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Chemical composition and physico-chemical properties of Mahsuri Mutant and Basmati rice

(Kandungan kimia dan ciri-ciri fisiko-kimia beras Mahsuri Mutant dan Basmati)

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Abstrak
Kandungan kimia dan ciri fisiko-kimia beras kisar dan beras perang varieti Mahsuri Mutant dan Basmati telah dinilai. Ciri fisiko-kimia yang ditentukan ialah amilosa, suhu penggelatinan dan kekonsistenan gel. Beras kisar Mahsuri Mutant mengandungi 79.71% karbohirat, 8.24% protein, 0.49% lemak dan 0.29% serabut kasar pada lembapan 10.71%. Pada lembapan 10.89%, beras kisar Basmati mengandungi 77.71, 9.84, 0.91 dan 0.29% karbohidrat, protein, lemak dan serabut kasar. Beras perang kedua-dua varieti didapati mengandungi mutu pemakanan yang lebih tinggi daripada beras kisar terutama dalam kandungan lemak, protein, serabut kasar, mineral, tiamina, riboflavin dan niasin. Ciri masakan menunjukkan bahawa beras perang mengambil lebih masa untuk masak dan mempunyai nisbah air penyerapan dan isipadu pengembangan yang rendah.

Abstract
The chemical composition and physico-chemical properties of milled rice and brown rice of Mahsuri Mutant and Basmati varieties were evaluated. The physico-chemical characteristics determined were amylose content, gelatinization temperature and gel consistency. Milled rice of Mahsuri Mutant contained 79.71% carbohydrate, 8.24% protein, 0.49% fat and 0.29% crude fibre at 10.71% moisture content. At a moisture content of 10.89%, Basmati milled brown rice contained 77.71, 9.84, 0.91 and 0.29% of carbohydrate, protein, fat and crude fibre respectively. Brown rice of both varieties had higher nutritional quality than milled rice, particularly with respect to the fat, protein, crude fibre, mineral, thiamin, riboflavin and niacin contents. Cooking properties showed that brown rice took a longer time to cook and had lower values in water uptake and volume expansion ratio.

Introduction

Rice is consumed mainly as whole grain cereal. Generally, it is consumed in the milled form, boiled or steamed, but a limited amount is also being consumed in the form of brown rice. The edible portion of rough rice, the brown rice, consists of about 8% protein, 75% carbohydrate and a small amount of fat, fibre and ash at 14% moisture content.

Starch is the major constituent of rice and is present in the endosperm as compound granules 3–10 μm in size. Protein is the next major constituent and exists in the endosperm as bodies 1–4 μm in size. The non-starchy constituents, particularly

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fat, fibre, minerals and vitamins, are concentrated in the bran layers and germ.

The cooking and processing characteristics of each grain type are determined by specific criteria. These criteria are based on a series of physico-chemical tests, which include amylose content, gelatinization temperature, gel consistency, water uptake capacity and cooking time.

This paper reports on the chemical composition and physico-chemical properties of Mahsuri Mutant, a new locally developed rice variety, and Basmati 370, an imported aromatic variety grown locally. These varieties have quite similar physical characteristics but differ in physico-chemical properties.

Materials and methods

A new locally developed rice variety, Mahsuri Mutant, and an imported aromatic variety grown locally, Basmati 370, were used in this study. Both varieties were obtained from Pulai, Baling, Kedah. Determination of chemical composition and physico-chemical properties were carried out on milled rice and brown rice of both varieties.

Brown rice was obtained by dehusking paddy using a dehusker. Brown rice was milled by a Satake whitener at 8–10% bran removal to produce milled rice. Whole grain brown rice and milled rice were separated from the broken grains using the rice grader.

Cleaned samples were used and ground using a cyclotex sample mill and analysis was carried out in duplicate. Protein, fat, crude fibre, vitamin and mineral were determined using standard methods AOAC (1984). Protein was determined by Kjeldahl nitrogen method using Kjeltec system 1026. Fat was determined by Soxhlex extraction and ashing was done at 620 °C to constant weight. Determination of crude fibre was carried out by Weende method using fibertec system. Carbohydrate was calculated from the difference.

Calcium and iron were analysed using atomic absorption spectrophotometer while potassium and sodium were analysed by flame emission spectrophotometer. Vitamin B1, B2 and niacin were determined by high performance liquid chromatography.

