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MINERAL COMPOSITION OF DIFFERENT RICE VARIETIES AND THEIR MILLING FRACTIONS

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Four Pakistani coarse rice varieties namely Irri-6, Irri-9, Sarshar and DR-83 were milled to obtain different fractions viz. brown rice, white rice, polished rice, bran and polishing. Chemical components such as moisture, ash, fat, fiber and NFE differed significantly due to differences in milling fractions as well as rice cultivars. The highest protein content was observed in the rice cultivar Sarshar (8.80%) followed by Irri 6 (8.77%) while among the different milling fraction, the maximum protein content was found in bran (11.71%). The highest ash content was found in Sarshar (3.79%) whereas among different milling fractions it was higher in bran (6.04%). Mineral contents were significantly higher in bran followed by polishing. Iron, zinc, manganese, copper contents ranged from 0.59 to 3.98 mg/100g, 1.12 to 4.69 mg/100g, 0.51 to 5.12 mg/100g, 0.28 to1.69 mg/100g respectively among different milling fractions. The mineral contents 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 among different varieties. Volume expansion ratio and water absorption ratio was higher in Sarshar (3.15& 2.31) among varieties and in polished rice (3.50 & 2.65) among the fractions. The rice varieties Sarshar and Irri-6 must be given more attention by the rice breeders to use in their hybridization programs as these varieties exhibit more proteins and minerals which are required to maintain normal body metabolism.

Keywords: Rice, coarse varieties, chemical analysis, mineral content, volume expansion ratio, volume absorption ratio.

INTRODUCTION

Rice (*Oryza sativa*) is one of the most important cereals in human nutrition, consumed by about 75% of the global population. Among the cereals, rice and wheat share equal importance as leading food sources for humankind. Rice is a staple food for nearly one-half of the world's population and provides 60 % of the food intake in Southeast Asia.

After wheat, rice is the most important food grain crop of Pakistan and is the major foreign exchange earner. Rice occupies about 11% of the total cropped area in the country, yielded 5024.8 thousand tons from area of 2519.6 thousand hectares during 2004-05 (GOP, 2005-06). Pakistan contributes about 11% in total world rice export and on an average 1/3rd of the total national rice production is exported every year which accounts for 5.7% of the total value added in agriculture and 1.3% to GDP.

Although rice has a relatively low protein content i.e. about 8% in brown rice and 7% in milled rice versus 10 percent in wheat, brown rice (caryopsis) ranks higher than wheat in available carbohydrates, digestible energy (kilojoules [kJ] per 100 grams), and net protein utilization (NPU). Rice protein is superior in lysine content to wheat, corn, and sorghum. Milled rice has lower crude fiber content than any other cereal, therefore; it makes rice powder suitable for infant food. Although rice is low in riboflavin and thiamine (vitamin) but its carbohydrate and protein percentage available is sufficient to sustain the energy needs for an adult whereas, for growing children, rice needs to be supplemented by other protein sources (Hegsted, 1969; Juliano, 1985).

Rice has been rightly considered as the queen among cereals for its nutritional quality and higher digestibility. In Pakistan two types of rice i.e. coarse and fine varieties are grown. The fine varieties of rice possess a specific aroma characteristic and cooking characteristics due to which these are very much liked all over the world and fetches higher price in the market.

Minerals present in rice like zinc, manganese, iron and copper play an important role in body regulatory functions other than cadmium and lead. A definite difference exists between varieties of brown and white rice in vitamins, minerals, and fiber and fat contents.

The study has been designed to assess the chemical composition, mineral status and cooking quality of different fractions including brown rice, white rice, polished rice, bran and rice polishing of different varieties obtained during milling.

MATERIAL AND METHODS

Four coarse rice cultivars i.e. Irri-6, Irri-9, Sarshar and Dr-83 grown during crop year 2001 were obtained from Nasirabad area of Balochistan province.

The paddy of each variety was cleaned to remove dust trash, stone and foreign matter and was de-hulled and milled by passing through "Stake sheller and McGill Laboratory Mill"(polisher) to obtain different fractions of rice i.e. Bran, Brown rice, white rice, polished rice and polishing. A portion of rice fractions was also ground by passing through "UDY Cyclone Mill" to get rice flour. The fractions and flour were analyzed for different physico-chemical and cooking quality characteristics.

The determination of moisture content (105ºC/12hr), Ash content (550ºC/5hr), Crude fat in Soxhlet apparatus (solvent ether), Crude protein by nitrogen determination using the Kjeldhal's method (N x 5.95) and Nitrogen free extract (NFE) by using formula and crude fiber was carried out according to their respective method given in AACC (2000).

