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## PREVENTION OF RANCIDITY AND EVALUATION OF ENZYME ACTIVITIES OF FOUR DIFFERENT VARIETIES OF RICE BRAN AND ITS OIL BY HEAT TREATMENT

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### ABSTRACT

Rahman ML, Uddin MM, Khatun S, Jalil MA, Talukder D (2012) Prevention of rancidity and evaluation of enzyme activities of four different varieties of rice bran and its oil by heat treatment. *J. Innov. Dev. Strategy*. 6(2), 39-43.

Four different varieties of rice bran were collected from the automatic rice mills of different parts of Bangladesh and the physico-chemical properties of the bran such as moisture, protein, oil content, free fatty acids (FFA), peroxide and iodine values were observed. Increased FFA of the untreated bran stored at different temperatures (0, 10, 20, 30 and 38°C) was also observed. The samples were then treated at higher temperatures (100 and 110°C) for different time intervals of 1, 3 and 5hrs. After 60 days storage FFA of untreated bran varied from 2.7 to 69.35%, 2.30 to 69.5%, 2.35 to 66.75% and 3.15 to 63.25% in BR 23, BRRI Dhan 27, BRRI Dhan 34 and Rani Salute, respectively. On the other hand, FFA of heat treated bran (100 and 110°C for maximum 5hrs) of the varieties were found to be ranged from 2.45 to 2.5%, 2.3 to 2.45%, 2.25 to 2.50% and 3.0 to 3.15%, respectively.

**Key words:** enzyme, lipase, polyunsaturated, antioxidant, antacid, Free Fatty Acid (FFA)

### INTRODUCTION

Rice bran is a highly nutritious by-product of rice milling industry in Bangladesh. After dehulling paddy the kernel, which is somewhat colored, called unpolished rice. This unpolished rice is passed through a polishing process and produced polished rice. The brownish or yellowish powder with pleasant flavor obtained during the polishing process is called rice bran. This bran, which constitutes about 7-9% of whole grain, is highly nutritious because it is rich in fat, protein, vitamin and minerals (Yokochi 1974). It is a potential source of oil (15-26%) (Raghavendra *et al.* 1965) which is similar to that of other good quality polyunsaturated edible oil and may be used as a healthful food component. Crude rice bran oil contains 2-4% tocoferol, which has nutritional and antacid effect (Luh 2003). De-oiled rice bran is more suitable for feed than raw bran due to higher nutritional value, higher digestibility and better keeping quality (Luh 2003). Rice bran oil has excellent stability because it contains natural antioxidants (Daniel 1951). It contains vitamin B<sub>1</sub> and vitamin A, which prevents beriberi and eye afflictions respectively (Sherman and Smidh, 1932). Hypercholesterolemic individuals who consumed rice bran oil or the tocotrienol-rich fraction from rice bran oil reduced TC (Total Cholesterol) and LDL-C (LDL-Cholesterol) (Rajnarayana *et al.* 2001). Although the rice bran is rich in many valuable nutrients but it has not yet become popular as human food due to the presence of enzyme-Lipase (Ali and Jalil, 2003), which deteriorates the quality of the bran. Lipase rapidly degrades the oil, making the bran rancid and inedible (Kahlon 2009). If lipase activity is not controlled immediately, it will produce a high FFA oil which is not fit for human consumption (Nasirullah *et al.* 1989). The present study is to prevent the degradation of the bran by controlling the action of lipolytic enzymes by heat treatment so that the shelf life of the bran can be improved up to a considerable length of time.

### MATERIALS AND METHODS

The experiment was conducted in Natural Product Research Division, Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratories, Rajshahi, Bangladesh during the month of December, 2009 to November 2010. Four different varieties of rice bran BR 23, BRRI Dhan 27, BRRI Dhan 34 and Rani Salute were collected from Rajshahi and other Northern districts and Khulna region, which are well known and very popular in the respective areas. BR 23, BRRI Dhan 27 and BRRI Dhan 34 varieties were collected from Noor Habib Grain Industries Ltd. Sopura, Rajshahi. Sarkar Rice mills, Rahanpur, Chapai Nababganj and Choudhuri Rice Mills Ltd. Dinajpur respectively and Rani Salute, a flavoured and delicious bran was collected from Ataur Auto Rice Mills Ltd. Khulna.

