International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2013 IJFAS Journal-2013-2-24/1203-1209
ISSN 2322-4134 ©2013 IJFAS

Chemical Characteristics and Mineral Contents in Whole rice grains, Hulls, Brown rice, Bran and Polished Ali Kazemi Rice in Gilan province - North of Iran

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ABSTRACT: In this study, the concentrations of some mineral elements in whole rice grains, hulls, brown rice, bran and polished rice from 10 major Alikazemi rice farmlands from 10 cities: Rasht, Shaft, Khomam, Masal, Soumahe Sara, Roudbar, Fuman, Astaneh-e Ashrafiyyeh Lashtenesha, Kochesfehan from Gilan province in the north of Iran in 2013 were determined by Atomic Absorption Spectrophotometer. All samples were collected in during harvesting of rice (August to late September 2013) in Gilan fields. Fat binding capacity (FBC) and water binding capacity (WBC) contents of rice bran and husk fibers varied significantly ($p<0.05$) in different paddy fields from different cities in Gilan Province. Rudbar samples has the highest level of WBC in rice bran and husk fibers while Astaneh-e Ashrafiyyeh samples has the highest level of FBC. The results of this research revealed that the removal of husk layer during dehusking and polishing substantially reduces the mineral nutrient value of rice grains. In general, the bran contains higher levels of iron, Manganese and Copper. Mn and Cu were mainly located in the hull while Iron and Zinc located in the bran. Polishing substantially reduces the mineral nutrient value of rice grains as only 2% of the total manganese 6% of the total Zn and Fe , 1% of Cu remained in polished rice and mainly parts of mineral elements were removed by the milling process if the hull and bran were thoroughly polished.

***Keywords*:** mineral contents, Fiber, grain, hull, bran, pollished Alikazemi rice

INTRODUCTION

Rice cultivation in the Northern Province areas of Iran has a long history, especially Somesara and Rudbar**.** Also rice is the second high consumption food among Iranian people. It is the most common crop grown in agricultural lands in the north of Iran (Chamannejadian et al., 2013; Khaniki and Zozali ,2005). Today, the population growth in Iran's domestic production of rice to meet the needs of the people and therefore, a significant amount of this product is imported from abroad despite Iran's rice acreage is only 600 hectares, the amount of land under cultivation is very small world. But there are different varieties and has a central role in discussions of research and research training is remarkable. In Asia, rice is the main dietary source for energy, protein, thiamine, riboflavin, niacin, iron and calcium (Juliano ,1997; Liang ,2007; FAO, 2004). The commercial rice-milling process leads to products with low-value fractions, such as husk and bran. The rice grain has a hard husk protecting the kernel inside. After the husk is removed, the remaining product is called brown rice including bran, germ and endosperm. Rice bran is produced as a by-product during the milling process in the production of white rice from brown rice (Revilla et al., 2009). For consumption purposes, rice kernels are composed of two parts, the inedible hull and edible brown rice. Brown rice (dehulled rice) is composed of surface bran (6-7% by weight), endosperm (≈ 90%) and embryo (2-3%) (Chen et al., 1998; Liang ,2007). Daily consumption of rice in Asia countries ranges between 158-178 g/ person-day (Nogawa and Ishizaki 1997; Rivai et al**.,** 1990).Hand pounding of paddy in a mortar with a pestle is still practiced in some remote areas. Pounding the paddy induces upward and downward forces on grain against grain that removes the husk and some bran layers. The pounding also results in a high percentage of broken kernels. The final cleaning is done by winnowing and gravity separation by hand (Kranner and Colville ,2011). The seeds of the rice plant are first milled using a rice huller to remove the chaff (the outer husks of the grain). At this point in the process, the product is called brown rice. The milling may be continued, removing the bran, i.e., the rest of the husk and the germ, thereby creating white rice(http://www.knowledgebank.irri.org) The rice grain consists of four major tissues: the hull, embryo, aleuronic layer, and starchy endosperm. The endosperm is the most important grain fraction with respect to human nutrition, as it is the part of the grain primarily consumed in many countries [Lu et al., 2013]. White rice, the main consumption product, is referred to as polished or whitened rice when 8-10% of mass (mainly bran) of the outer part has been removed from brown rice (Kennedy et al., 2002; Liang ,2007).

