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Elemental Composition of Rice Varieties and Their Importance to Human Health

(Review Paper)

Zohra Tahir[1], Shaista Anjum[1], Ayeesha Masood[1], Tariq Ismial[1]*

[1]Department of Botany University of Balochistan, Quetta-87300, Pakistan

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Corresponding Author, Dr. Tariq Ismail: tariqismail.dr@gmail.com

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Abstract

Rice is one of the most important staple foods for half of the world's population. People consume rice on a daily basis. Rice has been used by humans since 5000 BC. It is believed that rice is originated in Asia. Asian people get 80% of their daily caloric requirements from rice. Rice is cultivated and consumed across the globe for its nutritional health properties. With the growing world population, the demand for food production is also rising. Rice is estimated to be a crucial part of nourishing this increasing world population. At present, people get more than 20% of their calories from rice. Rice is a bulk source of numerous elements such as Nitrogen (N), potassium (K), calcium (Ca), sodium (Na), magnesium (Mg), Phosphorus (P), zinc (Zn), iron (Fe), manganese (Mn), Nickel (Ni), Aluminum (Al), Copper (Cu), Chromium (Cr). Apart from the elements Carbon (C), Hydrogen (H), and Oxygen (O) are the most abundant due to their presence in carbohydrates. Elements are necessary for normal metabolic functions and are essential components of a balanced diet. These mineral elements play a vital role in growth, cellular mechanism, and muscle contraction their deficiency may cause poor growth, osteoporosis, and weight loss. Rice may help to overpower the severity of certain diseases by meeting mineral/elemental deficiencies in the human body. Rice is easily digestible thus, may help in boosting metabolism. Due to its nutritional properties, rice is highly consumed and preferred over other cereals.

Keywords: Rice, World Population, Elemental Composition, Nutritional Properties.

Introduction

Rice (*Oryza sativa*) is one of the most important staple foods in the world and over half of the world's population depends on rice for their diet. The genus Oryza belongs to the tribe Oryzeae, subfamily Oryzoideae in the family Gramineae (Zhuang *et al.*, 1999). This genus is divided into four species, including the *Oryza sativa, Oryza officialis, Oryza granulate,*

and *Oryza ridely* species (Sweeney & McCouch, 2007). Rice is a staple food for half of the population in world. Rice is a nutritious cereal grain that possesses extraordinary dietary requirements. Rice is one of the major food grain crops in the world. It is easily digestible. Rice is mainly consumed as a whole kernel but it can also serve as the base material for a wide variety of applications. Brown rice contains more calories than polished white rice. Rice is free of gluten and cholesterol and contains traces of fat. The quality of rice grain not only depends on the variety, but it also depends on the crop production environment, harvesting, processing, and milling systems. Consumers judge the quality of rice on the basis of the size and shape of the rice grain (Shabbir et al., 2008).

Rice Grain

Rice grain develops after the processes of pollination and fertilization. The dehulled rice grain is known as brown rice as brownish pericarp covers it. The pericarp is the outermost layer of the grain and is removed when rice is milled and polished. The rice grain consists of 75-80 % starch, 12 % water and 7 % protein. Before marketing, whole rice is milled. The process of milling produces four fractions: brown rice, hull, white rice, and bran. Each of these fractions can vary in their chemical content according to the variety of rice and the type of milling performed (Oko *et al.*, 2012).

Aroma of Rice

Rice can be classified on the basis of aroma as aromatic and non-aromatic rice. Aromatic rice produces a special aroma during cooking. Many aromatic and non-aromatic rice varieties are grown. The aromatic rice varieties are sold at a premium price in local and international markets because of their pleasant aroma. Aroma is rated as the highest desired trait followed by taste and elongation after cooking by most consumers (Verma and Srivastav, 2017).

Rice Production in the World

Rice is the most widely grown crop and is the staple food of 3.5 billion globally (Muthayya *et al.*, 2014). It is reported that in 2013, the total rice production was 741 million tons, with 91% from Asia (Lin & Fukushima, 2016). Rice consumption and production are among the highest in Asian populations. Seventeen countries in Asia, nine countries in North and South America, and eight countries in Africa depend on rice for their food. Rice provides 20% of the world's dietary energy, whereas wheat and maize supply 19% and 5% respectively (Gadal *et al.*, 2019).