Rice bran usually contains some undesirable particles such as broken rice, hulls and other foreign matters. So, the bran of each variety was sieved (30mesh) very carefully in order to make the bran clean and fresh. The physico-chemical properties such as moisture (IUPAC 1967), oil (Hussain *et al.* 1995), protein (Lowry *et al.* 1951) iodine value (Williams 1966) and FFA, peroxide value (AOCS 1980) of each variety at different temperatures were determined by the standard methods.

#### *Storage at different temperature*

5 kg fresh bran of each four varieties was packed in four cellophane bags and stored in a temperature controlled refrigerator. After attaining the desired temperature i.e. 0, 10 and 20°C, 30 and 38°C, the FFAs of the bran samples were measured after each 10 days interval up to 60 days.

### ***Heat treatment of bran samples at different temperature***

Four different varieties of rice bran were taken in four different trays. After observing FFAs of the fresh bran at room temperature (30 to 38<sup>0</sup>C), the samples were then heated and the moisture content of the samples were recorded at 100 and 110<sup>0</sup>C in an electric oven with occasional stirring for 1, 3 and 5hrs. After heating, the samples were then taken out from oven and cooled at room temperature. The samples were packed again in cellophane bags and stored in room temperature under identical condition. The samples were then subjected for estimation of protein, oil, % of FFA, peroxide and iodine values and the observation was carried out for 60 days at 10 days intervals.

### **RESULTS AND DISCUSSION**

Physico-chemical characteristics of untreated rice bran stored at room temperature (30-38<sup>0</sup>C) for 60 days were determined by the AOCS methods and the results are depicted in Table1. The percentages of free fatty acid of four different varieties are found to be increased very rapidly in 1<sup>st</sup> 30 days and these are 2.7 to 69.35, 2.30 to 69.50, 2.35 to 66.75 and 3.15 to 63.25 in BR 23, BRRRI Dhan 27, BRRRI Dhan 34 and Rani Salute respectively. The results are in good agreement with the reported results of Maksud *et al.* 1998. They reported that, on storage the non stabilized rice bran is subjected to a rapid deterioration due to the great activity of the hydrolytic enzyme (lypase). It is remarkable to note that the rate of increase of FFAs in next 30 days found to be slower than that of initial 30 days (63.50 to 69.35, 56.90 to 69.50, 56.80 to 66.75 and 51.50 to 63.25) and the result are in good conformity with the United States patent 6245377. The patent reported that studies have repeatedly shown that free fatty acids develop rapidly in untreated rice bran during first few days or week after milling. No significant change in percentage of protein, oil, iodine value and moisture but the changes in peroxide values are remarkable which are 1.50 to 4.50, 1.55 to 5.55, 1.52 to 6.67 and 1.30 to 6.02 among the varieties of BR 23, BRRRI Dhan 27, BRRRI Dhan 34 and Rani Salute respectively.

Table 2 shows the variations in the rate of formation of FFAs at temperatures 0, 10, 20, 30 and 38<sup>0</sup>C of the 4 varieties of rice bran samples. The content of FFAs was initially low but increased rapidly with the rise of temperature. It was observed that in the very initial period of rice bran, which is within the first 12 hrs, the rate of formation of FFAs is around same in all 4 varieties.

At room temperature (30 to 38<sup>0</sup>C) the rate of FFA formation is very high up to 30 days of storage. After this period the rate ceases. At this temperature (30 to 38<sup>0</sup>C) the lipase activity is maximum in all the varieties and the results are in good agreement with the reported result of Haque *et al.* (2005). FFAs attain 69.35, 69.50, 66.75 and 62.50% for BR 23, BRRRI Dhan 27, BRRRI Dhan 34 and Rani Salute respectively after 60 days of storage (Table 2). It is observed that there is maximum rise in FFAs in case of BRRRI Dhan 34 (66.75%) and minimum in case of Rani Salute (62.50%). There are somewhat difference of FFAs were found due to the characteristics of lipases on the different varieties.

