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Nutrient Content in Rice Husk Ash of Some Malaysian Rice Varieties

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ABSTRAK

Analisis terhadap 60 sampel bijirin mewakili 10 varieti padi menunjukkan 21.33% kandungan sekam dan 13% abu. Dari segi kandungan nutrien abu sekam, 80.26% terdiri dari silika, 0.38% fosforus, 1.28% kalium, 0.21% magnesium dan 0.56% kalsium. Analisa statistik menunjukkan perbezaan bermakna kandungan nutrien abu sekam diantara varieti. Sebagai bahan yang berpotensi digunakan sebagai sumber baja, jumlah nutrien yang boleh didapati dari penggunaan abu sekam dibincangkan.

ABSTRACT

Analysis performed on more than 60 samples of 10 different paddy varieties showed 21.33% of the rough rice comprised rice husk, while 13% of the husk constituted rice husk ash. The nutrient content of rice husk ash was 80.26% silica, 0.38% phosphorus, 1.28% potassium, 0.21% magnesium and 0.56% calcium. Statistically, nutrient composition is significantly influenced by varietal differences. As a potential material for fertilizer use, the estimates of total nutrient supplementation available from rice husk ash per annum are discussed.

INTRODUCTION

Rice is an agricultural crop that continues to be an important source of food and nutrition in Malaysia. The total area planted with paddy in Peninsular Malaysia is 454 917 ha, which constitutes 61.3% of total paddy plantings in the country (Ministry of Agriculture 1993). Net average rice production in the peninsula amounted to 1 810 222 mt in 1992 (Ministry of Agriculture 1993).

A major derivative of paddy is the husk or hull, a fibrous, non-digestible product that comprises approximately 20% by weight of the rough rice. For the period 1991/92, this amounted to 362 044 mt. The most common use of this residue has been the production of heat energy by burning. Due to its abrasive character, poor nutritive value, low bulk density and high ash content, only a small proportion of rice husks has been utilized for non-energy related low value applications, such as chicken litter, animal roughage (Velupillai 1987), mulching and bedding materials (Hsu and Loh 1980). In many Asian countries, where the bulk of rice is produced and consumed, a major proportion of the husks is transported to open fields for disposal by burning. This practice is now strongly opposed and even prohibited in some countries under environment protection legislation. In general, rice husks are residue from the rice processing industry that costs money to dispose of in a manner that does not harm the environment. One method of turning this liability into an asset is to generate energy from rice husks in a variety of ways. A consequence from these methods is the production of rice husk ash, which is believed to contain various nutrients that enable it to serve as a source of fertilizer.

Rice husk production as a result of milling processes is estimated at 300 000 mt annually. Hence, burning is estimated to produce more than 63 000 mt of ash a year. Based on an estimated content of 1% phosphorus and 1.5% potassium in rice husk ash (Houston 1972), the total phosphorus (P) and potassium (K) which could be obtained exceed 600 mt and 1000 mt p.a. respectively, satisfying the fertilizer requirements of between 20 000 and 48 000 ha of paddy plantings at rates of 30 and 20 kg of P and K per ha respectively.

In the Malaysian context, it would be useful to evaluate the nutritive value of rice husk ash in an effort to create an attractive alternative for the rice processing industry, which could provide a new income source for a rice mill as well as eliminating or greatly reducing space for agricultural wastes. The objectives of this study are to determine the content of various nutrients in rice husk ash and to investigate the influence of rice variety on nutrient content.

MATERIALS AND METHODS

Methodology

Samples, 500 g per variety, of the following varieties: MR 1, MR 27, MR 70, MR 77, MR 82, MR 85, MR 89 and Imp. Mashuri, were obtained from the MARDI Unit, Besut, Trengganu. All samples were selected from uniformly fertilized plants (80 N: 30 P_2O_5: 20 K_2O kg ha^{-1}) and were dried at 70°C for 48 h. Rice husks were separated from the grain using the Satake milling machine, and were accumulated, weighed and stored for analysis.