Distribution patterns of micronutrients within the grains are important because a considerable portion of the whole grain generally is removed and lost during processing (milling) before consumption (Lombi et al., 2011) and mineral concentrations often decrease from the outer bran layers toward the endosperm(Cakmak ,2009) . The influence of WBC on functional properties of food is especially examined in bakery industry. Water plays important role on changes (including gelatinization, denaturation, yeast and enzyme inactivation , flavor and color formation) which are observed during baking(Luan ,2000) and addition of dietary fiber to bread, as a functional ingredient, led to decrease volume of bread and increase bread firmness (Luan 2000 ; Hu et al., 2009).

Knowledge of mineral localization within rice grains is important for understanding the role of different elements in seed development, as well as for facilitating bio fortification of seed micronutrients in order to enhance seeds' values in human diets [Lu et al., 2013].

This research builds upon:

- Determination and comparing essential and trace mineral contents as an nutritional value in Ali Kazemi rice samples in parts of rice grains after separation of whole grains into hulls and brown rice, and then milling the brown rice into bran and polished rice samples collected from ten major rice paddy (farmlands) from ten cities in Gilan Province: Rasht, Shaft, Khomam, Masal, Soumahe Sara, Roudbar, Fuman, Astaneh-e Ashrafiyyeh Lashtenesha, Kochesfehan in the north of Iran.
- Determination of Fiber and water contents of bran and hulls Alikazemi rice variety samples collected from different sites.
- Investigation the Effect of physical and chemical characteristics rice samples on their mineral contents.

Investigation the effect of different natural conditions such as soil and humidity on the level of mineral contents in rice samples due to find probable reasons of variations.

MATERIALS AND METHODS

Study Area

Gilan Province is one of the 31 provinces of Iran. It lies along the Caspian Sea, just west of the province of Mazandaran, east of the province of Ardabil, north of the provinces of Zanjan and Qazvin. The northern part of the province is part of territory of South (Iranian) Talesh. At the center of the province is the main city of Rasht. Other towns in the province include Khomam, Lashtenesha, Astaneh-e Ashrafiyyeh, Fuman, Lahijan, Langrud, Masooleh, Masal, Rudbar, Roudsar, Shaft, Talesh, and Soumahe Sara. The name and description of all the sites in this study are provided in figure 1.

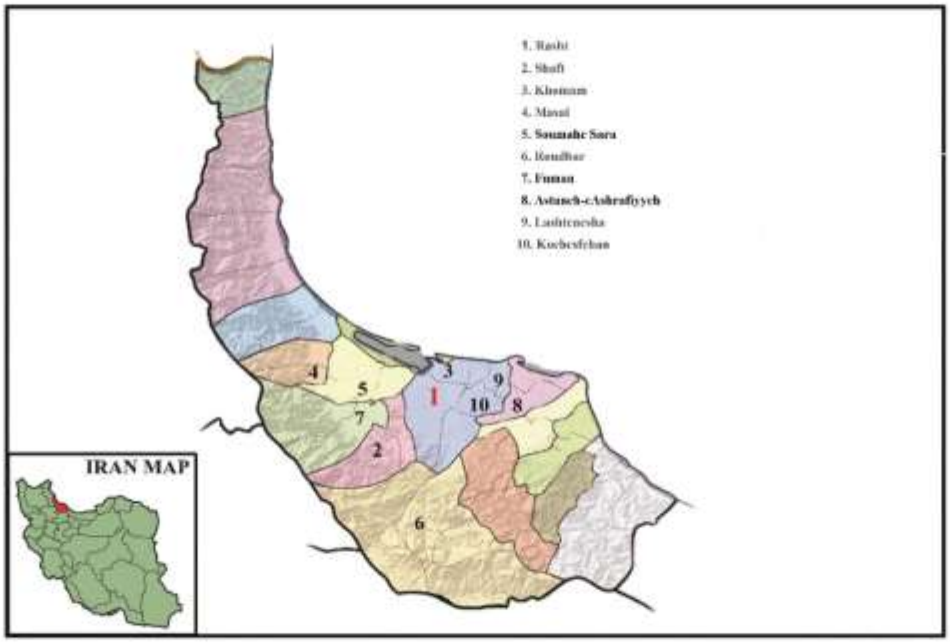

Figure 1. Description of rice sampling

Sampling method

At harvest time (August to late September 2013)500 Alikazemi rice samples were randomly in 5 states of: Whole rice grains, Hulls, Brown rice, Bran and Polished, collected from ten major farmland rice production areas in Gilan province in the north of Iran from cities : Rasht, Shaft, Khomam, Masal, Soumahe Sara, Roudbar, Fuman, Astaneh-e Ashrafiyyeh Lashtenesha, Kochesfehan and each samples consists of 20 subsamples . All sample sites were recorded using a hand-held Global Position System (GPS).As the aim of this study was determination of mineral elements: Fe, Zn, Cu, Mn, Ca and Mg in 5 different states : whole rice grains, hulls, brown rice, bran, all samples collected at the same time from each paddy .

