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Effect of Boiling on Mineral Contents in Rice

[1]Aadil Abbas, [2]Muhammad Farooq, [3]Muhammad Farrukh Nisar,
[1]Shakeela Rafique, [1]Tayyaba Komal and [1]Sumera Naeem

[1]Department of Chemistry, University of Gujrat, Gujrat, Pakistan
[2]Department of Statistics, University of Gujrat, Gujrat, Pakistan
[3]Department of Botany, University of Gujrat, Gujrat (50700), Pakistan

Abstract: Polished rice (*Oryza sativa* L.) contains essential minerals such as Na, K, Ca, Mg, Fe and P but certain protein and vitamins are present too being harmful for dialysis patients. The present study was conducted to investigate the way to produce rice with lower mineral contents. For this purpose the concentration of these essential minerals were determined in different varieties of rice viz. IRRI-6, Kernel and Sila. The samples of these three rice varieties were boiled to decrease mineral content and the mineral profile was determined by using atomic absorption, flame emission and UV visible spectroscopic techniques. Finally the percentage loss of minerals in the three rice varieties was calculated. The results show that different boiling regimes in IRRI-6 reduce maximum concentration of Fe, Na and K while Kernel have the highest reduction of Ca and P and in Sila the maximum concentration of Mg was reduced as compared to other minerals.

Key words: Dialysis · Minerals · Flame emission · UV visible spectroscopy · Rice · Varieties

INTRODUCTION

Rice (*Oryza sativa* L.) is the most useful staple food. There are two cultivated and twenty one wild species in this genus *Oryza*. There is significant improvement in rice varieties due to establishment of International Rice Research Institute in 1960 and rice production doubled over the period of 1966 to 1990 due to large scale adaptation of these improved varieties [1]. Rice has many forms; rough, brown, parboiled, regular-milled white precooked and individually quick frozen rice.

In all over the world, 75% of the population depends upon rice as major diet [2]. It is also the most important food grain after wheat in Pakistan and is known as queen among cereals due to its nutritional value and higher digestibility. Main varieties of rice in Pakistan are IRRI-6, IRRI-9, sarshar and Dr-83.These varieties are passed through different process to obtain brown, white, polished and bran rice. Highest protein contents are present in cultivar sarshar (8.80%) followed by IRRI-6 (8.77%).The content of Fe, Zn, Mn and Cu among these varieties are ranged from 1.57 to 1.94 mg/100g, 1.44 to 2.97 mg/100g, 1.57 to 2.33 mg/100g and 0.58 to 0.92 mg/100g respectively [2].

Rice has great nutritional value in human life as it contains fats, protein, vitamins and minerals. The essential mineral, K, Ca, Na, Mg, P, Fe, which are present in rice, play vital role in proper functioning of normal human body and are required in a definite quantity but Dialysis patient are often suggested a diet which is restricted in Na, K and P.[3].Excess or deficiency of these minerals causes different diseases e.g. excess of potassium in blood causes the heart contraction which leads to the slow pulse rate and the continuous increase of potassium causes the pulse rate to stop as a result cardiac arrest (sudden death) occur [4]. The most important is the uric acid and calcium oxalate stone. Chronic acidosis which is due to calcium, produces low urinary ph and forms uric acid crystals due to less solubility of uric acid [5]. Celiac disease is also caused by excess accumulation of calcium. It is the inflammatory disease of small intestine [6]. During interdialytic period accumulated sodium divided in to two parts one is active sodium, present in Extracellular spaces, other one is inactive sodium, accumulation of both these sodium causes hypertension, while vasoconstriction is only due to the active part [7].

For all these reasons dialysis patients can not take rice in their diet. It is there for necessary to produce such rice which are of mineral free or have low minerals quantity so that dialysis patients can take a sample of rice as routine diet.

Corresponding Author: Muhammad Farrukh Nisar, Department of Botany, University of Gujrat, Gujrat (50700), Pakistan, E-mail: farrukh_nisar@hotmail.com.

Different methods are suggested in previous studies to reduce the quantity of minerals in rice and other wheat item. Acid washing centrifugation (AWC) and cold hot water enzyme incubation (WEI) methods can be used for decreasing minerals like Ca, Mg, Zn, Cu, etc from different cereals including rice [8]. Na, p and phytic acid may also be decreased through soaking and boiling method [9]. Decrease of crude protein and some minerals take place through parboiling at 30, 45, 60 and 90 minutes, but maximum decrease take place at 90 min. The decrease in crude protein (32.5%), Ca (13.3%), Fe (16.66%), Na (5.76%) and K (2.31%) is estimated [10].

