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EFFECT OF PARBOILING AND MILLING PROCESSING ON CHEMICAL COMPOSITION, AND SOME NUTRITIONAL VALUES OF TWO RICE VARIETIES

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ABSTRACT

Two rice varieties, Sakha 104 (Japonica) low amylose and IR28 (Indica) high amylose were parboiled to study the effect of parboiling treatment on chemical composition, antinutrition factors and *In vitro* protein digestibility of their brown and white products. The results of this study can be summarized as follows. The paddy rice of raw (IR28) had the highest percentage of broken grains and the lowest percentages of head rice and white rice as compared with (Sakha 104) variety, where parboiling process led to decrease the percentage of broken rice from 15.40 to 1.30% for the (Japonica) Sakha 104 rice variety and from 15.40% to 7.70% for Indica rice variety (IR28). In addition, parboiling process help to increase the head rice and white rice percentages. Furthermore, parboiling led to decrease the percentage of broken rice as well as increase the hardness of rice grains. Parboiling process lowered the percentage of the lipids, fiber and amylose in rice. Whereas, it increased the ash and minerals content in white rice samples. Parboiling process showed a considerable decrease in antinutritional factor. On contrary, the *In vitro* protein digestibility of the different rice samples by such process was increased.

INTRODUCTION

Rice (*Oryza sativa*) is the most important cereal crop in the developing countries and is the staple food of over half the world's population. Rice has the lowest protein content, but its protein quality is the best. Lysine is the limiting amino acid in the three cereals rice, corn and wheat (Sotelo *et al.*, 1994). Compared with milled rice, brown rice has a higher content of protein, minerals and vitamins and a higher lysine content in its protein (Pedersen and Eggum, 1983). Parboiling is a hydrothermal process in which the crystalline from of starch changed into an amorphous one due to the irreversible swelling and fusion of starch. parboiling process helps to decrease the percentages of broken rice, crude protein and crude either extract, where it played an active role to increase the ash content of rice (Abou-Gharbia, 1989). Moreover, the parboiling process helps the various vitamins and nutrients to move from the surface towards the inner position of the kernel, hence increase the nutritive value of rice (FAO, 1993). Antinutritional factors in the rice grain are concentrated in the bran fraction (embryo and aleurone layer). They include phytin (phytate), trypsin inhibitor and Tannin (Juliano, 1985). All the antinutrition factors are proteins and all except phytin (Phytate) are subject to heat denaturation (FAO, 1993). This work was aimed to provide data for the effect of parboiling and milling processing on chemical composition, antinutritional factors and *in vitro* protein digestibility in rice.

MATERIALS AND METHODS

Materials:

Two varieties of rice *Oryza sativa* namely Sakha 104 (short gain Japonica) and IR28 (Long grain Indica) were employed in this study. Rice samples were obtained from the Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh Governorate, Egypt, during the season (2004). Rice samples were collected during the season 2004, transferred to the laboratory of Food Science and Technology Department, Faculty of Agriculture at Kafr El-Sheikh, Tanta University, Egypt.

Methods:

Parboiled rice were prepared by using Sakha 104 and IR28 varieties following the procedure of Singh *et al.* (1999) and modified by boiling the samples at 100°C for 20 minutes, then steaming under pressure (1.5 kg/cm^2) at 121°C for 15 minutes. Parboiled rice was dried in an air oven at 55°C until constant weight was reached. After drying rouch rice was dehulled and milled using stake testing machine. Total milled rice, head rice and broken rice percentage were calculated. Chemical composition of the brown and white rice were evaluated; moisture, protein (N x 5.95), total lipids, ash, fiber and minerals i.e.; P, K, Na, Ca, Cu, Zn, Fe and Mn contents were determined according to the methods of A.O.A.C. (1990). Amylose content was detected by simplified assay method of Juliano (1971).

In vitro protein digestibility of rice was carried out using the enzyme systems of pepsin followed by pancreatin as described by Akeson and Stahman, (1964). Tannin content was determined by using calorimetric method as given in A.O.A.C. (1990). Phytic acid was determined by using the method of Thompson and Erdman (1982) in which ferric chloride was used to precipitate ferric phytate. Phytate phosphorus was calculated from the ratio Fe/P in the ferric phytate as 3.5: 6 (Fe/P). Phytic acid content was determined by assuming the empirical formula $C_6P_5O_{24}H_{18}$. Trypsin inhibitor activity (TIA) was determined by method of Kakade *et al.* (1969) and expressed as the number of units inhibited per gram dry matter. One unit is arbitrarily defined as an increase of 0.01 absorbance unit at 280 mm in 20 min. per 10 ml of reaction mixture.

RESULTS AND DISCUSSION:

Milling output:

The milling output of different rice varieties are listed in Table (1).

