MINERALS CONTENTS OF SOME INDIGENOUS RICE VARIETIES OF SABAH MALAYSIA

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ABSTRACT

Rice is the staple food and diet for the people of South East Asia. This study was conducted to compare the mineral contents of various indigenous rice varieties grown and consumed by the local peoples in Sabah Malaysia. Concentration level and distribution of essential minerals Na, K, Mg, Cu, Zn, Fe, Mn, and Cr were evaluated in five varieties of brown and polished rice, namely TR8, MR159, TQR-1, TQR-2 and IR72 which was provided by the local agriculture research department. The analysis was conducted using Inductive Coupled Plasma Spectrometry (ICP-MS) and expressed as mg/g. The various rice varieties showed a significant difference ($P < 0.05$) with respect to their mineral contents. Potassium was found to be significantly higher in brown rice variety (MR159) with an average concentration of 1368.02mg/g than the polished rice varieties. The essential minerals in polished rice samples were found to be in the following order K>Na>Mg>Zn>Fe>Mn>Cu>Cr. On the other hand brown rice varieties showed the following trend for essential minerals concentration K>Mg>Na>Mn>Zn>Fe>Cr>Cu. When the concentration of minerals in various rice varieties were assessed for their contribution to the recommended daily allowance (RDA) it was found that iron is the only mineral which contributes significantly to the RDA (75.72%) for brown rice varieties and 37.12% for polished rice. Thus, it is necessary for the people of these areas to consume a wide variety of food to obtain sufficient quantity of various other minerals.

Key words: Rice, minerals, trace metals, Sabah, Malaysia

Introduction

Rice is the seed of the monocot plant of the genus *Oryza* and of the grass family Poaceae (formally Graminae) which includes twenty wild species and two cultivated ones, *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice). Oryza sativa is the most commonly grown species throughout the world today. Rice has been considered the best staple food among all cereals and is the staple food for over 3 billion people, constituting over half of the world's population (Cantral and Reeves 2002). The rice grain consists of 75-80 % starch, 12 % water and only 7 % protein with a full complement of amino acids. Its protein is highly digestible with excellent biological value and protein efficiency ratio owing to the presence of higher concentration (~ 4 %) of lysine (FAO, 1998). Minerals like calcium, magnesium and phosphorus are present along with some traces of iron, copper, zinc and manganese (Yousaf, 1992). metal that commonly found in rice are such as iron (Fe), zinc (Zn), manganese (Mn), chromium (Cr), cobalt (Co), copper (Cu), can enter human body through three routes namely ingestion, inhalation and dermal contact, with ingestion as the main route of exposure to human (2,14). Whole rice is milled before marketing. The milling process produces four fractions: brown rice, hull, white rice and bran. Each of these fractions can vary in chemical content according to the variety of rice and the type of milling performed. Un-milled rice contains a significant amount of dietary fibre and more nutrients than milled or polished white rice. Most rice is consumed as white polished grain despite the valuable food content of brown rice. In Europe where rice is not staple foods prefer brown rice. Pomeranz (1992) reported that rice composition differs according to the variety and processing method used. Minerals are chiefly located in the bran of the rice grain. Therefore, rice can only contribute significantly to the iron supply if it is eaten as brown rice (Frei and Becker, 2003). There are thousand varieties of rice around the world (IRRI, 2016). Based on Bernas Malaysia, there are eight main varieties of rice marketed in Malaysia, namely parboiled rice, basmati rice, glutinous rice, brown rice, local white rice, imported white rice, fragrant rice and broken rice.

Rice is an important food crop for the Sabah, particularly for the rural population. In addition to serving as a source of food and an important economic crop, rice also significantly shapes the cultural systems, beliefs, and traditions. Historically, rice was grown for subsistence, using traditional practices, and cultivated on a small scale. Most rice was grown in the hills. Currently, rice production in the state is only able to accommodate approximately 30-40% of the population needs. Rice is in high demand due to a large population and rapid population growth. Therefore, it is vital for Sabah to increase rice production. The problem is Sabah has limited land space resources, especially for rice cultivation, as large areas in Sabah are mountainous (Ubong and Ibrahim 2010).