Preparing method

Fiber determination

Fat binding capacity (FBC) and water binding capacity (WBC) of dietary fiber samples were estimated according to Azizah and Hu methods (Azizah and Yu, 2000; and Hu et al., 2009) , respectively. WBC of the extracted fiber samples was determined under external centrifugal force according to the standard AACC method**.**

Dietary fibers extracted in enzymatic method from rice bran and rice husk of alikazemi variety (Rasht, Shaft, Khomam, Masal, Soumahe Sara, Roudbar, Fuman, Astaneh-e Ashrafiyyeh Lashtenesha, Kochesfehan, in Gilan Province, Iran)according to enzymatic method (Salehifar and Fadaei 2011; Fadaei and Salehifar 2012; Fadaei et al., 2012).

Zinc, Manganese, Copper Determination

For Zinc, Manganese, Copper and Selenium concentration 50 gram of each prepared rice sample was weighed and oven-dried at 80 C^0 to a constant weight. Each oven-dried sample was ground in a mortar until it could pass through a 60 mesh sieve. The samples were stored in clean, dry, high density polyethylene bottles of 100 ml capacity with screw caps. Finally 5 gram of dried sample was weighed precisely on electronic balance (Shimadzu LIBROR AEX 200G). The samples were put in a 100 ml digestion flask and 20 ml of digestion mixture comprising of concentrated HNO3(65%) Merck and hydrochloric acid (70 %) Merck in the ratio of 3:1 was added to it and heated on a hot plate in the fuming chamber. Blanks and samples were also processed and analyzed simultaneously. All the chemicals used were of analytical grade (AR). This method has been followed in 5 stages:

whole rice grains, hulls, brown rice, bran and polished rice. Standardized international protocols were followed for the preparation of material and analysis of heavy metals contents (AOAC ,1998). The flasks were firstly heated slowly and then vigorously till a white residue is obtained. The residue was dissolved and made up to 10 ml with 0.1 N HNO_3 in a volumetric flask. The samples were analyzed by Flame Emission Spectrophotometer Model AA-6200 (Shimadzu, Japan) using an air-acetylene flame, using at least five standard solutions for each metal.

Iron Determination

The aliquot was passed through the atomic absorption spectrophotometer to read the iron concentration. Standards were prepared with a standard stock of 10 mg/L using ferrous ammonium sulphate where 3 - 60 ml of iron standard solution (10 Mg /L) were placed in stepwise volumes in 100 ml volumetric flasks. 2 ml of hydrochloric acid were added and then brought to the volume with distilled water. The concentration of iron in the aliquot was measured using the atomic absorption spectrophotometer in mg/L. The whole procedure was replicated three times.

Statistical Method

State differences on the basis of the states (Whole rice grains, Hulls, Brown rice, Bran and Polished) of rice samples were determined by student t-test. The changes were calculated by one way Anova and for analysis of the role of multiple factors univariate analysis was used by SPSS 17.Probability values of <0.05 were considered significant.

RESULTS AND DISCUSSION

Results

WBC and FBC contents of rice bran and husk fibers varied significantly ($p<0.05$) in different paddy fields from different cities in Gilan Province. Rudbar samples has the highest level of WBC in rice bran and husk fibers while Astaneh-e Ashrafiyyeh samples has the highest level of FBC.

