International Research Journal of Pharmaceutical and Applied Sciences (IRJPAS)
Available online at **www.irjpas.com**
Int. Res J Pharm. App Sci., 2013; 3(5):244-248

Research Article

UTILIZATION OF RICE BRAN FOR DEVELOPMENT OF CHAPATTI AND ITS GLYCEMIC RESPONSE IN NIDDM PATIENTS

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Abstract: Diabetes is one of the major chronic diseases in India. Glycemic Index (GI) is a measure of blood glucose raising ability of the available carbohydrate present in the food and an important tool in the management of diabetes. In the present study rice bran, a rich source of carbohydrate and antioxidant was incorporated at 20 percent level in the wheat chapattis. Its nutritive value, sensory evaluation, glycemic index (GI) and glycemic load (GL) were calculated. Total 20 subjects, 16 males and 4 females were selected with average age and BMI of 56.55 ± 6.37 and 26 ± 3.68 respectively. Overall acceptability scores were in acceptable range for controlled chapatti (8.99) and rice bran based chapatti (8.08). The GI of rice bran based chapatti (68.34 ± 11.49) was significantly lower ($p \leq .01$) than controlled chapatti (83.92±9.63). The peak blood glucose was found between 60-90 minutes of reference and both type of chapattis, however the mean blood glucose concentration was found lowest for rice bran chapatti. Results of present study on rice bran can be used for further utilization in the upliftment of nutritional and therapeutic status of diabetic patients.

Keywords: Glycemic Index, glycemic load, rice bran, area under curve and diabetes

INTRODUCTION

Obesity is an important risk factor in contributing to the development of type 2 diabetes and cardiovascular diseases. The risk of developing type 2 diabetes and heart diseases is reduced by the intake of whole-grain diets with high dietary fiber content and low glycemic index (GI) [9]. There has been considerable interest over the past decade in the possibility that diabetic control may be improved by lowering GI of food and increasing the fiber content of the diabetic diet [4, 5,11,14,15]. Research done by Foster-Powell (2002)[7] on GI indicates that even when foods contain the same amount of carbohydrate (i.e., carbohydrate exchanges), there are up to fivefold differences in glycemic impact. In addition, several observational studies have found that the overall GI and GL (GI x g -carbohydrate) of the diet, but not total carbohydrate content, are independently related to the risk of developing type 2 diabetes[15], cardiovascular disease[12], and some cancers[8]. American Diabetes Association acknowledges the use of low-GI foods in reducing postprandial hyperglycemia but asserts that there is insufficient evidence on long-term benefit of low GI foods to recommend their use as a primary strategy[2]. Keeping in view the previous studies, utilization of rice bran was done for the development of a low glycemic index food in type II diabetic patients.

MATERIALS AND METHODS

Procurement and stabilization of Rice bran: Rice bran sample was collected from a rice mill of *Mirzapur* Dist., Uttar Pradesh (U.P.), India. Rice bran stabilization was carried out in microwave oven, following the method of Malekian[13] *et al.* Rice bran (100g) packed in polyethylene microwave - safe bag was heated in a preheated (120°C, 3 min) microwave oven (2450 MHz, output power 550 W), followed by cooling at room temperature overnight. The heating – cooling process was repeated thrice.

Nutritional and chemical composition of rice bran: All determinations were done by following the AOAC (2000) official protocols[1]. The Soxhlet method was used for total fat determination. Crude fiber was obtained after digesting the sample with diluted acid, alkali and alcohol. Moisture was determined from sample weight loss after drying at 105°C until constant weight. Protein content was determined by Lowry's method using Folin-Ciocalteau reagent at 660 nm wavelength. Carbohydrate and energy was calculated by difference method. All samples were analyzed in triplicate and the mean was calculated.

Experimental diets: 50 g glucose in 200ml of water was used as *reference food (R F)*. Chapatti (unleavened flat bread) is a staple food of North India made of wheat flour. This is prepared from dough by rolling on a board and finally roasting is done on both sides. Two test foods (chapatti) were developed with 50g available carbohydrates as test food I and test food II. Whole wheat flour chapatti was standardized and used as *controlled chapatti (Test Food I)* and *rice bran chapatti (Test Food II)* was developed by replacing wheat flour with 17g of rice bran. Sensory evaluation of the *controlled* and *rice bran chapatti* was done with the help of nine point hedonic scale by a panel of seven judges.

