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CHEMICAL EVALUATION OF BLAK RICE COMPPARED WITH WHITE AND BROWN RICE

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ABSTRACT

The present work aimed to compare the chemical evaluation of white, brown and black rice. Chemical composition, amylose content and minerals conten (Mg, Na, Zn, Mn, Fe, Ca and K) were determined. The results showed that ash, crude fiber, protein and oil contents had decreased in white rice compared with brown and black rice, whereas the hydrolysable carbohydrate was increased in white rice than brown and black rice. In addition, black rice had lowered content of amylose compared with white and brown rice. White rice was lowered in all minerals and black rice was higher contents of Mg, Zn, Mn, Fe and K. Meanwhile, Na and Ca were higher in brown rice compared with black rice. In conclusion, this study found that brown and black rice are high contents of chemical composition and minerals.
Keywords: White rice, brown rice, black rice, chemical composition, amylose content, minerals content.

INTRODUCTION

Rice is one of the major cereal crops of Egypt. The annual rice production of paddy rice in Egypt amounts to about 6.0million ton Badawi (2000). In addition, rice is the staple food for half of the world's population, and provides 35–59% of the energy consumed by the 3 billion people in Asia. It is a major foodstuff and nutritional source not only in developing countries but also in North America and Europe. Rice also contributes to 69% of proteins consumed in South Asia, 51% in South East Asia Gregorio *et al.* (1999). It is well known that rice grains have layers on their surface such as bran. Brown rice is hulled rice, and white rice means the rice from which bran has been removed from the brown rice by polishing Ogiyama *et al.* (2008). Brown rice is hulled directly from rough rice, consisting of bran layers (6 – 7% of its total weight), embryo (2 – 3 %) and endosperm (about 90%) Lamberts *et al.* (2007), Ohtsubo *et al.* (2005). This is not caused by nutritional deficiency in rice grain itself, but due to it being traditionally eaten in the form of the milled white kernel. Milling of the brown rice to obtain milled rice removes bran layers that are rich in protein, fiber, oil, minerals, vitamins, and other phytochemicals Orthoefer and Eastman (2004), Yokoyama (2004), leading to loss of most of the nutritional components of the rice grain. Numerous studies have shown that the essential phytochemicals in fruits, vegetables and cereal grains, including rice, are significantly associated with reduced risk of developing chronic diseases such as cardiovascular disease, type 2 diabetes, and some cancers Liu (2007), Yawadio *et al.* (2007). A nutritional survey conducted in the Philippines suggested that about 50% of iron intake, even among high-income families, comes from cereals, rice and corn Gregorio *et al.* (1999). Black rice or black rice outer layer fractions significantly reduce serum lipid profiles Ling *et al.*(2002) and atherosclerotic plaque formation in hypercholesterolemic rabbits and in Apo-E deficient mice Ling *et al.* (2001), Xia *et al*.(2003).Thus, this paper reports the chemical composition, amylose content and minerals contents of white, brown and black rice.

MATERIALS AND METHODS

Materials:

Raw rice varieties (Giza 175 (high amylose) and black rice – October 2008) were obtained from Rice Breeding Section, Field Crops Research Institute, Agricultural Research Center, Egypt.

Methods:

Determination of chemical analysis :

The recommended methods of the Association of Official Analytical Chemists *AOAC* (1999) were adopted to determine the levels of crude protein, moisture, ash, oil and crude fiber. Nitrogen content was determined and multiplied by a factor 5.95 to determine the crude protein content. Moisture content was determined by drying the samples at 105°C to a constant weight. Ash was determined by the incineration of 1.0g samples placed in a muffle furnace, maintained at 550°C for 5h. Crude fat was determined by Soxhlet method. Crude fat was obtained by exhaustively extracting 5.0g of each sample in a Soxhlet apparatus using petroleum ether (boiling point range 40-60 °C) as the extracted. Crude fiber, a known weight of the sample (2g), was mixed with ignited asbestos (0.5g) and sulphuric acid (200ml, 1.25%, w/v). The mixture was boiled under a reflux condenser for 30min, filtered through a gooch crucible provided with asbestos mat then thoroughly washed with hot distilled water. The residue and the asbestos were boiled with aqueous sodium hydroxide solution (200ml, 1.25%, w/v) for 30min., then filtered through a gooch crucible as described before. The residue was washed with ethyl alcohol and acetone and dried at 110ºC to constant weight. The content of the gooch crucible was then ignited in an electric muffle at 550ºC to a constant weight. Ash content was determined and subtracted from the weight of treated material to give the fiber content. Total carbohydrates content was estimated by difference of mean values, i.e., 100 – (sum of percentages of moisture, ash, protein, lipids and crude fiber) Barminas *et al.* (1999).