The amylose content of samples was determined according to the simplified assay of Juliano (1972). The gelatinization temperature was estimated from alkali spreading value of 10 rice grains soaked in 15 mL of 1.7% KOH for 23 h at room temperature (Little and Hilder 1958). The gel consistency was determined based on the length of cold horizontal gel in millimetres in a 13 mm x 100 mm test tube according to the method of Cagampang et al. (1973).

The cooking characteristics were determined by boiling the samples in a cylindrical basket (diameter 43.5 mm and length 98 mm) following the small-scale cooking proposed by Sidhu et al. (1975). Water uptake of cooked rice was calculated from the ratio of the weight of cooked rice to that of raw rice. Volume of expansion was estimated from the ratio of the height of the cooked rice to that of raw rice. Total solid was determined from the residues of 10 mL cooking liquid after drying at 110 °C for 2.5 h.

Results and discussion

Chemical composition

The proximate composition of Mahsuri Mutant and Basmati is presented in *Table 1*. Moisture contents of milled rice were 10.71 ± 0.02% for Mahsuri Mutant and 10.89 ± 0.24% for Basmati. As the main component of rice, carbohydrate contents in milled Mahsuri Mutant and Basmati were 79.71% and 77.46% respectively. Carbohydrate in rice is mainly starch and it makes up 75% of the endosperm of rice (Kent 1983). The cooking and eating quality of rice is largely determined by its starch properties, particularly the amylose/amylopectin ratio.

The second major component of rice is protein. The protein content of milled rice is relatively low, which was 8.24 ± 0.08% in

Table 1. Proximate composition of Mahsuri Mutant and Basmati

Composition (% wet-weight basis)	Mahsuri Mutant		Basmati	
	Milled rice	Brown rice	Milled rice	Brown rice
Moisture	10.71 ± 0.02	10.85 ± 0.01	10.89 ± 0.24	10.72 ± 0.16
Protein (N x 5.95)	8.24 ± 0.08	8.78 ± 0.04	9.84 ± 0.03	10.69 ± 0.12
Fat	0.49 ± 0.02	2.37 ± 0.03	0.91 ± 0.04	2.79 ± 0.01
Ash	0.56 ± 0.01	1.47 ± 0.06	0.61 ± 0.01	1.63 ± 0.01
Crude fiber	0.29 ± 0.02	0.96 ± 0.03	0.29 ± 0.01	0.97 ± 0.01
Carbohydrate*	79.64 ± 0.19	75.63 ± 0.01	77.44 ± 0.28	73.20 ± 0.29

Number of samples = 2
*difference calculation

Table 2. Mineral and vitamin contents of Mahsuri Mutant and Basmati

Parameter	Mahsuri Mutant (mg/100 g)		Basmati (mg/100 g)	
	Milled rice	Brown rice	Milled rice	Brown rice
Phosphorus	131.00 ± 0	245.00 ± 0.70	123.00 ± 0.70	281.00 ± 1.41
Potassium	48.00 ± 0	130.00 ± 0	47.00 ± 0.70	133.00 ± 0.01
Sodium	30.00 ± 0	44.00 ± 1.40	27.00 ± 0.01	46.00 ± 0
Calcium	16.00 ± 1.40	35.00 ± 0	18.00 ± 0	28.00 ± 0.10
Iron	1.50 ± 0.07	1.70 ± 0.07	1.40 ± 0	1.80 ± 0
Thiamine	0.19 ± 0.01	0.90 ± 0.01	0.13 ± 0.01	0.33 ± 0.01
Niacin	2.93 ± 0	3.62 ± 0.01	2.39 ± 0.01	4.97 ± 0
Riboflavin	0.12 ± 0.01	0.10 ± 0.01	0.09 ± 0.01	0.13 ± 0.01

Number of samples = 2

Mahsuri Mutant and 9.84 ± 0.03% in Basmati. Brown rice of Mahsuri Mutant and Basmati contained 8.78 ± 0.04% and 10.69 ± 0.12 % protein respectively. Protein content is significantly influenced by variety, environment, crop, season and nitrogen fertilization (Juliano 1972).

It was observed that brown rice of Mahsuri Mutant and Basmati contained 2.37 ± 0.03% and 2.79 ± 0.01% fat respectively while the fat contents in milled rice of Mahsuri Mutant and Basmati were 0.49 ± 0.02% and 0.91 ± 0.04% respectively. These values are low in the milled rice, as much of the fat which is found in the bran and embryo, is lost during milling (Houston and Kohler 1970).