Rice provides caloric supply to 520 million people living in poverty in Asia. Leading rice-producing countries are located in tropical monsoon Asia, such as India, Indonesia, and

Thailand. These countries grow rice two or three times a year, due to high temperatures and abundant water. In Sub-Saharan Africa, rice consumption has steadily grown among urban dwellers and rice consumption has doubled since 1970. In Latin American countries rice intake has been reported to be increased by 40% in the last two decades. Rice is of special nutritional importance for the nutrition of large populations in Asia, Africa and so in Latin America (Muthayya *et al.*, 2014; Lin & Fukushima, 2016; Gadal *et al.*, 2019).

It is expected that by 2035 the demand for rice production will rise (FAO, 2017). By 2035 the rice requirement will increase by about 555 million tons. According to this report, the Asian and African countries will continue the growth and consumption of rice in the coming years. China tops the list of top ten rice-producing countries with a production of 145,500 million tons annually. India takes the second position as it produces 103,500 million tons. Bangladesh, Indonesia, and Vietnam are among the top five rice-producing countries. Brazil is in 9th position with 8,000 million tons of rice followed by Japan which produces 7,900 million tons (Gadar *et al.*, 2019).

Rice Production in Pakistan and Balochistan

Pakistan is a country where agriculture is the main economic sector that supports 45% of the country's workers, adds 21% to the country's GDP (Gross domestic product), and contributes almost 60% to the country's exports. It is estimated that Pakistan has about 23.4 million hectares under cultivation (Syed *et al.*, 2022). Pakistan produces about 6 million tonnes of rice each year and together with the rest of South Asia, supplies 25% of paddy rice of the world. According to the Pakistan Economic Survey 2016-17, rice was cultivated on 2724 thousand hectares and production was 6849 thousand tonnes. It contributes 0.6% of the GDP and 3.0% value added in agriculture (Kausar & Sharif, 2019). Balochistan is the largest province of Pakistan with respect to area but the smallest in population. In Balochistan, the area under rice production is 5.6%. In Balochistan, rice production during 2019-2020 has shown a positive growth rate of 7.1%, also increase in area of 1.2%, and a rise in yield of 5.8% per annum. The important rice-producing districts of Balochistan are Nasirabad and Jaffarabad (Rice Paddy Policy Analysis 2020-2021) which in 2021 produced 0.29 and 216.43 tonnes of rice (Crops Area and Production District wise 2021-22).

Mineral composition in Rice

Due to its nutritional properties, rice is highly consumed and preferred over other cereals. It is reported that rice contains a sufficient amount of minerals. Minerals are necessary for normal metabolic functions and are essential components in a sufficient and balanced diet. There are two forms of minerals: macro and micro minerals. Macro minerals are minerals that

are needed in large quantities to perform their functions The examples of macro minerals are i.e., calcium, magnesium, potassium, phosphorus, and sulfur. However, the human body also requires micro-minerals including copper, iron, cobalt, manganese, and zinc for its proper functioning. The mineral composition in rice varieties may be affected by the environment and location (Shabbir *et al.,* 2008; Muttagi and Ravindra, 2020).

The mineral composition of different rice varieties from different parts of the world was quantified highlighting the presence of crucial elements in varying amounts depending upon the types of the rice cultivars and collection sites. For instance., five rice varieties were collected from the Ethiopia region and were evaluated for their mineral composition. The results highlighted the presence of K (2645.5µg/g), Mg (1249.43µg/g), Cu (4.08µg/g), Zn (107.2µg/g), Fe (54.42µg/g), and Mn (19.7µg/g) (Tegegne *et al.,* 2020) and identified rice as a good source of elements. They further reported that a large number of diseases that are widely spread in Asia and Africa are due to the deficiency of these nutritious elements in foods and rice may help in reducing the severity of ailments by overpowering nutritional deficiencies in living tissues. They concluded that many local and hybrid rice varieties which are cultivated in different environmental and soil conditions, contained significant amounts of minerals like Mg, Ca, Cu, Fe, Ni, K, Zn, and Mn. These elements play important roles in maintaining metabolism and promoting human health *viz.*, K plays a significant role in cellular mechanisms. Ca plays a vital part in muscle contraction and nerve conduction; its deficiency causes osteoporosis. Whereas, Cu helps in developmental processes and a deficiency of Cu may cause poor growth. Zn plays a main role in growth; its deficiency leads to weight loss and weakened resistance to infections.

