CHEMICAL COMPOSITION OF RICE BRAN AND ITS FRACTIONS AVAILABLE IN MALAYSIA

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ABSTRACT

A total of 12 rice bran samples were collected from different sources and were analyzed for its proximate components, mineral contents and particle sizes. The quality of the rice bran available in Malaysia was found to be reasonably uniform. The dry matter, crude protein, crude fiber and ether extract contents were 92.58%, 12.11%, 7.01 and 16.38%, respectively. The average acid detergent fiber, neutral detergent fiber, lignin and ash contents were 6.56, 16.4 5.13 and 6.98%, respectively. The calcium and phosphorus levels were 0.05 and 1.45%; and Zn, Mn and Cu contents were 32.06 52.97 and 3.58 mg per kg respectively. The whole rice bran was fractionating to obtain the proportion of the particle size. The largest proportion of rice bran was within the particle size 0.15 mm (47.67%), followed by 0.215 mm (35.11%), 0.15 mm (4.11%) and 1.0 mm (3.38%).

Key words: Rice bran, Proximate components, Minerals and particle size

INTRODUCTION

Rice bran (RB), a by-products of rice obtained after milling of brown rice, consists of bran and polishing and includes embryos, inner and outer (true) bran layers, polishing from the starchy endosperm and some broken endosperm with few hulls (Grist, 1965). Bran contains more of the pericarp, tegmen, aleurone layers and embryo than polish, which contains relatively higher starchy endosperm. Bran may vary from 8.8 to 11.5 % of the weight of the brown rice; polish, 1.2 to 2.2% (Houston, 1972). The commercial RB is a mixture of bran and polish. It constitutes about 10% of paddy rice (Farrell, 1994) and is available in large quantities in the major rice producing areas of the world (Houston and Kohler, 1970). In the Far East and South East Asia the annual production is 40-45 million tons (Warren and Farrell, 1990a). Malaysia produces 253,800 metric tons of RB (Alimon, 1993). The RB varies widely in its composition; the variation in the composition is mainly due to the milling system and adulteration of hulls. Houston, (1972) in a review of the RB literature, found that crude protein (CP) values varies from 98-154g, kg^{-1}, lipid 98-154g kg^{-1} and ash 71-206g kg^{-1}. Variation in the composition of Australian RB was reported by Warren and Farrell (1990a), Indian RB by Zombade *et al.*, (1983) and Indonesian RB by Tangendjaja and Lowry, (1985). The wide range of variation in the composition of RB is due to the milling process and adulteration of hulls. In parts of Asia the bran and the bran hull mixture from a single-pass mill often classed as RB and in USA some hulls may also be included in the bran (Warren and Farrell 1990a). Because of difference in the milling of RB and adulteration with hulls, it is very difficult to provide reliable analytical data. The apparent variability in the chemical composition of RB often makes it confusing to use as an animal feed. Therefore the purpose of this work was to examine the chemical composition of the RB available in Malaysia for optimum utilization.

MATERIALS AND METHODS

A total of twelve RB samples were collected from five different times supplied by the local feed supplier who was requested to supply the fresh milled RB. After receiving the RB from the supplier, samples were taken

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and preserved in the freezer. Before chemical analysis the samples were allowed to stand in the room temperature for a 2-3 hours. The dry matter (DM), crude fiber (CF), and ash were determined following the methods of A.O.A.C. (1984). The determination of crude fiber (CF) of the samples were performed according to the method described by AOAC, (1984) and modified using the fibertec (Tecator). Ether extract (EE) or the lipid content was determined either by means of Soxtec System (Soxtec System HT 1043 Tecator) or Soxlet apparatus. For determination of nitrogen and minerals, the wet digestion method was followed. Approximately 0.25g of the sample was taken in the digestion tube and 5 ml concentrated H_2SO_4 was added. The samples were mixed slowly and placed in the heating block. After placing in the heating block the temperature was increased gradually. After appearing a ring like structure on the surface of the tubes, few drops of H_2O_2 (30%) was added. The tubes were allowed to heat for half an hour and H_2O_2 treatment was repeated. The routine was repeated until the contents were clears. The digested samples were allowed to cool and diluted to volume 100ml thoroughly mixed and filtrated. These samples were directly used for determination of the nitrogen and minerals. Nitrogen was determined by using the Kjeltec autoanalyzer 1080. Crude protein was determined by multiplying the nitrogen with the factor 6.25. Phosphorus was determined by using the spectrophotometer at 420 ηm and the Ca Zn, Mn and Cu were determined with atomic absorption flame photometer. The acid detergent fiber (ADF), neutral detergent fiber (NDF), and lignin were determined following the methods of van Soest, 1963; Van Soest and Wine, 1967.

Different particles were separated by fractionation with a mechanical sieve machine. A total of 8 samples were passed through a series of sieves with 2.0, 1.0, 0.50, 0.215 and 0.15-mm mash screen for 10 minutes. The samples were sieved in duplicate and the average values were taken and expressed as percentage. These samples were also analyzed for proximate components, ADF, NDF, lignin and minerals following the same procedure discussed above.

