

# Effect of different cooking methods on glycaemic index of Indian and Pakistani basmati rice varieties

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(Index words: GI, IBR, PBR, rice cooker, microwave)

## Abstract

**Introduction** Glycaemic index (GI) reflects the blood glucose response after ingestion of a 50g digestible carbohydrate portion. Many factors affect the GI, including degree of starch gelatinization.

**Methods** The objective was to determine the GI and the effect of different cooking methods on GI of a Pakistani basmati rice (PBR) and an Indian basmati rice (IBR) frequently purchased by Sri Lankans. This was a cross-over study. Participants were ten healthy individuals aged 20-30 years whose BMI range was 18.5-23.5 kgm<sup>-2</sup>. Proximate composition, [carbohydrate, protein, fat, soluble dietary fibre (SDF), insoluble dietary fibre (IDF) and ash], amylose content and GI of the two rice varieties were determined by using standard methods. Rice was cooked separately in a rice cooker and a microwave by adding 1 cup of rice (110 g) and 1 cup of water (150 ml). Glucose was used as the standard. GI values were expressed as the average value of 10 participants.

**Results** Fat, total dietary fibre (TDF), SDF and IDF contents were significantly ( $p < 0.05$ ) higher in IBR when compared to PBR. The GI values of IBR and PBR cooked in a rice cooker (GI=54 SD=8; GI=64 SD=12) or microwave (GI=43 SD=28; GI=56 SD=12) belonged to low and medium GI categories respectively. A percentage reduction in GI values was seen in PBR (12.5%) and IBR (20.4%) when cooked in a microwave oven compared to a rice cooker.

**Conclusions** Irrespective of the method of cooking PBR had medium GI and IBR had low GI.

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## Introduction

The GI is defined as "the incremental area under the blood glucose response curve of a 50 g digestible carbohydrate portion of a test food expressed as a percent of the response to the same amount of carbohydrate from a standard food taken by the same subject" [1]. Carbohydrates in foods are digested at different rates depending on several factors (amount of carbohydrate, nature of the monosaccharide components and starch, cooking or food

processing and other food components). Thus, foods are categorised into low (55 or less), medium (56-69) and high (70 or above) GI foods [1].

The prevalence of obesity and type 2 diabetes is rapidly increasing in both the developed and developing countries. The prevalence of diabetes in Sri Lankan adults was 10.3% in 2005 and increased to 18.6% by 2011 [3]. The prevalence of obesity in Sri Lankan adults was 9.2% in 2010 [4]. Consumption of more refined, fast release, staple carbohydrate foods is cited as one of the major reasons for the development of obesity and other non-communicable diseases [5]. Thus, selection of foods and dietary modifications are important to prevent or control these conditions.

Rice is the staple food in Sri Lanka contributing to glycaemic carbohydrates and thus to the glycaemic response. Basmati is a rice variety used by Sri Lankans. Though rice is our staple food, data related to GI of some commonly consumed imported basmati varieties are not available. Thus, the present study was conducted to determine the GI and effect of two commonly used cooking methods on GI of two imported basmati varieties available in Sri Lanka.

## Methods

An unstructured interview type market survey was carried out to collect information regarding the consumer purchasing trends and preferences. Following the survey, two basmati rice varieties Indian basmati rice (IBR) and Pakistan basmati rice (PBR) were selected. Rice adequate for the whole GI study (7 kg) was purchased from a retail shop at Battaramulla, Sri Lanka at the beginning of the study.

Two rice varieties were cooked separately in a rice cooker (Panasonic) and microwave (LG) by adding water (1 cup of rice (110 g): 1 cup of water (150 ml)). Portions containing a 50 g digestible carbohydrate of IBR and PBR were 147 g and 151 g respectively. Coconut sambol was prepared using coconut scrapings (150 g), red chili pieces (2 table spoons), onions (50 g), garlic (20 g), salt powder (1 tea spoon) and lime (2 pieces). Coconut sambol 20 g was served with each serving. Length and width of the

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two rice varieties were determined and rice categorised according to their length and shape [6].

Proximate compositions of the cooked rice of two rice varieties were determined by using standard methods. Samples for proximate analyses were prepared by drying cooked rice (40°C- 45°C, electrical oven, 24h, memmert, Germany) followed by milling (25000 RPM, 230V, 50-60 Hz, 300 W IKA<sup>®</sup> A11 basic Brazil).