PREPARATION OF ASH SOLUTION

The method employed was based on Poon (1978) and the Malaysian Standard (SIRIM 1980); 1-g samples of rice husk were heated in a ceramic crucible in a muffle furnace with temperatures increased to 300°C for 1 h and then to 500°C for 10-12 h until the rice husk was transformed into white ash. After cooling, the ash was weighed.

The ash was then moisturized with a few drops of distilled water, mixed with 2 ml concentrated hydrochloric acid, and then dried with periodic heating on a hot plate in a fume chamber at 100-150°C before being mixed with 5 ml nitric acid (20%) and digested on a water bath for 1 h. The mixture was then filtered (using size 2 filter paper) into a volumetric flask. The crucible bowl was washed repeatedly, and the filtrate kept for analysis.

Determination of Nutrient Content in Ash

Silica (Si) was determined gravimetrically using the HCl dehydration method (Willard and Cake 1920; Yoshida 1972). Phosphorus (P) was determined calorimetrically using the vanadomolybdate yellow colour method (Koenig and Johnson 1942) while potassium (K) was determined by flame photometry (Mitchel 1964). Calcium (Ca) and magnesium (Mg) were determined by atomic absorption spectrophotometry method (Wacker *et al.* 1964).

RESULTS AND DISCUSSION

Rice Husk Content in Relation to Varietal Differences

Analysis indicated that percentage of rice husk is significantly influenced by varietal difference at 0.1% level (Table 1). The percentage of rice husk ranged from 23.6% in MR 70 to 20.1% in MR 1. This indicates that different rice varieties produce varying amounts of rice husk.

TABLE 1
Rice husk and rice husk ash content (%) in different varieties

Variety	Rice husk (%)	Rice husk ash (%)
MR 1	20.07[e]	11.83[de]
MR 10	21.58[bc]	12.83[bcde]
MR 27	21.63[bc]	14.00[ab]
MR 70	23.60[a]	13.83[ab]
MR 73	20.97[cd]	14.33[a]
MR 77	21.15[cd]	14.00[ab]
MR 82	20.33[de]	13.33[abc]
MR 85	20.27[de]	12.67[bcde]
MR 89	21.35[c]	11.67[e]
Imp. Mashuri	22.33[b]	12.00[cde]
Mean	21.33	13.05

*Values within columns with the same letter are not significantly different at $p < 0.01$ (DMRT)

Total Ash Produced by Burning of Rice Husk

The percentage of ash produced by different varieties was highly significant at 0.1% level, and ranged from 11.7% in MR 89 to 14.3% in MR 73 (Table 1). This compares with 13.2-29.0% reported by Houston (1972).

Relationship between Variety and Nutrient Content in Rice Husk Ash

For all nutrients, there was a significant difference in the percentage composition among varieties (Table 2). The range in these values was compared with values of Houston (1972) for American varieties (Table 3).

In all varieties, percentage of Si was highest. Rice plants are known as accumulators of Si and can contain up to 10% (DW) in husks. Si impregnates the walls of epidermal and vascular tissues (Kitagishi and Yamane 1981), strengthens plant tissues, reduces water loss and retards fungal infection (Tinker 1981). Values of Si are lower for Malaysian varieties, while American varieties show a greater range for P, K, Mg and Ca.

CONCLUSION

Rice husk, which constitutes 21.33% of paddy weight, becomes a waste material of the milling process. Burning of rice husk produces 13% ash, which contains various nutrient elements.