Table 1 . Functional properties and Chemical characteristics of fiber contents in Alikazemi rice variety samples

Agriculture Area	WBC (ml/g) in Rice Bran	WBC (ml/g) in Rice Husk	FBC (ml/g) in Rice Bran	FBC (ml/g) in Rice Husk
Rasht	8.00	6.95	3.49	3.40
Shaft	8.06	7.09	3.51	3.43
Khomam	8.02	7.05	3.55	3.41
Masal	8.01	7.01	3.52	3.39
Soumahe Sara	7.87	7.04	3.58	3.48
R0udbar	8.07	7.09	3.58	3.49
Fuman	8.03	7.04	3.51	3.44
Astaneh-e Ashrafiyyeh	7.66	6.90	3.59	3.50
Lashtesnesha	7.87	6.95	3.47	3.39
Kochesfehan	7.95	7.02	3.50	3.43

The concentrations of Zn, Fe, Cu and Mn were determined in different parts of rice grains after separation of whole grains into hulls and brown rice, and then milling the brown rice into bran and polished rice. For inter-area differences in those elements in the rice, the statistical analysis showed no significant differences ($p > 0.05$) among the different farmlands in 10 different cities in Gilan areas.

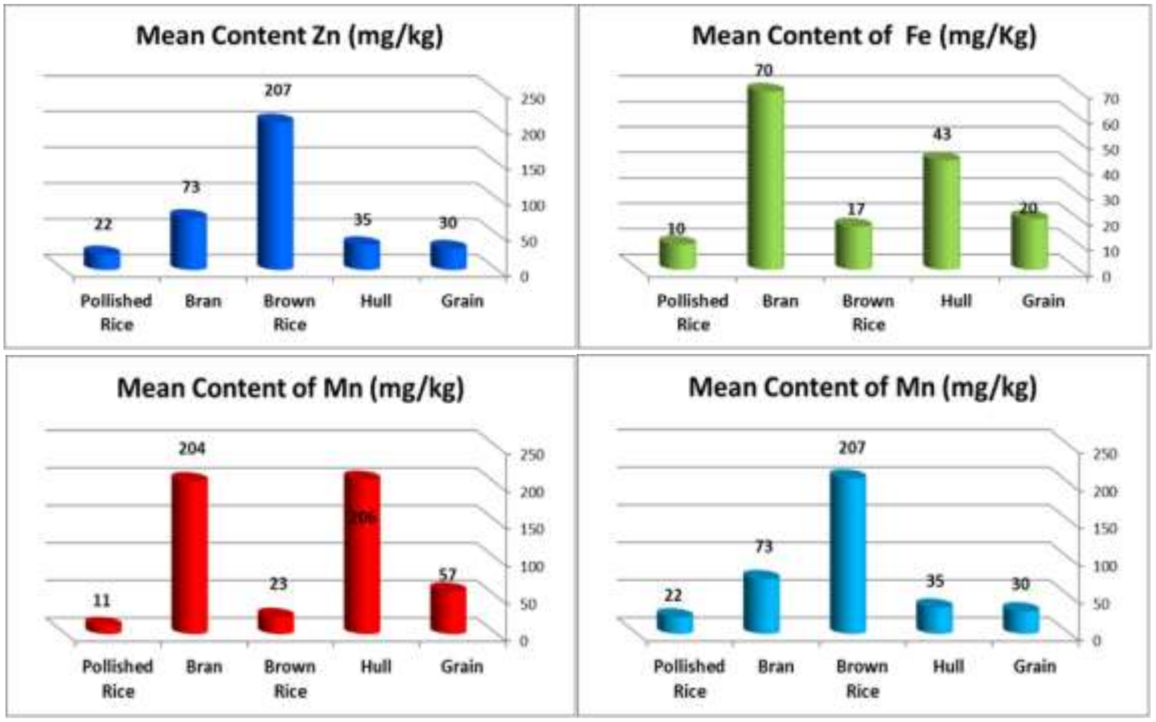

Figure 2. The mean elemental concentrations of rice grains, hull, brown rice, bran, and polished Alikazemi rice. All concentrations are expressed as mg /kg DW

As shown in Figure 2, the mean concentrations of Fe and Zn in the different grain fractions were: bran >hull >whole grain > brown rice > polished rice, whereas the relative concentrations of Mn and Cu were in the order: hull > bran > whole grain > brown rice > polished rice . the percentage of mineral elements in different state of fractions were indicated in figure 3