The moisture and ash contents were measured by AOAC official methods [7,8]. The digestible carbohydrate content, fat and soluble and insoluble dietary fibre contents were determined with Holm's method, Croon and Guchs and by the method of Asp *et al.*, respectively [9,11]. The crude protein was determined by Kjeldahl method [12]. Amylose and amylopectin contents of two rice varieties were determined by Juliano method [13].

GI of the two rice varieties was determined using a standard method [14]. Determination of the GI was carried out as a cross over study. Ten apparently healthy volunteers aged 20-30 years with BMI ranging from 18.5-23.5 kgm<sup>-2</sup> were selected. The participants were asked to refrain from smoking, drinking alcohol and to restrict vigorous physical activity the day before.

Following an overnight fast (10 hours), a finger prick capillary blood sample was obtained. Glucose was used as the standard food (GI=100). The test foods (PBR and IBR) and the standard food were served to the same individual on separate occasions. Each subject was served with test food containing 50g available digestible carbohydrate portions to be consumed within 10-15 minutes with 250 ml drinking water. Glucolin (gsk Glaxo Wellcome Ceylon Ltd, Sri Lanka) that contained dextrose monohydrate was used as the standard. Glucolin 55g corresponding to 50 g available carbohydrate was dissolved in 250 ml water and was consumed by the same individual on a different occasion. Capillary blood samples were collected at 30, 45, 60, 90 and 120 min after the first bite of the meal. The meals were given on two different days to the same participants to allow a wash-out period.

Serum glucose concentrations were determined with a Glucose-Oxidase kit (GOD-PAP/BIOLABO-France). The GI was calculated using the mean of the individual incremental area under the curve of the test food and of the standard food (FAO, 1993). The glycaemic load (GL) values of foods were calculated (GL= GI digestible starch perserving (g)/100).

The data were analysed using the Statistical Package for Social Science (SPSS) Software (version 19) and Microsoft office Excel 2007. Chemical compositions and GI are presented as means and standard deviations. The results were analysed using independent sample t-test.

Approval for the study was obtained from the Ethics Review Committee, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka. Informed

written consent was obtained from all participants prior to the study.

## Results

The colour of the pericarp of both PBR and IBR was white. They belonged to the long grained and had a slender shape [15]. The proximate compositions of the two rice samples are given in table 1. Except for the digestible carbohydrate, ash and moisture, all other nutrients, such as fat, TDF, SDF and IDF were significantly higher in IBR when compared to PBR ( $p < 0.05$ ). Both rice varieties belonged to the high amylose category (IBR-25.5% and PBR-25.1%).

**Table 1. Proximate composition of PBR and IBR of cooked flour (per 100 g dry matter)**

Nutrients in 100 g of rice flour	PBR	IBR
	Mean ± SD	
Moisture (cooked rice)	63.0 ± 0.5	64.0 ± 0.5
Ash	0.6 ± 0.03	0.7 ± 0.03
Digestible carbohydrate	84.3 ± 1.1	81.7 ± 3.0
Protein	9.4	9.9
Fat	1.4 ± 0.13*	1.5 ± 0.06*
TDF	2.9 ± 0.13*	4.0 ± 0.04*
SDF	1.5 ± 0.02*	2.3 ± 0.05*
IDF	1.3 ± 0.13*	1.7 ± 0.05*

n=6 (except for protein, n=2); SD:-Standard Deviation; \*Significant differences at 95% confidence interval.

The mean peak blood glucose concentrations of PBR and IBR cooked in a rice cooker and microwave oven are given in figures 1 and 2. The percentage reduction of peak blood glucose concentration for PBR cooked in a rice cooker was 19% and microwave oven was 20.4% compared to glucose. The peak was at 30 minutes for PBR cooked in the microwave and at 45 minutes when the sample was cooked in a rice cooker (Figure 1). The GI of PBR cooked in rice cooker as well as microwave were in the medium GI category.

The percentage reduction of peak blood glucose concentration for IBR cooked in a rice cooker was 23% and for microwave oven was 24.3% when compared to glucose. However, peak was obtained at 30 minutes for both microwave cooked and rice cooker cooked IBR samples (Figure 2). When considering the IBR, both cooking methods elicited low GI values (Table 2).