In another study conducted by Gee *et al.,* (2019), the mineral contents of three Malaysian white and brown rice varieties were quantified. Their data showed the presence of Al (5.33µg/g), Ca (2.33µg/g), K (8.33µg/g) and Mg (1.33µg/g) in selected rice varieties. The results further deciphered that the selected brown rice varieties showed a relatively higher concentration of quantified elements than the white rice varieties. They concluded that as brown rice is processed and turned into white rice by the removal of bran and germ layers, there may be a reduction in mineral composition along with dietary fiber and other vitamins, etc. Although, Numerous supplements are added to white rice varieties while polishing, still the original brown rice varieties are more nutritious than the processed white rice varieties. Oko and Ugwa, (2011) also determined the mineral composition of five rice varieties collected from Nigeria and their results revealed the presence of many important

elements in selected varieties *viz.*, P (5400µg/g), Na (1700µg/g), Mg (2600µg/g) and Ca (1100µg/g) in Nigerian rice samples.

Apart from cultivated species, the Genus Oryza has many wild species as well, which are distributed worldwide. All cultivated species and their wild ancestors are diploids and are among the species with the AA genome (Vaughan et al., 2008). The formation of cultivated rice from wild rice significantly altered desired traits, such as increased yields and changes in nutrient status (Moner et al., 2018; Zhao et al., 2018). To explore the nutritional benefits of wild rice Surendian *et al*., (2014) conducted a study and quantified mineral contents in wild rice varieties collected from North America.

The wild rice varieties exhibited different mineral elements in varying amounts including Fe (51µg/g), Zn (120µg/g), Ca (250µg/g), Cr (1.4µg/g), Mn (18µg/g) and Na (60µg/g). They stated that wild rice is used in a wide range of food products and is naturally a rich source of starch, protein, minerals, and various antioxidants with low-fat profile. Wild rice is also an excellent source of Fe, Zn, Ca, P, K, and Mg. The Zn composition in wild rice is even greater than in wheat, corn, and oats showing its worth as a supplementary source in mineral deficiencies.

In the Balochistan province of Pakistan, four rice varieties Irri-6, Irri-9, Sharshar, and Dr-83 were evaluated for their mineral composition by Anjum *et al*., (2007). They recorded Cu (9200µg/g), Fe (19400µg/g), Mn (23300µg/g) and Zn (29700µg/g) in those rice samples. They found that rice varieties contain a large quantity of Zn, Mn, and Fe followed by Cu along with carbohydrates, proteins, and dietary fiber. A specific variation exists between the mineral contents of various rice varieties. Among other constituents of rice, the minerals are important for the health of humans. Rice protein is higher in lysine as compared to wheat, sorghum, and corn. Milled rice has a lower fiber content than other cereals, making rice a more suitable food. The carbohydrates and protein content present in rice are sufficient to sustain the energy requirements of a human.

Conclusion

The elemental composition of daily food products is crucial for human health as it provides essential nutrients to maintain a healthy life. Rice is a staple food for half of the population in world. Thus, exploring and understanding the mineral composition of rice varieties is important for assessing their nutritional value while unveiling consistency in mineral content of different varieties may help in maintaining product quality. In this era of food insecurities,

knowledge of the mineral content of rice varieties may allow food producers to market their varieties as more nutritious based on the presence of high mineral content. Furthermore, Dietitians and nutritionists may use data on mineral elements to help individuals plan well-rounded diets. Varieties of Rice with specific mineral profiles can be recommended based on dietary needs. Rice varieties with known elemental profiles may also influence international trade as exporters and importers rely on the mineral content of rice to comply with international standards and regulations related to food safety and quality. It is therefore suggested that rice varieties consumed on a daily basis must be evaluated for their elemental composition as exploring the mineral elements of rice is critical for enhancing nutrition, product quality, and consumer health.

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