Cooking quality was evaluated by volume expansion ratio and water absorption ratio. The volume expansion ratio was calculated by dividing the volume of cooked rice by the volume of raw rice in the former whereas; by dividing the weight of cooked rice by the weight of raw rice (Juliano, 1985).

The mineral content i.e. Fe, Cu, Zn, Mn, Pb and Cd were determined by using atomic absorption spectrophotometer (Perken Elmer) according to method given in AOAC (1990). Firstly, the samples were wet digested as reported by Richards (1969). The digested samples were transferred to 100ml volumetric flask and volume was made with distilled water and then filtered. Samples were then analyzed in Atomic Absorption spectrophotometer and estimation of each element was carried out.

RESULTS AND DISCUSSION

Chemical analysis

The results pertaining to chemical analysis are presented in Table 1 and 2 on the basis of varietal differences and milling fractions respectively, whereas, mineral estimate values are presented in Table 3.

The mean values for the moisture content in different rice varieties (Table 1) ranged from 9.19 to 11.10%. The highest value for this parameter was observed in Sarshar and the lowest in Dr-83. In different milling fractions the moisture content ranged from 8.61to11.08% (Table 2) indicating the lowest in bran protein whereas while the highest moisture content was found in brown rice respectively. This moisture content is confirmed with the earlier results reported by Souci et al (1986) and Eggum (1979).

Crude protein content in different rice varieties ranged from 7.80 to 8.80% showing highest value of protein content was found in Sarshar and lowest in Irri-9 varities. While in different milling fractions the protein content ranged from 6.11 to 11.71%. The highest protein content was found in bran and the lowest in polished rice. The results obtained in this study are in line with earlier studies reported by Pederson and Eggum (1983), Eggum et al (1982).

The ash content in different rice varieties ranged from 3.16 to 3.79% obtained in Sarshar (highest) and in Dr-83 (lowest). In different milling fractions the ash content ranged from 0.54 to 6.04%. The highest ash content was found in bran whereas the lowest was found in polished rice. The findings of the present study are in accordance to the studies reported by Juliano (1985) and Willis *et al.* (1982). The ash content may be different in different milling fractions due to degree of severity during milling for the separation of bran.

Fat content in different rice varieties ranged from 5.16 to 6.14% the highest value of fat content was present in Irri-6 and lowest in Irri-9. While in different milling fractions the fat content ranged from 0.73 to 14.65% the highest in bran and the lowest in polished rice. The results of present study are in agreement with earlier results reported by Willis *et al.* (1982) and Juliano (1985) who also gave the fat range 0.9 to 1.97% in different milling fractions.

Crude fiber content ranged from 2.17 to 2.57% in different rice varieties showing highest value of fiber content in Irri-6 and the lowest one in Irri-9. Milling fractions showed the fiber content range from 0.21 to 8.38%. The highest fiber content was observed in bran and the lowest in polished rice and white rice. These results are comparable with the findings of Maningat (1981), Willis *et al.* (1982) with same results and Juliano (1985) who found the fiber content ranged from 0.2 to 11.4% in different milling fractions.

NFE values in different rice varieties ranged from 67.75 to 71.43%. The highest value of NFE was found in Irri-9 and lowest in Irri-6. Different milling fractions exhibited NFE value ranged from 61.21 to 81.19%. Maximum NFE value was found in polished rice and the lowest in polishing. These findings are confirmed with the earlier results reported by James and Mc Caskill (1983).

Mineral Content

The results pertaining to mineral contents during the study are presented in Figure 1 and 2 on the basis of varietal differences and milling fractions respectively.

The highest iron content was found in Irri-6 (1.94%) and lowest was found in Irri-9 (1.37%). While in different milling fractions the highest iron content was found in bran (3.98%) and lowest was found in polished rice (0.44%). These results of iron in present study are in agreement with earlier findings as reported by various workers for Ash, Protein, Fat and Fiber