The objective of the present study was to determine and compare the concentration of some of the essential minerals in five varieties of brown as well as polished rice from Sabah. Assessment of metal in rice were conducted using acid digestion method (HNO_3 combined with other types of acids such as H_2SO_4, H_2O_2 and $HClO_4$). The values obtained from the study were then compared with the Recommended Dietary Allowances (RDA) for their contribution to the daily intake.

Research design

Five local rice varieties namely MR159, IR72, TQR1, TQR2 and TR8 were obtained from Agriculture Research Department, Tuaran, Sabah Malaysia. Prior to the analysis, samples of brown rice varieties were milled and polished at the Agriculture rice station.

Digestion of the samples

The samples were digested using the wet ashing according to the AOAC, (2012) About 2 g of the rice samples were digested with 10 mL of nitric acid HNO_3 (70%) in a 500 mL conical flask. The conical flasks were left for 24 hours for digestion. After 24 hours the conical flask containing the digest was placed on the hot plate in a fume chamber. The conical flask was then heated at 70°C until the solution turned clear to pale yellow. In addition to that hydrogen peroxide was also added for accelerating the process of sample oxidation. The clear pale solution was then filtered through Whatman nylon filter 0.45µm and made to the desired concentration using deionised water and stored in plastic bottles until analysed by ICP-MS.

ICP-MS Analysis

Perkin Elmer *Elan 9000* ICP-MS was utilized for the determination of minerals concentration. In order to calibrate the instrument 50ppb, 100ppb, 150ppb, 200ppb, and 250ppb of standard solution were prepared. About 0.1 mL of the solution was diluted with 10 mL of deionised water. The minerals determined include Sodium, Potassium, Magnesium, Iron, Copper, Zinc, Chromium and Manganese, in five rice varieties. Standard operating instructions were followed for the analysis.

Statistical Analysis

Data obtained from the study was analysed SPSS 17. The values indicate an average of three replicates. ANOVA and t-test were used to determine the significant differences among the rice from, varieties of rice and the mineral concentration.

Results and Discussion

The analysis of mineral contents in rice varieties was done using Inductive Coupled Plasma Mass spectrometry (ICP- MS) ELAN 9000 Perkin Elmer. Both macro and micro minerals were determined in five local rice varieties of Sabah. The results from the study are tabulated in **Table 1.**

Table: 1. Mineral Content of Brown and Polished Rice Varieties of Sabah

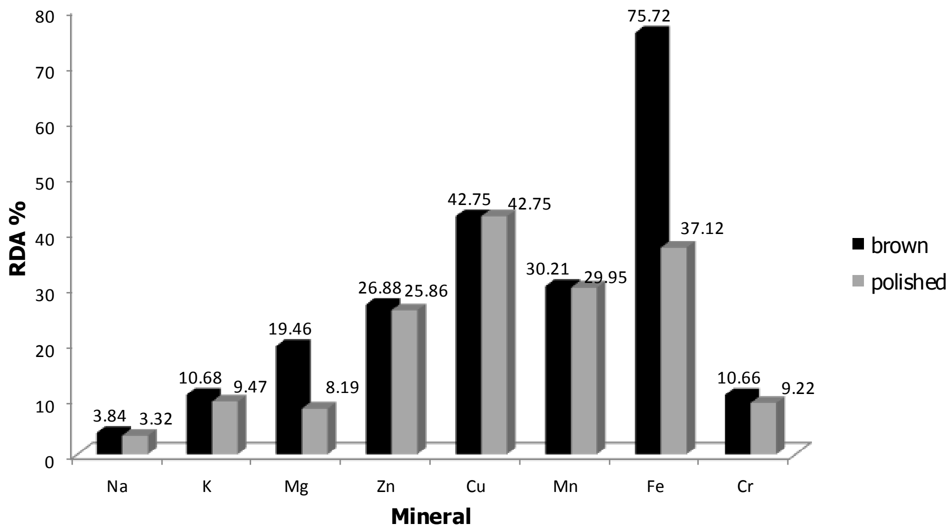
Rice Varieties		**Mineral Contents mg/g †**							
		K	**Mg**	**Na**	**Mn**	**Zn**	**Fe**	**Cr**	**Cu**
TR8	Brown	835.10	256.11	75.72	24.59	13.73	18.47	1.42	0.88
	Polished	266.17	53.85	72.24	7.52	11.84	8.02	1.12	1.13
MR159	Brown	1368.02	273.40	179.57	26.42	13.32	18.93	1.73	1.55
	Polished	264.90	66.58	105.56	2.46	10.68	9.68	1.14	1.14
TQR-1	Brown	734.17	197.32	81.45	22.70	9.76	10.56	1.35	1.92
	Polished	185.73	44.75	58.44	3.06	9.95	15.14	1.25	2.74
TQR-2	Brown	1174.40	232.56	52.53	23.06	9.66	11.67	1.31	0.95
	Polished	302.67	92.44	91.43	2.26	9.35	7.96	1.43	1.16
IR72	Brown	683.34	224.84	61.26	25.33	20.53	13.74	1.48	2.23
	Polished	253.21	43.69	137.61	3.04	13.75	7.52	1.45	1.38