Glycemic index calculation of the developed product: Twenty diabetic patients aged between 45 to 65 year were taken from two wards of Varanasi. All the subjects were appraised about the experiment and their consent was taken. Approval of ethical committee was also taken before experimentation. All the subjects were requested to arrive at 6'O clock in the morning after fasting of 10 to 12 hours for three days. The determination of blood sugar was done at different intervals i.e. 0 (fasting) min, 15, 30, 45, 60, 90 and 120 min after feeding reference food (50 g glucose) , controlled chapatti and rice bran based chapatti on three different days. Their blood samples were taken by pricking with the help of softclix lancing device, all the blood samples were inserted into glucometer (Accu Check-Active) and readings for blood glucose were noted.

Computation of Glycemic Index (GI) and Glycemic Load (GL): Changes in blood glucose concentration were calculated separately for each post meal period by using the blood concentration before meal (time 0) as a baseline. Postprandial responses were compared for maximum increase and incremental area under the glucose curves for each food. The protocol used was adopted from that described by Wolever *et al*.[22] and is in line with the procedures recommended by the Food and Agriculture Organization / World Health Organization[6]. Area under curve (AUC) is a parameter used to calculate GI. Glycemic index (GI) and Glycemic load (GL) of a specific serving of each food was calculated using the following formula:

Glycemic index (GI) = AUC of test food /AUC reference food x 100

$$\textbf{Glycemic Load (GL)} = \frac{\textbf{Glycemic Index of food} \times \textbf{carbohydrate eaten (g)}}{\textbf{100}}$$

RESULT AND DISCUSION

The general profile of NIDDM subjects are presented in Table 1. Average age of the NIDDM subjects was 56.55 year and 80 % subjects were male whereas 20 % were females. Average BMI of selected subjects was 26, where 20%, 70% and 10 % subjects were normal, over weight and obese respectively.

Table 1. General profile of NIDDM subjects selected for GI estimation (n=20).

S. No.	Variables			
			N	%
1.	**Age (years)**	45-55 55-65 Average ± SD	8 12 56.55±6.37	40 60
2.	**Gender**	Male Female Total	16 04 20	80 20
3.	**Income group (Thousand / month)**	15-25 25-30 30-50	4 7 9	20 35 45
4.	**BMI**	Normal (18.5-24.9) Over Weight (25-29.9) Obese (>30)	4 14 2	20 70 10
		Average ± SD	26 ±3.68	

Sensory characteristics of the controlled chapatti and rice bran based chapatti are shown in Table 2. The scores for color, texture, flavor and taste differs considerably but the overall acceptability differs slightly and the rice bran based chapatti had acceptable score. Our results are in agreement with Sharma *et al*.[19], who stated that Stabilized full fat rice bran up to 20% level and un-stabilized full fat or stabilized defatted rice bran up to 10% was found suitable in various food products.

Table 2. Mean sensory scores of controlled and rice bran based chapattis.

	Colour	Texture	Flavor and taste	Overall acceptability
Controlled chapatti	8.9 ± 0.07	8.75 ± .043	8.89 ± .017	8.99 ± 0.0
Rice bran based chapati	7.83 ± 0.07	7.70 ± 0.05	7.75 ± 0.125	8.08 ± 0.072

Table 3 shows the ingredients and nutritive value of wheat chapatti (control) and rice bran chapatti. The carbohydrate content in both chapattis was similar (50 ± 1g). Fat and fiber content of rice bran chapatti was higher than control chapatti as rice bran contains higher amount of fiber and since full fatted rice bran was used, the fat and calorie content of rice bran chapatti was also higher.

Figure 1 shows the incremental blood glucose response curves for the glucose, controlled chapatti and rice bran chapatti. Results depict that the subjects being diabetic shows high fasting blood glucose levels for glucose, controlled chapatti and rice bran chapatti. When compared with reference glucose, mean blood glucose level is lower in both controlled chapatti as well as rice bran chapatti at all time intervals. However, the peak value of blood glucose in reference food and both foods was found between 60- 90 min. The similar results were obtained by Urooj and Puttaraj[21]. Results reported by Thondre and Henry[19], showed that the peak blood glucose values were reached at 30 minutes for the reference food glucose and at 45 minutes for chapatti having 0, 2, and 6 g β-glucan. Chapatti with 4g β-glucan showed peak value at 60 minutes. In the case of chapatti with 8 g β-glucan, the peak blood glucose level was reached relatively early at 30 minutes but was maintained almost at the same level until 60 minutes. With all the treatments, the blood glucose levels rapidly dipped after 60 minutes, except for chapatti with 8 g β-glucan where it declined slowly.