RESULTS

The chemical composition of the RB samples is presented in (Table 1). The average DM, CP, EE and ash contents of the whole RB samples were 92.58, 12.11, 6.53 and 7.15%, respectively. The DM, CP, EE and ash values were closer than those were observed in the CF content. The CF values were 4.38-8.59%. The average ADF, NDF and lignin values were 6.15, 16.4 and 5.13%, respectively and the corresponding ranges were 4.42-9.49, 11.11-21.34 and 1.22-6.93 respectively.

The chemical composition of the particle sizes is also presented in (Table 1). The DM, CP, CF, EE, ash, ADF, NDF and lignin contents were 91.74, 11.91, 6.16, 16.99, 6.98, 7.97, 16.93 and 7.34%, respectively. Variation was observed in the CF and lignin content. The DM, CP, CF, EE, ash, and NDF content of the particle size 2.0 mm, were 86.51, 6.64, 0.42, 2.0, 1.0 and 3.63%, respectively. For the size 1.0 mm, the values were 88.44, 7.18, 1.1, 2.98, 1.22, 2.9, 4.84 and 0.8%, for DM, CP, CF, EE, ash, ADF, NDF and lignin respectively. Similarly, for the size 0.05 mm, 91.23, 10.85, 6.6, 16.67, 5.81, 8.27, 14.31 and 7.8%; for the size 0.215 mm, the values were 91.95, 13.26, 7.42, 17.96, 7.78, 8.14, 19.71, and 5.95%; and, for the size 0.15 mm, 92.05, 12.85, 4.4, 16.36, 7.36, 7.6, 12.09 and 0.66% respectively

The mineral contents of the whole RB and the particle sizes are presented in (Table 2). The calcium and phosphorus contents were 0.05 and 1.45%, respectively for the RB samples. On the other hand the zinc, manganese and copper content of whole RB were 32.06, 52.97 and 3.58 $mgkg^{-1}$ respectively. The mineral contents of different particle sizes were 1.29%, 33.73, 25.03 and 4.11 $mgkg^{-1}$ for P, Zn, Mn and Cu respectively. Variation was observed in the P and Mn content of different particles with a range of 1.26- 1.79; 29.3- 36.34; 46.76-61.64 and 15.49-43.89 respectively. The range was wider for copper (Table 2).

Table 1. Chemical composition of whole rice bran and its fractions

Sample	DM	Crude Protein	Crude Fibre	Ether Extract	Total Ash	ADF	NDF	Lignin
1	91.79	11.47	6.41	15.89	6.54	7.41	15.51	6.93
2	91.95	11.86	6.29	15.22	6.71	7.48	16.54	4.35
3	91.84	11.87	6.01	14.59	6.77	6.92	16.03	1.22
4	91.58	11.91	8.59	15.63	6.51	6.92	16.46	3.89
5	91.18	11.92	6.06	15.80	6.35	5.04	11.35	-
6	93.2	11.74	6.05	16.77	6.45	4.98	13.81	5.26
7	93.57	11.98	4.33	17.01	6.69	5.18	11.79	2.63
8	93.31	11.94	5.68	17.19	6.47	5.25	11.1	8.76
9	92.52	12.39	7.11	18.36	8.13	4.42	21.33	-
10	92.55	12.68	7.35	16.21	8.27	9.49	21.34	11.4
11	93.22	12.72	7.51	15.45	8.63	7.14	21.06	3.3
12	92.3	12.95	7.01	17.21	8.32	8.96	20.48	3.58
Mean	92.58	12.11	6.53	16.31	7.15	6.59	16.4	5.13
± Sd	0.69	0.45	1.07	1.10	0.89	1.64	13.93	3.07
Particle								
2.0 mm[a]	86.51	6.64	0.42	2.0	2.95	-	3.63	-
1.0 mm[b]	88.44	7.18	1.1	2.98	1.22	2.9	4.84	0.8
0.5 mm[b]	91.23	10.85	6.60	16.67	5.81	8.27	14.31	7.8
0.215 mm[b]	91.95	13.26	7.42	17.96	7.78	8.14	19.71	5.95
0.15 mm[b]	92.05	12.85	4.40	16.36	7.36	7.6	12.09	0.66
Mean	91.74	11.91	6.16	16.99	6.98	7.97	16.93	7.34
± Sd	0.45	1.54	1.58	0.84	1.03	0.47	4.54	2.32

[a] Mean of four samples; [b] mean of eight samples

The particle size of the whole RB is shown in (Table 3). The fractions were 0.22, 4.33, 13.13, 35.11, 47.67 and 0.38%, for 2.0, 1.0, 0.50, 0.215, 0.15 and <0.15 mm particle size respectively. The corresponding ranges were 0-1.0, 2.6-12.54, 8.11-14.76, 23.21-39.53, 41.79-53.71 and 0.16-0.74%.

DISCUSSION

The DM, CP and EE content of the analyzed samples of whole RB were almost similar. The results are in agreement with Warren and Farrell, (1990a) and Zombade *et al.*, (1983). The lower range of variation in DM, CP and EE (Table 1.) indicate that the RB available in Malaysia is reasonably uniform. Even though there observed variation in the CF content, but the values were comparatively lower than reported by Warren and Farrell, (1990a) and Zombade, *et al.*, (1983). However, the lower CF content is an indication of good quality RB.