In presence of moisture remaining in the bran samples enzymes become active and the enzymetic hydrolysis of the fatty oils started. So, heating the bran at 110<sup>0</sup>C for 5 hrs removed almost all the moisture (Table 3) and arrested the activity of lipase. Variation of moisture content was studied by heating the bran sample for 5 hrs. at 60, 75, 90, 100 and 110<sup>0</sup>C. Table 3 shows that the percentage of moisture at room temperature are 10.28, 10.16, 10.24 and 9.40% and after heating at the temperature 110<sup>0</sup>C are 0.40, 0.35, 4.41 and 0.35 in BR 23, BRRRI Dhan 27, BRRRI Dhan 34 and Rani Salute respectively.

After the heat treatment and determining the moisture the samples were subjected to determine the FFAs periodically. Table 4 indicates that as the heating and duration of heating rises, the rate of formation of FFAs decreases. Heating the bran samples below 100<sup>0</sup>C did not destroy the enzyme (Lypase) but somewhat prevents their activity. The samples were heated for different periods of time (1, 3 and 5hrs) at 100 to 110<sup>0</sup>C the moisture almost removed and thus the activity of lipase became near about zero. Table 4 shows that the FFAs of the samples stored for 60 days and heated for 5 hrs. at 100 to 110<sup>0</sup>C are 2.50, 2.45, 2.52 and 3.15 respectively.

The change in physico-chemical characteristic of treated rice bran of four different varieties (heated at 110<sup>0</sup>C for 5hrs. and 60 days storage) are shown in Table 5. Heat treatment at 110<sup>0</sup>C for 5 hrs. does not affect the protein or oil content of the bran and FFA, iodine and peroxide values also remain in desirable condition which represent good keeping quality of an oil. Above 110<sup>0</sup>C, the bran may become char and some properties may be destroyed. According to the results of Table 4 and 5 it is clear that moisture and lipase are mainly responsible for the rancidity of the rice bran and its oil and their effects are more or less same among the above four varieties.

Table 1. Physico-chemical characteristics of untreated rice bran at room temperature 30-38<sup>0</sup>C

Variety of the bran	Duration of storage days	Characteristics					
		Moisture	Protein	Oil %	FFA	Iodine value	Peroxide value
BR 23	0	10.50	14.50	20.35	2.70	105.15	1.50
	30	11.00	14.30	20.55	63.5	104.00	2.45
	60	11.50	14.25	20.40	69.35	102.00	4.50
BRR1 Dhan 27	0	10.16	15.15	21.25	2.30	105.75	1.55
	30	10.25	15.15	21.15	56.90	105.15	2.90
	60	10.50	14.25	20.50	69.50	104.20	5.50
BRR1 Dhan 34	0	10.24	16.25	17.50	2.35	105.02	1.52
	30	10.25	16.15	17.10	56.80	103.01	4.32
	60	11.00	15.10	17.59	66.75	102.35	6.67
Rani Salute	0	9.40	16.15	17.05	3.15	100.50	1.30
	30	9.50	16.00	16.50	51.50	100.25	4.40
	60	9.25	16.12	16.54	63.25	100.20	6.02

Table 2. Formation of % FFA in rice bran when stored at 0, 10, 20<sup>0</sup>C, 30 and 38<sup>0</sup>C

No of days bran stored	Storage temperature <sup>0</sup> C	Variety of the bran			
		BR 23	BRR1 Dhan 27	BRR1 Dhan 34	Rani Salute
0	0	2.25	2.30	2.35	2.90
10	0	10.50	11.00	8.25	6.50
	10	14.95	16.40	10.55	12.00
	20	22.90	25.00	20.00	16.50
	30	32.50	33.15	27.25	23.35
	38	33.80	37.00	27.90	26.75
20	0	19.00	19.50	13.50	12.15
	10	25.90	26.80	20.55	20.75
	20	43.95	45.50	37.00	32.00
	30	50.15	51.25	46.05	40.50
	38	52.55	54.60	47.10	43.80
30	0	22.95	25.10	19.25	16.95
	10	32.50	36.00	29.10	29.50
	20	55.15	56.90	48.95	45.10
	30	62.10	63.15	54.95	51.50
	38	63.00	64.50	56.80	53.00
40	0	26.50	29.10	22.52	22.25
	10	36.10	38.00	32.40	34.10
	20	60.10	63.20	54.50	53.20
	30	65.50	66.10	58.90	55.75
	38	66.90	67.50	61.20	57.50
50	0	27.90	30.50	23.80	24.95
	10	38.50	39.00	35.25	37.99
	20	64.00	63.40	57.80	56.90
	30	67.50	66.50	62.20	58.50
	38	68.00	68.35	65.10	60.49
60	0	28.90	31.80	25.01	25.50
	10	39.50	40.40	36.75	39.00
	20	64.95	64.50	59.05	59.21
	30	38.10	68.80	63.25	60.75
	38	69.35	69.50	66.75	62.50