The mineral content of rice may vary due to the influence of the mineral content of the soil and the irrigation water (Juliano 1993). The mineral content of the rice was higher in brown rice than in milled rice (*Table 2*). According to Houston and Kohler (1970), more minerals are present in the aleurone and outer layer of milled kernel than towards the centre, and there is considerable loss of mineral during milling and polishing of rice.

The water-soluble vitamins i.e. thiamine, riboflavin and niacin were higher in the brown rice than in milled rice (*Table 2*). Most of the vitamins are concentrated in the bran fraction. Abrasive or friction milling to remove the pericarp, seed coat, testa, aleurone layer and embryo to yield milled rice results in loss of vitamin (Juliano 1993) .

Physico-chemical properties

Amylose content is the most important characteristic of grain quality of milled rice. The amylose/amylopectin ratio of starch as indexed by the amylose content is the main influence of cooking and eating quality of

Table 3. Physico-chemical properties and cooking characteristics of Mahsuri Mutant and Basmati

Parameter	Mahsuri Mutant		Basmati	
	Milled rice	Brown rice	Milled rice	Brown rice
Amylose (%)	26.1 (high)	20.9 (intermediate)	19.9 (low)	14.6 (low)
Gelatinization temp. (group)	Intermediate	Low	Intermediate	Low
Gel consistency (mm)	34 (hard)	30 (hard)	36 (hard)	29 (hard)
Cooking time (min)	1.50 ± 0	23.30 ± 0	15.00 ± 0	22.20 ± 0
Water uptake ratio	3.74 ± 0.01	2.61 ± 0.05	3.55 ± 0	2.40 ± 0
Volume expansion ratio	4.28 ± 0.08	3.51 ± 0.14	4.50 ± 0.14	3.03 ± 0
Solid loss	0.51 ± 0.01	0.49 ± 0.01	0.62 ± 0	0.26 ± 0

rice. Amylose content may be classified as low (10–20%), intermediate (20–24%) or high (>25%). It was observed that Mahsuri Mutant had a high amylose content, whereas Basmati had a low amylose content (*Table 3*). The amylose content of rice varieties may vary according to the temperature during the grain ripening whereby the amylose content generally decreases as the mean temperature increases (Resurrection et al. 1977). In addition to that, the amylose content of rice is also influenced by the nitrogen fertilization whereby the value decreases slightly with nitrogen fertilization but is not affected by the stage at which nitrogen is applied (Paule 1979).

The gelatinization temperature of rice starch is defined as the temperature at which nearly all the starch granules in a sample lose their birefringence. Gelatinization temperature can be grouped as low (<70 °C), intermediate (70–74 °C) and high (>74 °C). Milled rice of Mahsuri Mutant and Basmati were classified as having intermediate gelatinization temperature as shown in *Table 3.* There is some evidence that the degree of starch crystallinity, the molecular size, the degree of branching of amylopectin fraction and the diffraction intensity of the amylose in rice may have relation to its gelatinization (Juliano 1972).

Gel consistency of rice is an index of cooked rice texture. It is classified as hard (26–40 mm), medium (41–60 mm) and soft (61–100 mm). From the study, it was found that both Mahsuri Mutant and Basmati had a hard gel (*Table 3*). Fat and protein content may have an effect on gel consistency values of rice. The effect of lipids on gel consistency is probably caused by the formation of an amylose-fatty acid complex. The higher lipid content of the outer layer of the rice grain (bran and aleurone) may explain the low values of gel consistency in brown rice and thus the degree of milling is a very important factor affecting gel consistency.

The cooking properties of brown rice differed from that of milled rice (*Table 3*). Brown rice takes a longer time to cook and is lower in water uptake ratio although it requires more water to cook. The volume expansion ratio of brown rice is also lower as it is limited by the layers that enclose the endosperm. Cooking time of rice is directly affected by the gelatinization temperature of starch and the protein content.

Conclusion

The nutrient content of milled rice and brown rice of Mahsuri Mutant and Basmati was determined. Brown rice of both varieties had higher nutrient content than the milled rice. Mahsuri Mutant had a high amylose content with intermediate gelatinization temperature and hard gel consistency while Basmati had the same gelatinization temperature and gel consistency but a low amylose content.

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