Variation was also observed in the DM, CP, CF, EE, and ash content of different particle sizes. The CP, CF, EE and ash content of the particle size 2.0 mm were lowest, which was followed by the particle size 1.0 mm. It was identified that the particle size 2.0 mm, had only whole rice and very few hull. Similarly, the size 1.0 mm, contained mainly broken rice and a few hull. A greater proportion of hull fraction was present in the particle size 0.50 mm (Table 3). The nutrient content of the particle size 0.5 mm, 0.215 mm and 0.15 mm were found to be almost similar to each other. The reason could be due to the presence of whole rice and broken rice. It is evident that variation in the composition among different particle size is due to the proportion of whole rice, broken rice, germs and hull contents in the respective size. It is also clear that the proportion of

Table 2. Mineral contents of rice bran and its fractions

Sample	Mineral content				
	Ca	P (%)	Zn $mgkg^{-1}$	Mn $mgkg^{-1}$	Cu $mgkg^{-1}$
RB 1	.054	1.44	29.3	56.77	3.15
2	.064	1.43	30.3	61.64	4.39
3	.038	1.37	30.9	54.96	3.11
4	.052	1.44	30.4	53.73	2.91
5	.042	1.44	29.6	54.53	4.0
6	.056	1.39	35.2	55.22	1.5
7	.046	1.37	29.8	50.06	3.73
8	.049	1.34	30.18	48.22	3.78
9	.053	1.26	31.17	46.76	3.80
10	.055	1.43	36.09	57.29	4.08
11	.047	1.74	36.34	51.53	3.93
12	.049	1.79	33.68	55.37	3.784
Mean	.05	1.45	32.06	52.97	3.57
± Sd	.007	0.149	2.58	5.04	8.21
Particle					
0.5 mm		0.4938	27.84	20.17	4.79
0.215 mm		1.63	38.32	42.15	4.09
0.15 mm		1.76	34.68	30.73	3.45
Mean		1.29	33.73	25.02	4.09
± Sd		0.69	5.48	20.93	.66

different particle in the whole RB is responsible for the chemical composition as well as the quality of the rice bran. The nutrient obtained in the particle size 2.0 mm was very similar with that of the nutrient content of white rice reported by Juliano, (1985).

The acid detergent fiber (ADF) represents the crude lignin and cellulose fractions of plant material and silica. Warren and Farrell, (1990a) determined the ADF content of the rice bran of different varieties of RB. The ADF content of the analyzed RB was 6.59 with a minimum of 4.42 and maximum of 9.49. However, the ADF content of the RB was reasonably lower than that obtained by Warren and Farrell, (1990a) who got 12.2% ADF in Australian RB. There observed difference in the ADF content of different particle. Due to the presence of white rice and broken rice in the particle size 2.0 and 1.0 mm, the ADF content was lower.

The neutral detergent fiber (NDF) consists mainly of cellulose, hemicellulose and lignin. The NDF value obtained in the RB samples were lower than that obtained by Warren and Farrell (1990a). Likewise with the ADF content, there observed difference in the NDF content of different particles.

Lignin confers chemical and biological strength of cell wall and mechanical strength to the plant. It is highly resistant to the chemical degradation. Strong chemical bound exists between lignin and plant polysaccharides. The lignin content was quite reasonable, even the value was lower than that those of (Warren and Farrell, 1990a). The lignin content of the size 1.0 mm. was higher as it had higher amount hull. The fractionation of whole of RB was performed to determine particle size to ascertain the milling standards. The presence of the large particle is an indication of the milling standard (Warren and Farrell, 1990a). Although the proportion of the particle size >1.0mm was only 0.22%, but there were some variation. However, the obtained value was lower than that of Warren and Farrell, (1990a) who obtained 0.71% for particle size>1.0mm. The particle >1.0mm includes

Table 3. Fractions of different particle size in whole rice bran

Sample	Particle size (%)					
	2.0 mm	1.0 mm	0.5 mm	0.215 mm	0.15 mm	< 0.15 mm
1	0.11	2.60	14.76	37.46	44.91	0.16
2	0.17	3.68	15.10	38.9	44.89	0.33
3	0	12.54	15.66	23.21	41.79	0.23
4	1.00	3.70	8.11	32.72	48.34	0.74
5	0.18	2.38	14.33	37.87	53.71	0.53
6	0.14	2.36	13.86	39.53	44.67	0.43
7	0.12	3.18	12.95	36.12	47.34	0.29
8	0.09	4.24	10.29	34.29	49.94	0.34
Mean	0.22	4.33	13.13	35.11	47.67	0.38
± Sd	0.31	3.38	2.62	5.7	4.11	0.18

the whole and /or brcken rice and the hull. Very little hull was found for the particle > 1.0mm, only whole rice and some broken rice was obtained. In particle size 1.0mm, the major portion was broken rice, which was reflected in the protein contents. It could be concluded that the quality of the RB available in Malaysia is good.

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