Table 3. Moisture content in rice bran at different temperature

Temperature 0°C	Moisture content in different varieties of rice bran			
	BR 23	BRRi Dhan 27	BRRi Dhan 34	Rani Salute
30-38 (room temperature)	10.28	10.16	10.24	9.40
60	8.30	8.10	8.25	7.50
75	6.95	6.25	6.85	6.30
90	3.39	3.32	3.40	3.02
100	0.75	0.72	0.70	0.62
110	0.40	0.35	0.41	0.35

Table 4. Formation of % (Free fatty acid) in rice bran when heated at 100 and 110°C

No. of days bran stored	Heat treatment period hrs.	Varieties of bran							
		BR 23		BRRi Dhan 27		BRRi Dhan 34		Rani Salute	
		100°C	110°C	100°C	110°C	100°C	110°C	100°C	110°C
0	0	2.45	2.48	2.30	2.30	2.25	2.25	3.00	3.00
10	1	14.25	5.10	15.40	5.40	12.70	4.85	12.03	5.67
	3	7.41	3.14	7.91	3.35	7.21	3.25	7.50	3.25
	5	5.20	2.50	5.32	2.45	4.50	2.50	5.11	2.95
20	1	23.10	8.00	23.56	8.15	20.55	7.75	19.10	7.75
	3	12.20	3.50	1.010	3.90	10.25	4.50	10.35	4.20
	5	7.10	2.50	7.15	2.45	7.10	2.50	4.64	3.15
30	1	24.75	8.50	24.70	8.96	24.30	8.38	23.00	8.50
	3	14.50	3.43	16.10	4.50	15.03	3.65	14.20	4.42
	5	7.09	2.50	7.31	2.45	7.05	2.50	6.72	3.15
40	1	28.51	9.52	28.95	9.60	26.44	9.00	25.33	8.77
	3	16.50	3.64	17.01	3.95	16.48	3.76	15.51	4.58
	5	7.17	2.50	7.45	2.45	7.50	2.50	6.93	3.15
50	1	29.90	9.81	29.88	9.85	27.50	9.25	26.46	9.02
	3	17.42	3.59	18.20	4.70	17.21	3.81	16.42	4.71
	5	7.37	2.50	7.57	2.45	7.70	2.50	7.15	3.18
60	1	30.30	9.95	30.58	10.05	28.20	9.35	27.10	9.50
	3	18.10	3.65	18.65	4.80	17.66	3.95	17.15	4.95
	5	7.57	2.50	7.85	2.45	7.70	2.50	7.17	3.15

Table 5. Change in characteristics of treated rice bran and its oil at the temperature 110°C

Variety of the bran	Duration of storage after heat treatment days	Characteristics				
		Protein	Oil %	FFA	Iodine value	Peroxide value
BR 23	0	14.36	20.25	2.55	105.85	1.50
	30	14.35	20.30	2.59	105.25	1.55
	60	14.32	20.25	2.60	105.00	1.55
BRRi Dhan 27	0	15.14	18.45	2.53	105.75	1.55
	30	15.15	18.40	2.55	105.50	1.50
	60	15.12	18.42	2.60	105.50	1.52
BRRi Dhan 34	0	16.25	17.80	2.50	105.02	1.52
	30	16.20	17.75	2.45	105.59	1.59
	60	16.00	17.85	2.50	105.25	1.65
	90	16.10	17.90	2.50	104.85	1.69
Rani Salute	0	16.15	17.05	3.15	150.00	1.30
	30	16.10	17.00	3.15	125.00	1.39
	60	16.05	17.15	3.10	125.00	1.45

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## CONCLUSION

The FFA values of untreated and treated (at 110°C) rice bran in this study showed that the lipase activity of rice bran can be prevented successfully by the heat treatment method. Therefore, it can be concluded that, heating the bran under the above suitable condition and storing it in moisture proof containers would serve to keep the bran in good condition for a considerable length of time (at least 60 days). As a result various kinds of food products can be prepared by using stabilized rice bran.

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