It is customary to wash rice before cooking. The effect of washing is to dissolve some of the nutrients from the grain the amount removed depends upon the degree of milling and time duration of washing. The use of excess water causes the depletion of most vitamins and minerals. In boiling process, however, most of the essential minerals lost and this diet cannot fulfill needs of normal human body [11] but can be used for dialysis patients due to their low quantity requirement of minerals. In the present study, the reduction in mineral concentration is estimated by adopting this simple boiling method.

MATERIAL AND METHODS

Determination of Minerals in Polished and Boiled Rice: Three rice varieties viz. IRRI-6, Kernel and Sila are used in this study. These are transferred to china crucibles, de-moisturized, weighed and immediately placed in desiccators. Ashes are then made from IRRI-6, Kernel and Sila rice in muffle furnace at 550 0C. Digestion of the ash of each rice variety was made with 1.0g ash in HNO3 and distilled water and boiled for 10 minutes. The mixture was then filtered and diluted to 100ml by distilled water. Determination of minerals in the sample and standard solutions were done by Atomic absorption spectroscopy (AAS), UV-Vis spectroscopy and Flame Emission spectroscopy (FES) techniques.

Preparation of Sample, Standard Solutions and Analysis: Rice samples (kernel, sila and IRRI-6) are prepared. The standard solutions for Iron, Magnesium and Calcium are prepared by dissolving 4.83g of Mohr's salt [$(NH_4)_2SO_4.FeSO_4.24H_2O$], 8.36g of hydrated magnesium chloride ($MgCl_2.6H_2O$) and 2.77g of Calcium Chloride ($CaCl_2$) respectively in 1000ml of distilled water. These standard are then analyzed by atomic absorption spectrophotometer by using respective hallow cathode lamp for each mineral. Potassium and sodium standards are prepared by dissolving 1.91g of potassium chloride (KCl) and 2.4g of sodium chloride (NaCl) respectively in 1000ml of distilled water and then analyzed by Flame emission spectrophotometer using respective flames for each mineral.

Phosphorous standard are prepared indirectly by dissolving 2.5 g of Ammonium Vanadate (NH_4VO_3) in 100ml hot water at 50°C. Then 20ml conc. HNO_3 is added and diluted with water to 1ml in a graduated flask. 50g of ammonium molybdate $(NH_4)_6Mo_4O_{24}.4H_2O$ is dissolved in warm water and diluted to 1L in graduated flask and the solution is filtered before use. 0.4g of phosphate sample is dissolved in 2.5M HNO_3 to give 1L in a graduated flask 10ml of this aliquot solution is placed in 100ml graduated flask. 50ml of water is added, 10ml of ammonium molybdate solution, 10ml of ammonium vanadate solution is added and the solution is diluted up to the mark. Absorbance of the solution is determined at 460nm against a blank solution prepared in the same manner using 1cm cells. A series of standards from potassium di-hydrogen phosphate cork ring the range 1 to 5mg phosphorous per 100ml and containing the same concentration of acid, ammonium molybdate and ammonium vanadate is prepared as previous solution. A calibration curve is constructed and used to calculate the concentration of phosphorous in sample.

Further more, 25g of each rice variety (Kernel, Sila, IRRI-6) are taken and boiled and then the mineral profiled for each mineral is estimated by using same procedure as for polished rice. Table 1 shows the absorbance/emission for each mineral in polished and boiled rice of each variety of rice.

RESULTS AND DISCUSSION

The estimated average concentration of different minerals like calcium, magnesium, phosphorous, iron, sodium and potassium in different verities of rice as IRRI-6, Kernel and Sila, both in polished and boiled rice, are shown in Table 1. The table also shows the percentage reduction in mineral concentration after boiling the rice.