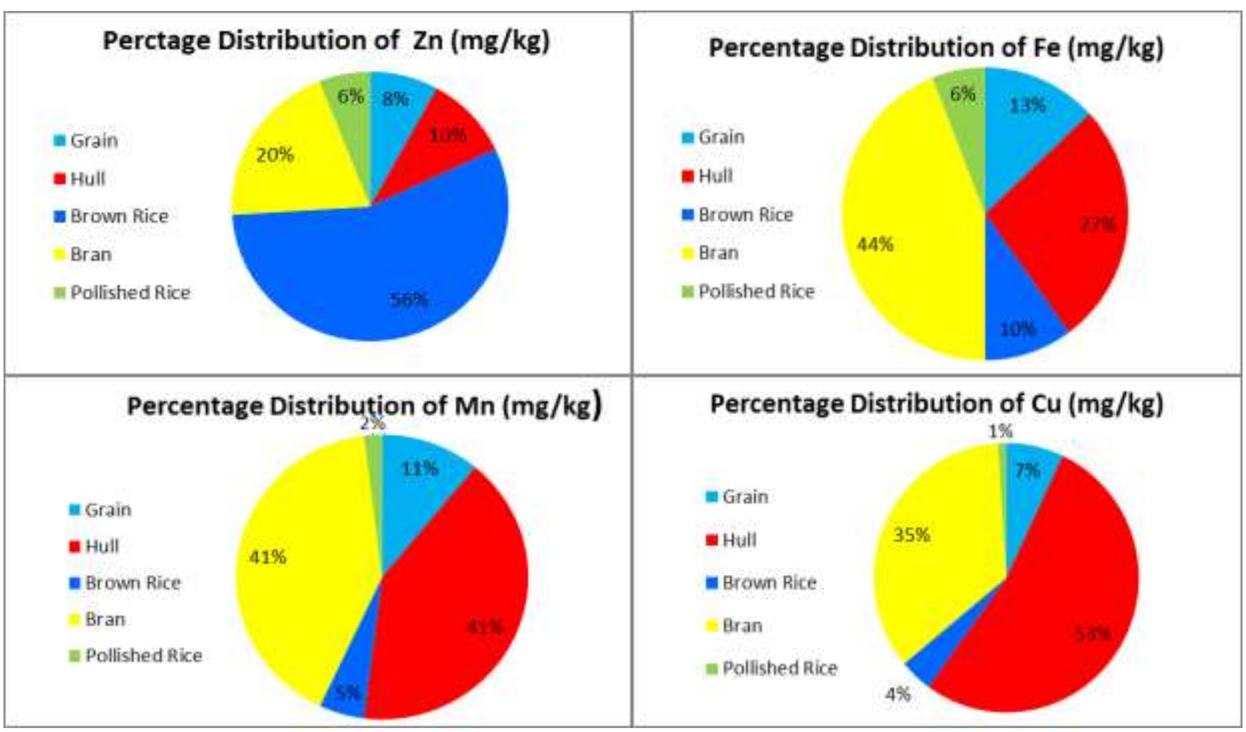

Figure 3. Percentage distributions of Zn, Fe, Cu and Mn in different fractions of Alikazemi rice grain

The Zn concentration of bran was about 2.4 times the concentrations in the whole grain rice and about 3.3 times greater than polished rice while the concentration of Fe in bran was 4 times the concentration in brown rice. Variations in the other elemental concentrations in the different rice fractions were even higher than those for Cu. The Mn concentration in the bran was 18 times its concentration in polished rice. Concentrations of Mn in the hull and bran were 9 times higher than those in the polished rice. In polished rice the concentration of all studied mineral elements was much lower than other fractions

Discussion

The present study examined the baseline of essential and trace elements in 100 rice grain samples produced in ten administrative areas of North province of Iran in 2013. For inter-area differences in those elements in the rice, the statistical analysis showed no significant differences ($p > 0.05$) among the eight administrative areas, suggesting that inter-area differences were not substantial in most cases. The results of this research revealed that the removal of husk layer during dehusking and polishing substantially reduces the mineral nutrient value of rice grains. In general, the bran contains higher levels of iron, Manganese and Copper. Mn and Cu were mainly located in the hull while Iron and Zinc located in the bran. Polishing substantially reduces the mineral nutrient value of rice grains as only 2% of the total manganese 6% of the total Zn and Fe , , 1% of Cu remained in polished rice and mainly parts of mineral elements were removed by the milling process if the hull and bran were thoroughly polished**.** The result of this study may be useful in order to optimize various germination procedures of edible seeds, in order to enhance the nutritional quality of food mixtures based on coarse cereals . However, more studies especially in other varieties of rice such as *oryza sativa* is recommended**.**

ACKNOWLEDGEMENT

Financial Supports from Pharmaceutical Sciences Branch, Islamic Azad University (IAUPS) is gratefully acknowledged.

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