Table 3. Nutritive value of control and rice bran based chapatti for GI calculation

Menu	Ingredients	Amount (g)	Fat (g)	Carbohydrate (g)	Fiber (g)	Protein (g)	Energy (Kcal)
Controlled *Chapatti*	Wheat flour	70	1.19	48.5	1.33	8.47	238.7
Tomato Chutney	Tomato Onion Salt	50 5 to taste	0.1 0.05 -	1.8 0.63 -	0.25 0.03 -	0.45 0.9 -	10 2.95 -
Total			**1.29**	**50.93**	**1.61**	**9.82**	**242.65**
Rice bran Based *Chapatti*	Wheat flour Rice bran	56 17	1.02 3.47	41.64 6.59	1.14 1.56	7.26 1.887	204.6 65.22
Tomato Chutney	Tomato Onion Salt	50 5 to taste	0.1 0.05	1.8 0.63	0.25 0.03	0.45 0.9	10 2.95
Total			**4.59**	**50.66**	**2.98**	**10.49**	**282.77**

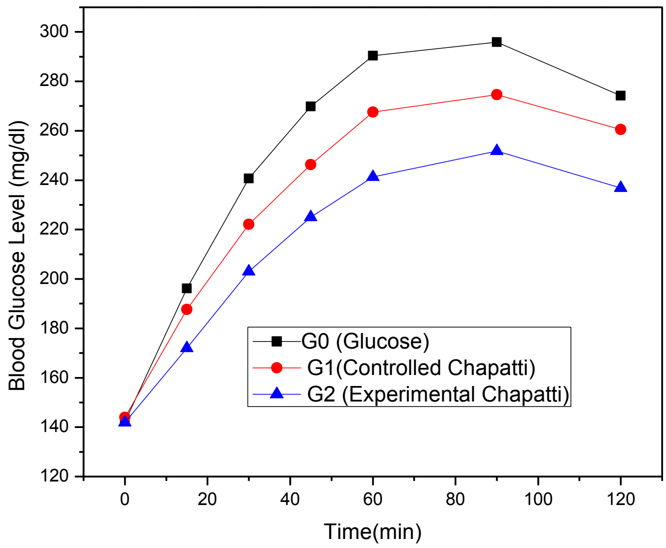

Figure 1. Graphical representation showing mean blood glucose concentration of the reference, control and rice bran based chapatti in diabetic subjects.

Table 4 shows the mean values of AUC, GI and GL of NIDDM patients after consuming control and rice bran chapatti. The mean AUC, GI and GL value of rice bran chapatti were significantly lower in NIDDM subjects when compared to the controlled chapatti. The mean GI of controlled chapatti was significantly (p≥ .01) lower than the rice bran chapatti. Similarly the GL of controlled chapatti was also found significantly lower than control. Bran being higher in fibre could be a contributing factor in lowering the GI. Studies have reported that rice bran fiber concentrate may be responsible for reductions in glucose level in type II diabetic patients[16]. The presence of dietary fiber is correlated with delayed digestion of food with decreased glycemic response. This characteristic is related to the viscosity of soluble fiber[9].

Table 4. Glycemic response of controlled and rice bran based chapattis in NIDDM patients.

Test Food	AUC (mmol/l)	CI	GI	CI	GL
Controlled chapatti (Average ± SD)	108.94 ± 17.64	4.2	83.92 ± 9.63	2.1	41.96 ± 4.81
Rice bran chapatti (Average ± SD)	89.32 ± 20.08	5.0	68.32 ± 11.4	2.3	32.83 ± 5.28
t-value			9.31*		7.16*

CI-Confidence Interval,* significant at ≤ p =.05

Results of Radhika *et al.*[17] gave GI of wheat flour roti and atta mix roti to be 45.1 and 27.3 respectively for 50g carbohydrate composition which is lower than GI reported in present study (68.3). The reason for the difference may be due to the difference in type of subject as healthy subjects were taken by Radhika *et al*[17]., whereas diabetic subjects are taken in the present study. This justification is supported by the results of Urooj and Puttaraj[21] who showed that the GI value of chapatti, when calculated in NIDDM subjects was found 81 whereas in healthy subjects GI was 44.

CONCLUSION

The results of the present study depicts that rice bran can be successfully used for preparation of chapatti as it shows acceptable sensory scores. The rice bran chapatti had lower GI and GL when compared to the controlled (wheat) chapatti; hence it could be incorporated into other Indian food preparations to replace high GI foods. Such foods may be incorporated in the diets of type II diabetic patients for managing their blood glucose level.

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