The variety Sila of polished rice shows maximum average concentration of Calcium (Ca^{2+}) while minimum concentration is found in variety IRRI-6. After boiling the rice, the maximum concentration is found in IRRI-6 while minimum is in kernel. The results reveal that there is maximum reduction of Ca^{2+} in variety Kernel whereas the reduction is minimum in IRRI-6. The maximum and minimum average concentration of Magnesium (Mg^{2+}) is found in Kernel and IRRI-6 respectively in polished rice. In case of boiled rice, the maximum and minimum concentration of Mg^{2+} is found in IRRI-6 and Sila respectively. The maximum reduction is found in Sila while the remaining two varieties shows approximately equal

Table 1: Absorbance/Emission of minerals in polished rice, boiled rice and water of boiled rice

	Absorbance								
	Polished Rice			Boiled Rice			Water of Boiled Rice		
Mineral	IRRI-6	Kernel	Sila	IRRI-6	Kernel	Sila	IRRI-6	Kernel	Sila
Fe2+	0.07	0.10	0.20	0.040	0.050	0.030	0	0	0
Ca2+	0.013	0.019	0.018	0.013	0.009	0.011	0.009	0.014	0.013
Mg2+	1.913	2.034	1.966	1.665	1.966	1.365	1.581	1.437	1.568
Na2+	1500	1530	1600	91	180	129	107	60	215
K+	194	194	194	25	72	26	47	34	48
P	0.22	0.26	0.23	0.20	0.23	0.22	0.22	0.24	0.24

Table 2: Average Concentration of Mineral in Polished and Boiled Rice and Percentage reduction

	Concentration of Mineral (ppm)								
	Polished Rice			Boiled Rice			Reduction (%)		
Mineral	IRRI-6	Kernel	Sila	IRRI6	Kernel	Sila	IRRI-6	Kernel	Sila
Calcium(Ca^{2+})	18.0	23.0	24.0	17.0	14.0	15.0	5.6	39.13	37.50
Magnesium(Mg^{2+})	18.0	20.0	19.5	17.0	19.0	16.0	5.6	5.00	17.94
Iron (Fe^{2+})	29.0	34.0	66.0	20.0	25.0	19.0	31.0	26.40	71.21
Phosphorous(P)	4.35	5.0	4.5	3.90	4.4	4.30	10.34	12.0	4.44
Sodium(Na^{+})	340.0	350.0	380.0	90.0	168.0	128.0	73.52	52.0	66.31
Potassium(K^{+})	67.0	67.0	67.0	53.0	64.0	55.0	20.90	4.47	17.91

level of reduction of Mg^{2+} after boiling the rice. The highest mean contents of Iron (Fe^{2+}) are found in Sila and lowest mean contents are in IRRI-6 in case of polished rice. In boiled rice, the highest and lowest mean contents are in same form as in case of polished rice. After boiling rice, we get maximum reduction of Iron (Fe^{2+}) in Sila while the kernel shows minimum reduction of Fe^{2+}.Regarding Phosphorous (P), the results shows maximum mean value for kernel and minimum mean value for IRRI-6 when the rice are either in polished form or boiled form. However, we get reduction in the contents of Phosphorous (P) after boiling rice. The results show that the maximum reduction is found in kernel. The highest mean Sodium (Na^{+}) is shown by Sila in polished rice and kernel in boiled rice, however, the maximum reduction is found in IRRI-6. The most interesting picture is for Potassium (K^{+}) that the average contents are same for three verities of rice when the rice are in polished form. In boiled rice, the highest contents are found in Kernel and minimum in IRRI-6. For this mineral, the maximum reduction of Potassium (K^{+}) is also found in IRRI-6.

In the six minerals that are investigated in the present study, the highest concentration of four minerals are found in the Sila verity and the lowest contents for all minerals are found in Iri-6, when the rice are polished. In boiled rice, five minerals have high concentration in Kernel and one have high concentration in IRRI-6. Regarding reduction in mineral concentration, three mineral shows maximum reduction in IRRI-6, two in Sila and one is found in Kernel.

CONCLUSION

Rice, which is known as queen among cereals due to its nutritional value and higher digestibility, is most important food grain in Pakistan after wheat. It contains fats, protein, vitamins and minerals as K, Ca, Na, Mg, P, Fe whose definite quantity play vital role for normal human body functioning. However, these minerals are toxic for dialysis patients due to its high concentration especially in polished rice. That's why; the physician does not recommend rice for dialysis patients. Rice can be made eatable for such patients by reducing the concentration of minerals. This study proposes a method of reducing concentration of minerals. Three varieties of rice; IRRI-6, Kernel and Sila are taken and the concentration of K, Ca, Na, Mg, P, Fe are determined before and after boiling the rice. We see that sufficient reduction in concentration of

these minerals is achieved after boiling rice. However, the percentage of reduction varies in different varieties. On the basis of our finding, we can suggest that the boiled rice can be used for dialysis patients. However, further studies may be conducted to determine the amount of boiled rice keeping in mind the required quantity of minerals for dialysis patients.

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