On average, nutrient composition of rice husk ash was 80.26% Si, 0.38% P, 1.28% K, 0.21% Mg and 0.56% Ca. Statistically, differences in the percentages

TABLE 2
Nutrient content of rice husk ash in different rice varieties

Variety	Nutrient (%)				
	Si	P	K	Mg	Ca
MR 1	81.47[abcd]	0.43[abc]	1.33[cd]	0.30[a]	0.71[a]
MR 10	74.70[bcd]	0.36[bcde]	1.39[bc]	0.17[bc]	0.57[abcd]
MR 27	85.67[a]	0.36[bcde]	1.26[de]	0.12[c]	0.56[bcd]
MR 70	84.72[ab]	0.41[abcd]	1.50[a]	0.17[bc]	0.35[e]
MR 73	82.35[abc]	0.34[cde]	0.88[f]	0.20[b]	0.50[cd]
MR 77	88.52[a]	0.32[e]	1.03[e]	0.21[b]	0.49[cd]
MR 82	77.85[abcd]	0.33[de]	1.15[e]	0.20[b]	0.50[cd]
MR 85	71.43[d]	0.38[abcd]	1.34[bcd]	0.22[b]	0.67[ab]
MR 89	82.02[abc]	0.46[a]	1.42[abc]	0.29[a]	0.62[abc]
I. Mash	73.82[cd]	0.44[ab]	1.46[ab]	0.21[b]	0.60[abc]

*Values within columns with the same letter are not significantly different at $p < 0.01$ (DMRT).

TABLE 3
Range of percentage composition of nutrients

Nutrient	Malaysian varieties	American varieties[1]
Si	71.43–88.52	91.1–97.0
P	0.32–0.46	0.1–1.3
K	0.87–1.50	0.4–2.5
Mg	0.12–0.30	0.1–1.2
Ca	0.35–0.71	0.2–1.4

([1]Source: Houston 1972)

of these nutrients were highly significant among the different varieties.

These findings suggest rice husk ash is a potential supplementary fertilizer source, convenient for paddy cultivation. From these results, it is estimated that 35 644 mt silica, 169 mt phosphorus, 568 mt potassium, 93 mt magnesium and 248 mt calcium are available annually from rice husk ash. The use of rice husk ash as a fertilizer would also alleviate the problem of its disposal. However, research on formulating cost-effective methods of producing rice husk ash, without aggravating air pollution, is needed.

REFERENCES

HOUSTON, D.F. 1972. *Rice Chemistry and Technology*. St. Paul, Minnesota: American Association of Cereal Chemists.

HSU, W.H. and B.S. LOH. 1980. *Rice Hulls in Rice Production and Utilization*. Westport, Connecticut: Avi Publishing.

KITAGIHI, K. and I. YAMANE. 1981. *Heavy Metal Pollution in Soils of Japan*. Tokyo: Japan Science Society Press, p. 302-308.

KOENIG, D. and P.P. JOHNSON. 1942. Determination of phosphorus in biological materials. *Industrial Engineering Chemistry A.E.* **14**: 155.

MINISTRY OF AGRICULTURE. 1993. *Paddy Statistics*. Kuala Lumpur: Planning and Development Division.

MITCHEL, R.L. 1964. Analysis of potassium in solution. *Commonwealth Bureau Soils Technology Communications* **44A**: 193-196.

POON, Y.C. 1978. Method of leaf analysis in Malaysian laboratories. In *Proceedings on Soil and Leaf Analytical Methods: Techniques and Interpretations*. ed. A.M. Mokhtaruddin and H. Aminuddin. Malaysian Society of Soil Science, Universiti Pertanian Malaysia, p. 11-23.

SIRIM. 1980. *Standard 2689: Recommended Methods for Plant Chemical Analysis*. Part I-VIII. Standards and Industrial Research Institute of Malaysia.

TINKER, P.B. 1981. Levels, distributions and chemical forms of trace elements in food plants. *Philosophical Transactions of Royal Society, London* **41**: 294-299.

VELUPILLAI, L. 1987. *Rice Hull Utilization for Energy – Review of The Technologies*. Baltimore: American Society of Agricultural Engineers.

WACKER, W.E.C., C. IDDA and K. FUWA. 1964. Analytical techniques for exchangeable and soluble salts. *Nature, London* 202: 4927-4939.

WILLARD, A.C. and T. CAKE. 1920. Silica: Analysis and determination. *Journal of American Chemical Society* **42**: 2208.

YOSHIDA, S. 1972. *Laboratory Manual for Physiological Studies of Rice*. Los Banos, Philippines.

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