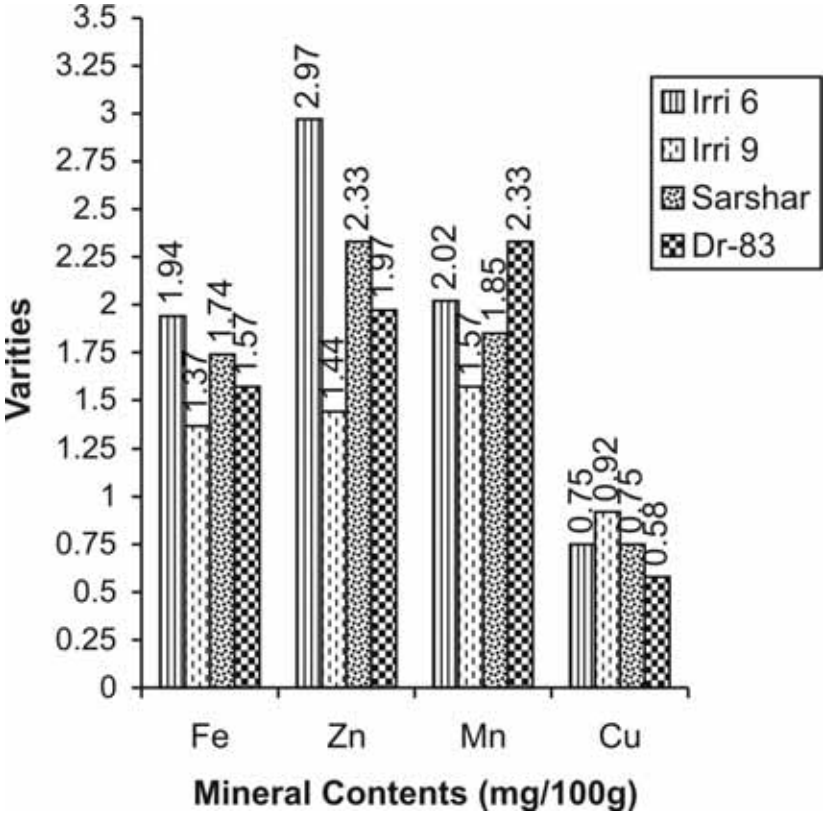
Table1. Chemical analysis of different Pakistani rice varieties

Varieties	Moisture	Protein	Ash content	Fat content	Fiber content	NFE
Irri 6	11.04a	8.77a	3.67b	6.14a	2.57a	67.75d
Irri 9	10.01b	7.80c	3.43c	5.16d	2.17d	71.43a
Sarshar	11.10a	8.80a	3.79a	5.80b	2.47b	68.14c
Dr-83	9.19c	8.12b	3.16d	5.45c	2.31c	71.21b
Mean	**10.33**	**8.37**	**3.51**	**5.64**	**2.38**	**69.63**

Table 2. Chemical analysis of fractions obtained from different Pakistani rice varieties

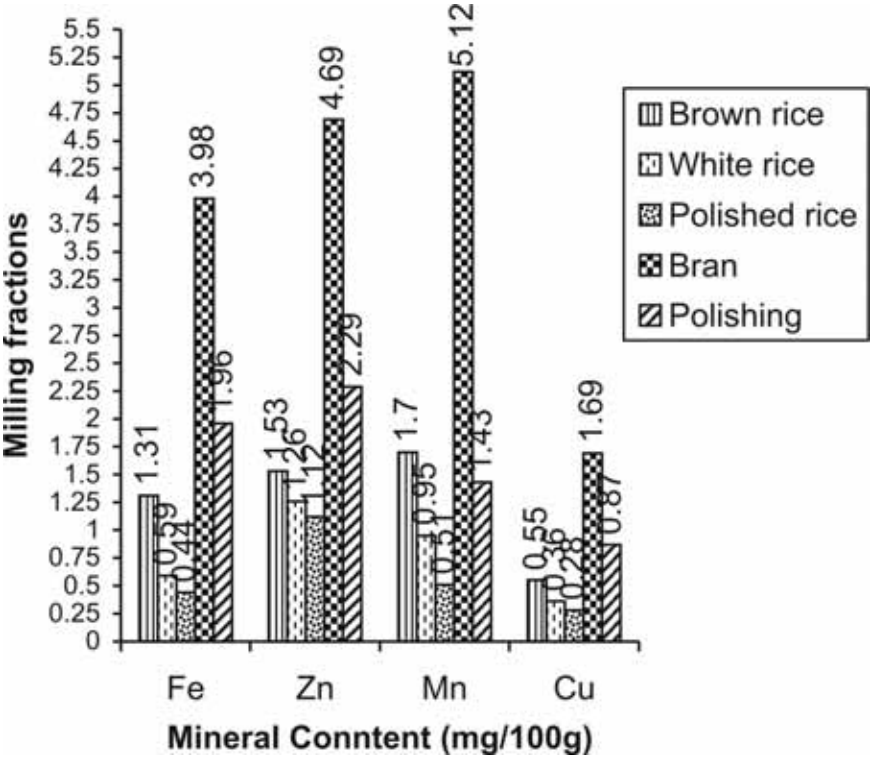
Milling Fractions	Moisture	Protein	Ash content	Fat content	Fiber content	NFE
Brown rice	11.08a	7.23c	1.42c	2.13c	0.79c	72.21c
White rice	10.93a	6.46d	0.66d	0.97d	0.21d	80.96b
Polished rice	10.99a	6.11e	0.54d	0.73c	0.21d	81.19a
Bran	8.61c	11.71a	6.04a	14.65a	8.38a	47.58e
Polishing	9.93b	10.73b	5.91b	9.72b	2.30b	61.21d
Mean	**10.115**	**8.7525**	**3.2875**	**6.5175**	**2.775**	**67.735**