Significant differences were observed between the GI values of two rice varieties when using the same cooking method ( $p < 0.05$ ). For each rice variety the GI values did

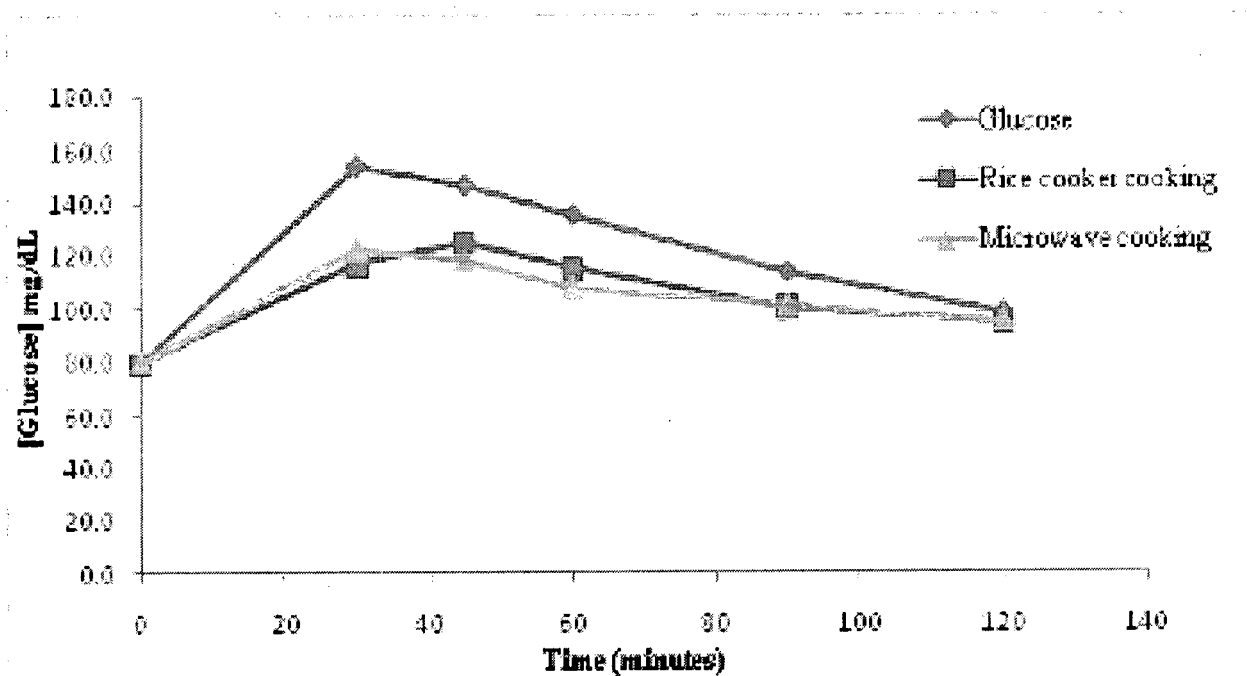


Figure 1. Glycaemic responses of glucose and PBR variety cooked in a rice cooker and microwave oven.