Results showed that the hulls percentage of the two rice varieties (Sakha 104 and IR28) were 19.67 and 20.60%, respectively, which decreased after parboiling treatment. The percentage of brown rice were 80.33 and 79.40% for the two studied rice varieties, respectively. Moreover, parboiling treatment caused an increment in previous mentioned percentage. These results are in agreement with those found by Biswas and Juliano (1988), Juliano and Perez (1993) and Gab-Alla (1997).

Table (1):Milling output (%).

Rice variety	Treatment	Hulls	Brown rice	Total milled rice	Head rice	Broken rice
Sakha 104	Raw	19.67	80.33	70.50	65.10	5.40
	Parboiled	18.50	81.50	71.70	70.40	1.30
IR28	Raw	20.60	79.40	61.70	46.30	15.40
	Parboiled	19.85	80.15	67.90	60.20	7.70

Concerning total milled rice of the two tested rice varieties revealed that, samples of Sakha 104 showed an increase in previous mentioned parameters compared with those of IR28, while the percentage of the total milled rice increased as a function of parboiling process. This increment may be related to the adhesion between the outer layer of the grain (aleuron layer) and the endosperm. These results are in the same trend of those reported by Wiset *et al.* (2001).

The percentages of head and broken rice varied according to the length of the rice varieties as Sakha 104 had lower percentage of broken rice than that of Indica rice variety IR28. Parboiling process led to increase the percentage of the head rice regardless to the used rice varieties Sakha 104 and IR28. The head rice percentage increased from 65% to 70.4 for Sakha 104 and from 46.30 to 60.20 for IR28. Remarkable reduction was observed in broken rice percentage upon subjecting the tested rice varieties to parboiling treatment. This may be attributed to the increase in hardness of the rice grain that occurred following parboiling process, which play an active rule for improving the head rice yields and hardness values.

Chemical composition:

The chemical composition of rice varieties which are determining factors for nutritional quality are presented in Table (2). The moisture content of brown rice grain for the two tested rice varieties were higher than those of white rice grain. Apparent also from the same table that, slight decrease was occurred as a function of parboiling treatment in both brown and white rice varieties. These values are in line with those of (Dharmaputra, 1997). Crude protein, fat and ash tended to decrease with the milling for the two tested rice varieties this could be explained by the removal of the caryopsin, coat, aleurone and subaleurone layers. Crude protein content in brown rice Sakha 104 variety had the highest level of crude protein 8.91%, while the lowest value was recorded in parboiling white rice of IR28 variety. Parboiling process caused an increasing in crude protein content of parboiling white rice. On contrast, parboiled brown rice samples seems to show little decrease in their protein content. This could be related to the leaching out that take part of the non protein nitrogen and albumin as reported by (FAO, 1993). Parboiling caused a reduction in the total lipids content in both brown and white rice varieties. These results could be attributed to the effect of parboiling process whereas, the oil of the kernel travel to its surface. Hence, the brown will contain a higher percentage of oil and endosperm in turn will loose its oil (Pomeranz, 1992). Apparent also from the same table that, in contrast, ash content of parboiled brown rice was decreased as a function of parboiling process of milled rice. The increase in ash content of parboiled milled rice may be due to the penetration of the water soluble mineral salts throughout the grain during soaking and steaming process (Singh *et al.*, 1990). These results are in accordance with the findings reported by Ragab *et al.* (1988) and Park *et al.* (2001). Amylose content is considered the single most important characteristic for predicting rice cooking and processing behavior (Zhout *et al.*, 2002). Data presented in Table (2) also indicated that milling was considered one of the major factors that helped to increase the amylose content of rice varieties. Hence, white rice grains of IR28 variety contained the highest amount of amylose content 29.4%.Where parboiled brown rice of Sakha 104 variety had the lowest value 18.8%. On the other hand, parboiling process caused a reduction in amylose content of all samples. Crude fiber percentage for the brown rice was higher than the of white rice variety. Parboiling lead to decrease the percentage of crude fiber for the two studied varieties. These results are in accordance with the findings reported by (Gab-Alla 1997).

Minerals composition:

The ash content of rice varieties was important to some extent, it contained the nutritionally important minerals. Some of which are shown in Table (3). Potassium content was the highest element among all of the determined mineral contents. In addition, brown rice contained the high mineral contents of the tested rice samples. Whereas, parboiling process caused an increasing in most of minerals content of parboiled white rice. On contrast, parboiled brown rice samples seems to show a little decrease in their minerals content. These results are in accordance with those of (Bhattacharya and Ali 1985 and El-Akary 1992) who reported that, mineral migrate from outer layers into endosperm during parboiling treatments.

Antinutritional factors:

The presence of antinutritional factors is one of the major drawbacks limiting the nutritional quality of food (Kakade *et al.*, 1969). A preliminary evaluation of some of these factors in rice was carried out (Table 4). Trypsin inhibitor activity (TIA) values for all rice samples showed differences between brown and white rice and parboiling process effective in inactivating protease inhibitors in rice samples. These results are in agreement with those found by Juliano (1985). Phytic acid has been considered to reduce the availability of mineral elements (Luh, 1980). Milled rice contains much less phytic acid than that of the brown rice. A clear decrease was recorded in

Table (2):Effect of parboiling process on the chemical composition of different varieties of brown and white rice (%).