Fig.1. Mineral contents in different rice varieties



showing similar pattern. The bran is relatively rich in minerals (Eppendorfer *et al.* 1983; Sotelo *et al.* 1990). The highest zinc content was found in Irri-6 (2.97%) and lowest was found in Irri-9 (1.44%). While in different milling fractions the highest zinc content was found in bran (4.69%) and lowest was found in polished rice (1.12%). The results for zinc content are in line with earlier findings reported by Juliano (1980), Eppendorfer *et al.* (1983) and Sotelo *et al.* (1990) who reported higher zinc contents in bran and lowest in white rice.

Fig. 2. Mineral content of different milling fractions of rice varieties



The highest manganese content was found in Dr-83 (2.33%) and lowest was found in Irri-9 (1.57%). While in different milling fractions the highest manganese content was found in bran (5.12%) and lowest was found in polished rice (0.51%). The findings of present study are similar to earlier findings of Houston and Kohler (1970) and Eppendorfer *et al.* (1983).

The highest copper content was found in Irri-9 (0.92%) and lowest was found in Dr-83 (0.58%). While in different milling fractions the highest copper content was found in bran (1.69%) and lowest was found in polished rice (0.28%). The range of copper in different fractions of rice varieties is confirmed by the results of the Juliano (1990), and Eppendorf *et al.* (1983) and Sotelo *et al.* (1990).

The lead was not found in all fractions of rice cultivars by the procedure adopted. Since the presence of lead and cadmium are injurious to health, therefore present results suggested that rice cultivars can be safely consumed.

Cooking quality

The means values of volume expansion ratio and water absorption ratio are given in Table 3-4.

Table 3. Means of cooking quality parameters of different Pakistani rice varieties.

Varieties	Means of Volume expansion ratio	Means Volume absorption ratio
Irri 6	2.74	2.30
Irri 9	2.68	2.25
Sarshar	3.15	2.31
Dr-83	2.99	2.30
Mean	**2.89**	**2.29**

Table 4. Means of cooking quality parameters of fractions obtained from different Pakistani rice varieties

Varieties	Means of Volume expansion ratio	Means Volume absorption ratio
Brown rice	1.95	1.71
White rice	3.22	2.51
Polished rice	3.50	2.65
Mean	**2.89**	**2.29**

Volume expansion ratio

The significantly highest volume expansion ratio was exhibited by Sarshar (3.15) while the lowest was observed in Irri-9 (2.68) (Table 3). The lowest volume expansion ratio was observed in brown rice (1.95) (Table 4). Volume expansion ratio in different milling fractions in present study is similar with earlier findings of Awan (1988). High variability in fractions was observed within and between varieties for volume expansion ratio. In Pakistan rice varieties with more volume expansion ratios are preferred generally.

Water absorption Ratio

The highest water absorption ratio was in Sarshar (2.31) while lowest was in Irri-9 (2.25). The lowest water absorption ratio was observed in brown rice (1.71) followed by white rice (2.51) and polished rice (2.65). The results in present study are in agreement with earlier studies reported by Awan (1988).

The results regarding volume expansion ratio and water absorption ratio showed significant variations among the rice cultivars. This indicates that the rice cultivars i.e. Sarshar and Irri-6 with higher ratio of volume expansion and water absorption capacity regarded as better in cooking quality than others.

CONCLUSIONS

The present study indicated significant variation in cooking, chemical characteristics and mineral contents among rice cultivars and milling fractions. Therefore, differences can be exploited by the rice breeders in their hybridization. Sarshar was found to be superior in cooking quality and mineral contents followed by Irri-6. All the cultivars and milling fractions free from lead and cadmium (not identified) also suggest the safe use of the tested rice cultivar for human consumption. It is concluded from the present study that Sarshar and Irri-6 should get more attention by the rice breeders to use in their hybridizing programs.

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