Determination of minerals content:

Total content of Mg, Na, Zn, Mn, Fe, Ca and K were determined in samples as sulphate using the wet ashing method with acid mixture (nitric: perchloric: sulphuric acid) in the ratio of (8: 1: 1) Chapman and Pratt (1978). Mg, Na, Zn, Mn, Fe, Ca and K were determined in the digested solution using atomic absorption (FMD3 Zeiss).

Statistical analysis:

Mean values of data were obtained from triplicate determination. Values expressed are mean ±*SD*. Significance of differences between control and treated samples were evaluated using Duncan's multiple range tests at 5% level.

RESULTS AND DISCUSSION

Chemical composition of white, brown and black rice :

Chemical composition of white, brown and black rice are shown in Table 1. The results showed that ash, crude fiber, protein and oil content were decreased in white rice (0.52, 0.66, 7.54, 0.59%) compare with brown rice (1.66, 1.25, 8.92, 1.10%) and black rice (1.65, 2.80, 9.80, 1.99 %), respectively. On the other hand, the hydrolysable carbohydrate in white rice (79.95%) had higher compared with brown rice (76.59%) and black rice (73.53%). These results are in accordance with those reported by Heinemann *et al*. (2005) they found that more nutrient components such as proteins, lipids, dietary fibers, vitamins and minerals in brown, parboiled brown and parboiled milled than white rice. The protein contents ranged from 5.71% to 7.42%, showing a decreasing trend in milled samples. Food composition tables assessed herein report protein contents for commercial rice from 7.02% to 8.3% for brown rice and 6.3–7.3 for milled rice with small variations in moisture contents Scherz *et al*.(2000), *USDA* (2004),*USP* (2004). Brown rice contains more nutrient components such as proteins, lipids, dietary fibers, vitamins and minerals than white rice Ohtsubo *et al*. (2005). The crude fat content in brown and parboiled brown rice was similar (P40:05) which means value of 2.69% and 2.65%, respectively. Milled samples were not differ significantly among themselves neither (P40:05). As expected, crude fat content was lowered in milled rice than in brown rice due to bran removal. A wide variation in ash contents was observed in milled rice samples from different suppliers, ranging from 0.33 to 0.59/100 g, even though the average value of 0.47/100 g seemed to be similar to the mean value observed in parboiled milled rice of 0.55/100g Heinemann *et al*. (2005). However, El-Hissewy *et al.* (2002) found that the protein content was decreased with milled rice, this is attributed to the removal of the outer layers of the grain during milling that contain same of the total protein content. In addition, most of the crude oil is presented in the outer layers and the embryo of the rice grain. Previous studies focused on the relationship between the nutrient loss and the degree of milling (DOM), and showed that the losses of lipids, proteins, vitamins and minerals accelerated significantly as the DOM increased Lamberts *et al.* (2007) and Rohrer and Siebenmorgen (2004). During the milling process from brown rice to white rice, the losses of proteins Lamberts *et al.* (2007) reached 28.6%.

Table (1) : Chemical composition of white, brown and black rice(on dry weight basis).

Constituents / Samples	Oil	Ash	Protein	Crude fiber	Moisture	Hydrolysable carbohydrates
White Rice	0.59 ±0.03	0.52 ±0.03	7.54 ±0.42	0.66 ±0.4	10.74 ±0.60	79.95 ±4.21
Brown Rice	1.10 ±0.06	1.66 ±0.09	8.92 ±0.52	1.25 ±0.07	10.48 ±0.62	76.59 ±4.03
Black Rice	1.99 ±0.11	1.65 ±0.10	9.80 ±0.54	2.80 ±0.15	10.23 ±0.64	73.53 ±4.33

Values are mean ± *SD*, n = 3

Amylose contents of white, brown and black rice:

The amylose contents of white, brown and black rice are listed in Table 2. The results showed that the amylose content was lowered in black rice (11.01) compared with white rice and brown rice (28.54 and 22.80). A long grain intermediate amylose rice (22-24%) from the current crop year is considered acceptable Kohlwey *et al*. (1995). Optimum amylose content that gave the best expansion ; this optimum increased (from 0 to 29% amylose) with increasing steam pressure (from 0 to 3 kg/cm^2) used for parboiling. Therefore, for each rice variety there was a specific processing condition under which it gave the best expansion. At the same time, the highest overall expansion was given by rice having a combination of 27·5% total amylose and 13·5% hot water-insoluble amylose (dry basis), either parameter alone being insufficient Chinnaswamy and Bhattacharya (1984).

Minerals content of white, brown and black rice:

Samples of white, brown and black rice were subjected to minerals analysis using atomic absorption where magnesium, sodium, zinc, manganese, iron, calcium and potassium were determined.

Table (2): Amylose content of white, brown and black rice.