† Values are expressed as a mean of three replicates.

From all the five rice varieties analysed it is found that all of these varieties showed similar trend in the distribution of minerals. This is obvious in the case of potassium which showed higher concentration among the minerals, while copper is the lowest among the all. It was observed that there was a considerable loss of magnesium in the rice varieties due to the removal of bran layer. Of all the five rice varieties MR159 showed the highest concentration of eight minerals analysed. By using the statistical analysis independent samples T –test, a comparison of brown and polished rice varieties showed a significant difference ($p<0.05$). The analysis of ANOVA also showed that the type of rice (brown or polished) and rice varieties possess a significant difference among themselves. However, when both factors are tested together, copper shows no significant difference ($p<0.05$). Overall, the variations observed in different rice samples can generally be attributed to a number of factors such as varietal differences, soil composition, geo-graphical location, environmental factors, agricultural chemicals, postharvest processing, and the quality of trace element analysis. In general, the values obtained for the rice samples from this study are either lower than or consistent with general values published for food plants. (Adu-Kwarteng, 2003).

When the concentration of the minerals in these rice varieties were compared to their contribution towards the recommended daily allowance (RDA), it was found that trace minerals such as zinc , copper and iron contributed significantly to the RDA with single portion of rice 128g. **Figure: 1** However, it should be kept in mind that although these rice varieties does contribute, but of course it is not sufficient enough for the consumer daily nutrient intake. Therefore, consumers are advised to eat a balanced diet containing fruits and vegetables and other cereals, containing all the other essential nutrients.

Fig: 1. Contribution of mineral by rice to the RDA by single portion of rice (1 portion= 128g).



The nondestructive analytical technique used, the ICP MS method, proved to be well suited to the assay of rice matrices, even in their normal state, for their trace element content. It is thus adviseable that, an average consumer should try to include brown rice in their diet to fully utilize all the essential minerals and other nutrients. Besides that, researcher can take more effort to fortify or enrich the rice grains that are produced commercially as this will help to fight the deficiencies of some minerals among the local population. The farmers and the government should also take action to produce better varieties other rice varieties. It appears that the rice samples had normal levels of the nutritional (essential) metals usually found for food plants. The total intake of a mineral is not the only issue regarding the nutritional value of a food or diet. Absorption of minerals depends on a number of variables which determine its bioavailability (Welch 2005; Fan *et al.* 2008). Soetan *et al.* (2010) stated that there is a need to do such studies frequently, so as to assess the data on the mineral element composition of human, especially in the developing countries.

Among the trace minerals, Cu, Fe, Mn, and Zn are conidered micronutrients because they are essential for physiological processes in living organisms; therefore, they make significant components of the soil–plant–food components, or the food chain. Considering that microelement malnutrition is recognized as a global nutritional problem has received substantial public attention in the last few decades. Deficiency of micronutrients in soil and rice, and consequently in the diet, leads to "hidden hunger" with serious health-related human health. Therefore, the desirable micronutrient density in major staple foods, such as rice, is an important matter of great concern in agricultural and food sciences. The knowledge on metal concentrations and genetic potential of cultivated and wild cereal species in the uptake of microelements, as well as their transport and storage, may help in breeding and growing high-efficient crops, containing satisfactory amounts of essential metals. Besides this , there is a lot of genetic variability within the major grain cereals – wheat, rice, and maize – which could be exploited in attaining the desired amount of essential trace metals in food, taking into account our specific physiological requirements. Research and development is needed that will enhance not only the yield but also the concentrationand biological value, of micronutrient-rich foods are required to accomplish controlled and sustainable metal content in the food chain.

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