODS, 2004).

Sixteen elements out of 109 are vital for the appropriate growth and maturity of the crop. Among these Mg and S are macronutrients, needed in larger quantity while, Fe, Cu, Zn, B, Mb, Mn and Cl are micronutrients, needed in smaller quantity for the vegetative and reproductive development of the plant (Imran and Gurmani, 2011). Seventeen genotype of the Kernel rice of three locations were studied for the absorption of soil micronutrients and also the influences of intrinsic soil variable on these elements were studied. Fe, Zn, Cu and Mg were significantly varied with respect to genotype and location; similarly, these elements were affected significantly by the environmental interactions. Furthermore, soil pH and Phosphorous concentration had significantly affected the Fe concentration while the concentration of Zn was dependent on the electrical conductivity of the soil and also on the Zn availability (Pandian *et al*., 2011).

Six domestic types of red rice (Karad, Matali, Begmi, BhriguDhan, Sukara and Chohartu), selected from the district Chamba, Himachal Perdesh, India, analyzed for macro and micro nutrients and compared with HPR-2143, the variety of white rice. During the examination, Fe was found maximum in Matali and minimum in Chohartu, similarly, Zn contents were examined highly in Matali and minimally in HPR-2143. Likewise, BhriguDhan had the largest Mg and Mn concentration while Karad had the lowest contents of the Mn and Mn. At the same time, the concentration of Na was found to be maximum in Matali and minimum in Sukara while, K was reported to be in the highest concentration in Sukara and in the lowest concentration in Begmi (Sharma *et al*., 2012). Liao *et al*. (2013) compared the bioavailability and bioaccumulation of Cu, Pb, Cd and Cr in the grown in the Non-Flooded controlled irrigated (NFI) and Flooding Irrigated (FI) soils and concluded that NFI took higher metal concentration of Cd, Cu and Pb than FI while the concentration of Cr in the roots of NFI rice was lower than FI. They further stated that Cr bound to Fe and Mn oxides were more stable under NFI conditions, played important role in the bioavailability of Cr in paddy soil while Cu, Cd and Pb, bound to organic matters were more likely to be released and improved the bioaccumulation of the these metals in NFI’s rice.

Three nutrients sources, i.e., organic, integrated use of organic and inorganic and chemical fertilizer were used for the growth of medicinal rice, Njavara in karamana, studied their nutrients concentration by analyzing the dry root matter at weekly intervals. The concentrations of N, P, K, Fe, Mn and Zn in the rice were higher significantly by using conventional management practices than other established techniques. By the use of integrated nutritional sources, the concentrations of N, P, K, Fe, Mn and Zn were higher than organic and inorganic sources (Rani and Sukumari, 2013).

Emumejaye (2014) studied the concentration of trace elements and heavy metals including Cu, Zn, Fe, Ni, Be, Cd, Cr, Hg and Pb in the samples of rice purchased from the market of Delta State, Nigeria. He concluded that level of trace elements were below the permissible limit while Pb and Fe were detected to have high concentration in some samples.

CONCLUSION

It is concluded from this research that the rice KSK-282 had taken up Ni in minimum concentration as compared to other selected rice varieties. KSK-134 had absorbed Ca, Fe and Mn in maximum amount while Cr in minimum amount as compared to other rice types. BAS-515 had taken up the maximum quantity of Pd in contrast with other 6 varieties. While K nutrient was taken up comparatively maximum by IR-6 rice. Similarly IR-6 had absorbed Ca and Na in lowest concentration as compared to other rice plants. BAS-2000 had taken up Ni in highest amount from soil under similar conditions as compared to other varieties of rice. KSK-133 had up taking maximum quantity of iron (Fe) when evaluated this rice type to other varieties. Super-BAS had shown the uptake of Na, Cr and Zn in larger amount while Mg in smaller amount in contrast to other rice types.

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