Samples / Constituent	White Rice	Brown Rice	Black Rice
Amylose	28.54±1.49	22.80±1.27	11.01±0.58

Values are mean ± SD, n = 3

The results are reported in Table 3 and the results showed that the all minerals (Mg, Na, Zn, Mn, Fe, Ca, K) were lowered in white rice (34.0, 92.5, 35.0, 21.2, 41.0, 264.0 and 97.7mg/ 100g, respectively) compared with brown rice (79.7, 263.6, 51.0, 40.9, 44.0, 385.0 and 102.2mg/ 100g) and black rice (92.3, 110.0, 66.0, 61.4, 89.0, 341.0 and 188.0mg/ 100g) , respectively. However, Na and Ca were higher in brown rice (263.6 and 385.0mg/ 100g) compared with black rice (110.0 and 341.0mg/ 100g). On the other hand, Black rice was higher content of Mg, Zn, Mn, Fe and K compared with brown rice. Fe and Zn in black rice (89.0 and 61.9mg/100g) were higher than in the white (41.0 and 21.1mg/100g) and brown rice (44.0 and 40.9mg/100g), respectively. Our results are in accordance with those reported by Lamberts *et al*.(2007), Ohtsubo *et al*. (2005) reported that brown rice contains more nutrient components such as proteins, lipids, dietary fibers, vitamins and minerals than white rice. Prom *et al*. (2007) reported that milling process resulted in 25 – 84% iron loss from different brown rice cultivars. The present paper evaluates the iron content in different cereal foods (black rice, red rice, sticky rice and millet) and different rice seeds as well as in the milling products, and the iron bioavailability of different forms. The data showed that the iron content in black rice was higher than in the other rice types, and in rice chaff and husk the content is still fairly high. However, the iron content in rice and fine rice, which are the people's main staple food, is fairly low. As to the bioavailability of iron, it is fairly low in vegetable foods, almost at the level of 10% Meng *et al.* (2005). Liang *et al*. (2008) who reported that levels of minerals in rice products can be ranked in decreasing order as follows: rice bran > brown rice > white rice; this is related to their distribution in the rice kernels and the effect of processing. Liang *et al.* (2009) found that Ca, Fe and Zn amounted to 173 ± 1, 28.7 ± 3.8 and 24.5 ± 0.3 in white rice, respectively. Also, they amounted to 284 ± 18, 50.7 ± 9.2 and 34.0 ± 0.4 in brown rice, respectively. The contents of most elements were similar in brown and parboiled brown rice, except for K and P contents, which were higher in brown rice (P40:05). Milled rice had significantly lower contents of K, P and Se (64.0%, 31.48% and 31.58%, respectively) than brown rice. On the other hand, the milling process did not affect some minerals such as Fe, Cu and Zn (P40:05), which display important physiological functions. Parboiled milled rice showed 18% ash enrichment in comparison with milled rice, and higher contents of K and P. Lower contents of Mn, Ca and Zn were observed, even though contents of other nutritionally important elements were basically similar to milled rice. The brown rice analysed showed concentrations of P,Mn and Na lower than those reported in literature, indicating the usefulness of selecting nutritionally promising varieties for commercial production Heinemann *et al*.(2005). During the milling process from brown rice to white rice, the losses of total minerals Lamberts *et al.* (2007) reached 84.7%.

Table (3): Minerals in white, brown and black rice (mg/100g).

Samples / Elements	white rice	brown rice	lack rice
Mg	34.0	79.7	92.3
Na	92.5	263.6	110.0
Zn	35.0	51.0	66.0
Mn	21.2	40.9	61.4
Fe	41.0	44.0	89.0
Ca	264.0	385.0	341.0
K	97.7	102.2	188.3

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التقييم الكيميائي للأرز الأسود مقارنا ًبالأرز الأبيض والبني

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يهدف هذا البحث إلى مقارنة الأرز الأسود بالأرز الأبيض والبني. تم في هذه الدراسة إجراء التقدير الكيميائي وتقدير الأميلوز، كذلك المعادن (Mg, Na, Zn, Mn, Fe, Ca and K). أوضحت النتائج أن الأرز الأبيض ينخفض في محتواة من الرماد، الألياف، البروتين، الزيت مقارنة بالأرز البني والأسود ولكنة يرتفع في محتواة من الكربوهيدراتية الكلية. بالإضافة إلى ذلك وجد أن الأرز الأسود ينخفض في محتوى الأميلوز مقارناً بالأرز الأبيض والبني. أوضحت الدراسة أيضاً أن الأرز الأبيض يحتوي على كمية أقل من المعادن والأرز الأسود يحتوي على أعلى نسبة من Mg, Zn, Mn, Fe and K. بينما الأرز البني يحتوي على نسبة أعلى من Na and Ca مقارنة بالأرز الأسود. أوضحت الدراسة أن الأرز البني والأسود افضل من الأرز الأبيض عند تقيمهم كيميائياً كذلك أعلى في المحتوى من المعادن.

قام بتحكيم البحث

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