Rice variety	Treatment	Moisture		Protein		Total lipids		Amylose		Ash		Fiber	
		Un*	P**	Un	P	Un	P	Un	P	Un	P	Un	P
Sakha 104	Brown	12.34	12.07	8.91	8.78	2.82	2.73	19.60	18.80	1.51	1.37	1.31	1.15
	White	11.44	10.64	7.77	7.99	0.84	0.72	20.50	19.70	0.46	0.68	0.55	0.43
IR28	Brown	11.93	11.52	8.25	8.11	2.51	2.38	28.60	27.70	1.12	0.00	1.10	0.90
	White	11.85	11.35	7.17	7.35	0.55	0.41	29.40	28.51	0.37	0.51	0.42	0.31

Un* = Unparaboiled
P** = Parboiled

Table (3):Effect of parboiling process on the minerals composition of different varieties of brown and white rice.

Rice variety	Treatment	%		Mg/100 g													
		P		Na		K		Ca		Cu		Fe		Zn		Mn	
		Un	P	Un	P	Un	P	Un	P	Un	P	Un	P	Un	P	Un	P
Sakha 104	Brown	0.21	0.19	19.20	19.00	182.10	182.10	18.80	18.69	0.61	0.55	1.70	1.40	1.61	1.61	1.10	0.91
	White	0.15	0.22	7.80	8.19	74.30	78.65	11.70	10.10	0.42	0.47	1.40	1.52	0.91	0.87	0.75	0.87
IR28	Brown	0.18	0.15	21.10	21.00	197.50	197.30	23.50	23.40	0.53	0.47	1.50	1.40	1.22	1.20	1.00	0.90
	White	0.12	0.16	7.40	8.10	128.00	141.00	12.50	16.20	0.37	0.42	1.20	1.30	0.82	0.77	0.85	0.93

Un* = uparboiled
P** = Parboiled

Tannins have been claimed to adversely affect the digestibility of dietary protein and to a lesser extent that of available carbohydrate and lipid (Mosely and Griffiths, 1979). Milled rice was found to have a low level of tannin in comparison to brown rice, as ell as parboiling process caused a decrease in tannin content in tested rice.

In vitro enzymatic digestibility of rice proteins:

The digestibility of rice proteins were estimated using a combination digestions of pepsin followed by pancreatin. The results of Table (4) indicated that, casein protein was more digestible than rice proteins. Apparent also from the same table that, protein of white rice samples were more susceptible to the digestion than that of brown rice.

Table (4): Effect of parboiling process on the antinutritional factors of different varieties of brown and white rice.

Rice variety	Treatment	Phytic acid mg/100 g		Tannins mg/100 g		TIA (TIU/g)		*In vitro* protein digestibility (%)	
		Unp	P	Unp	P	Unp	P	Unp	P
Sakha 104	Brown	826	450	400	218	19.50	0.00	63	66
	White	133	65	150	80	8.30	0.00	69	76
IR28	Brown	841	491	440	239	25.20	0.00	61	64
	White	148	81	170	55	10.50	0.00	67	73
Casine		N.D	N.D	N.D	N.D	N.D	N.D	93.5	N.D

N.D = No determined
TIA= Trypsin inhibitor activity

This result may be due to the fact that white rice contain lower fiber and tannin than those of brown rice. However, parboiling process helped to increase the protein digestibility in both brown and white rice samples. This may be due to the denaturation that occurred as a function of subjecting rice proteins to parboiling our findings are coincided with those of (Wu and Inglett, 1974 and Resureccion *et al.,* 1993).

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تاثير علميتى الغلى والتبيض على التركيب الكيماوى والقيمة الغذائية لصنفين من الارز

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أجريت هذه الدراسة بهدف معرفة تأثير عمليتى الغلى والتبيض على التركيب الكيماوى ومضادات التغذية وهضمية البروتين صنفين من الارز سخا ١٠٤ يابانى منخفض الاميلوز و IR28 هندى عالى الاميلوز ، بنى وابيض. تبين ارتفاع نسبة الكسر فى IR28 بالمقارنة بالصنف سخا ١٠٤. عمليه الغلى أدت الى خفض نسبة الكسر من ٥,٤ الى ١,٣% و ١٥,٤ الى ٧,٧% لسخا ١٠٤ و IRCA على التوالى. كذلك إزدادت نسبة الحبوب السليمة للارز البنى والابيض. وصلابة الحبوب وإنخفاض مستوى الليبيدات والالياف والاميلوز وزيادة الرماد والمعادن للارز الابيض. أدت عمليه الغلى ايضا لانخفاض مستوى مضدات التغذية وزيادة هضمية البروتين.