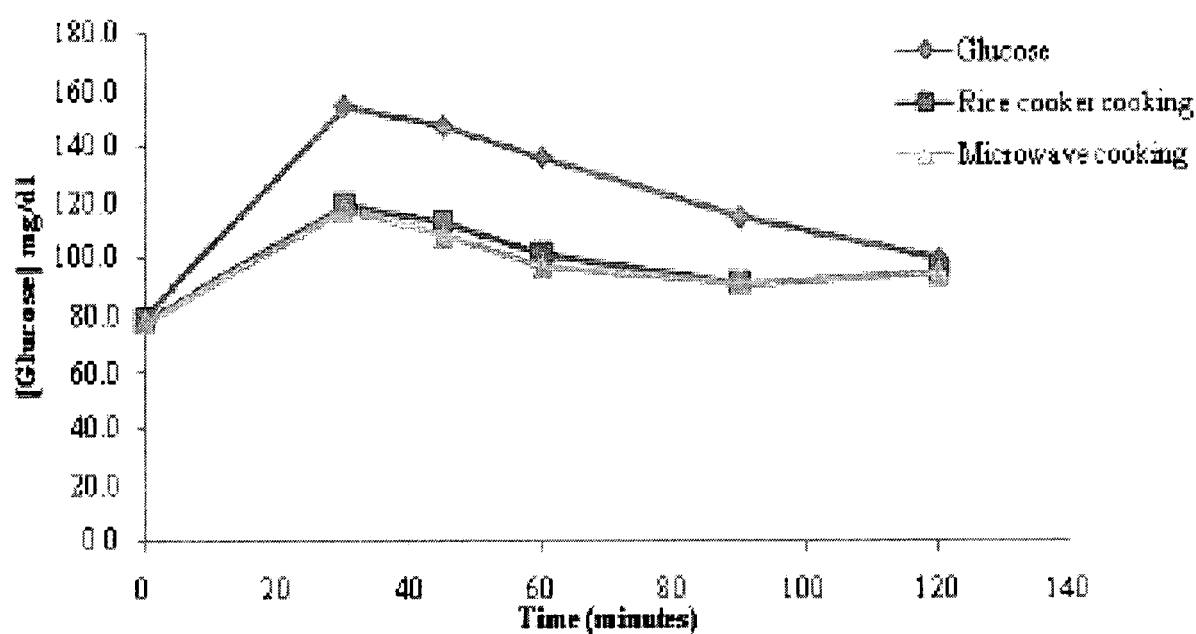


Figure 2. Glycaemic responses of glucose and IBR variety cooked in a rice cooker and microwave oven.

not significantly differ according to the cooking method ( $p>0.05$ ). However, microwave cooking compared to cooking in a rice cooker showed a percentage reduction of 12.5% for PBR and 20.4% for IBR. The glycaemic load (GL) of both rice varieties cooked in the rice cooker and

microwave were in the high GI category ( $>20$ ). However, the GI value of IBR when cooked in a microwave (GL=22) was lower than the others.

### Discussion

**Table 2. Glycaemic indices of PBR and IBR cooked in a rice cooker and a microwave**

	<i>PBR cooked in a rice cooker</i>	<i>PBR cooked in a microwave</i>	<i>IBR cooked in a rice cooker</i>	<i>IBR cooked in a microwave</i>
Mean GI ( $\pm$ SD)	64 $\pm$ 12	56 $\pm$ 14	54 $\pm$ 8	43 $\pm$ 6
Peaking time	45 minutes	30 minutes	30 minutes	30 minutes
Peak reduction (against glucose)	19%	20.4%	23%	24.3%
Reduction in GI compared to rice cooker	-	12.5%	-	20.4%
Glycaemic load	32	28	27	22

\*n=10

Different rice varieties cultivated in different geographical regions may affect the physical and chemical properties of the rice grain which will contribute to different GI values [16]. Different cooking methods also can affect the GI [17]. During cooking, heat and water soften the hard compact starch granules causing these to imbibe water, swell and eventually rupture. As a result of this, individual amylose and amylopectin molecules are released leading to gelatinisation. This makes starch more bio-available for enzymic action leading to increased glucose absorption. Thus, physical-chemical properties of starch and degree of starch gelatinisation influence the glycaemic response and the GI of a food [17].

GI of IBR cooked in a rice cooker and microwave were in the low GI category. It has been reported that the GI of an Indian basmati rice variety cooked in an electric cooker elicited low GI, which is compatible with our data [18]. The GI of the PBR cooked in a rice cooker and microwave were in the medium GI category. The data are comparable with previous findings where the GI of four basmati rice varieties were in the medium GI category [19].

According to available data, red raw (80), white raw (81), red basmati (73) and white basmati (73) elicited high GI while keeri samba (66) belonged to medium GI category [20]. However, parboiled *nadu* (40) available in the Sri Lankan market showed a lower GI compared to IBR and PBR [20]. Thus, among all varieties, IBR and parboiled *nadu* elicited the lowest GI.

Portion sizes containing 50 g digestible carbohydrate of IBR and PBR were 147 g and 151 g respectively. All the female participants reported the portion size to be adequate whereas the males found the portion size to be inadequate. Thus, GL of both rice varieties cooked in the rice cooker and microwave were in the high GL category (>20) when considering the actual portion size consumed.

In this study, rice was given with 20 g of coconut sambol which consists of carbohydrate, protein, fat and dietary fibre (Table 3) [21]. There is a negative relationship for both fat and protein with GI [1]. However, their effect

on GI is not seen unless relatively large quantities of nutrients (about 30 g of protein and 50 g of fat per 50 g carbohydrate portion) are added to a meal [22]. Thus, when considering the present study, effect of nutrients contributed by coconut sambol for GI can be considered negligible. Also the effect of dietary fibre from coconut sambol affected both rice meals evenly.

In conclusion PBR showed medium GI values and IBR showed low GI values when cooked in either a rice cooker or a microwave.

### Conflicts of interest

**Table 3. Nutritional values per 100 g of fresh coconut**

<i>Nutrient</i>	<i>per 100 g</i>
Carbohydrate	15.23 g
Protein	3.3 g
Total Fat	33.49 g
Cholesterol	-
Total dietary fibre	9 g

Data extracted from USDA National Nutrient Database (2013)

We declare that there are no conflicts of interest.

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