# ORIGINAL ARTICLE

# Glycaemic Index (GI) of an Indian Branded Thermally Treated Basmati Rice Variety : A Multi Centric Study

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### Abstract

**Background:** Glycaemic Index (GI) is the classification of carbohydrates based on their ability to raise blood glucose levels and evidence shows that its usage has beneficial health implications. Rice forms a part of the Indian staple diet and one of the major energy contributors. Hence, it is important to establish the Glycaemic Index (GI) value of rice. However, due to availability of different varieties of rice it is important first to identify a lower GI variety and to make it available to the Indian population. Subjecting rice to thermal processing is also known to reduce the GI of rice.

**Objective:** An Indian thermally treated basmati rice variety was hypothesised to be low in GI. This multi centric study was conducted to test this hypothesis in healthy volunteers.

**Study Design:** In this study, out of 83 participants, data points of 70 healthy volunteers were taken into consideration for arriving at the final GI value. The study procedure was similar to the recommendations by FAO/WHO. A multi centric trial was conducted to nullify any regional or genetic variability.

**Results:** It was observed that reference glucose curve had the maximum average peak of 166.37 mg/dL while the basmati sample had a lower peak (136.22 mg/dL). The mean blood glucose incremental area under the curve for reference food was 5969.64 mins.mg/dL (SEM 95.94) and for rice it was 3267.81 mins. mg/dL (SEM 76.21).

**Conclusion:** In this study The GI of Indian branded basmati rice was found to < 55 thus, placing it in lower GI category. The Indian basmati rice because of its lower GI can prove to be a healthier rice alternative.

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# Introduction

A merican Diabetes Association (ADA) lays emphasis on the amount of carbohydrates consumed to optimise glucose control in medical nutrition therapy. However, a large body of evidence exists stating that the source of carbohydrate is also important and should be considered.<sup>1</sup> In order to quantify the variation in rates of absorption of carbohydrates in blood stream and their postprandial blood glucose responses the concept of glycaemic index was developed.

The classification of carbohydrates based on their ability to raise blood glucose was termed as 'Glycaemic Index (GI).<sup>2,3</sup> According to Jenkins *et al*, 1981 Glycaemic Index (GI) can be defined as the incremental area under blood glucose response curve of a 50 g carbohydrate from a reference food (white bread or glucose) taken by the same subject over a specified period of time.<sup>4,5</sup> As per glycaemic index foods are categorised as low (GI value  $\leq$  55), medium (GI value 56-69) or high GI foods ( $\geq$  70).<sup>1</sup>

Recent studies have shown the ability of lower GI meals to help improve glycaemic control in diabetics.<sup>6</sup> Studies in healthy individuals,<sup>7,8</sup> in adults with type 2 diabetes<sup>9</sup> and

in youth with type 1 diabetes<sup>10</sup> have shown that the use of glycaemic index methodology in the selection of carbohydrates can have beneficial implications on blood glucose responses. Low GI foods have also shown to have a positive effect in preventing the prevalence of cardiovascular diseases (CVD).<sup>11,12</sup> The GI concept may thus be of particular benefits to Indians due to high prevalence of impaired glucose tolerance and diabetes.<sup>13</sup>

Rice forms an integral part of the staple diet for more than half of the world's population. Rice and wheat (60-65%) are the main energy providers in Asian diet.<sup>14</sup> The number of total varieties of rice present in India goes in thousands based on their colour, dimensions, smell and nature of starch.<sup>15</sup> Rice varieties can be classified either based on length i.e. long or short grain, based on length/breadth ratio as superfine, fine and coarse and based on texture and amylose content namely; waxy (1-2% amylose), non-waxy (> 2% amylose), very low (2-12% amylose), low (12-20% amylose), intermediate (20-25% amylose) and high amylose (25-33% amylose) varieties.<sup>16</sup>

One of the premium rice varieties consumed in India is Basmati. Basmati is an aromatic rice variety popular because of its long grain and texture.<sup>17</sup>

The GI results of rice have been very variable. White rice has exhibited varied GI from as low as 54 to as high as 121.<sup>18</sup> Basmati even though stated to be a healthier alternative basis GI has shown varied GI results and falls mainly in medium GI category with few studies placing it in low GI category.<sup>19</sup> Hence it becomes difficult to incorporate rice in a therapeutic diet if the specific rice variety is not tested first.<sup>18</sup> Certain processes such as thermal processing are known to lower the GI of the food product and hence, subjecting a particular rice variety to such a process may lower the GI of that rice variety.<sup>20</sup>

In this study a thermally treated branded basmati rice variety was subjected to GI evaluation. As there is paucity of information on the GI of locally available and commonly consumed rice varieties in India this information may be of importance to health practitioners who have the responsibility of advising diets which give controlled glycaemic response.

India is also a culturally and genetically diverse country.<sup>21</sup> Hence, the objective of the trial was to estimate GI of Indian branded basmati rice variety at three different locations in India; North India (Delhi), South India (Bangalore) and West India (Mumbai) to nullify any regional variability.

# Methodology

The study was conducted as per FAO/WHO 1998 methodology.<sup>5</sup> However the subject number was

increased from seven to ninety to ensure greater precision and detect small differences in GI. The study was approved by the Independent ethics committee for west (Mumbai) and by respective Institutional ethics committees for north and south centres; in accordance to Declaration of Helsinki.

#### Subject Population

The subjects were healthy, non diabetic, aged 18 to 45 years, having BMI 18.5 - 22.9 kg/m<sup>2</sup>. Volunteers were excluded if their fasting blood glucose levels were above 100 mg/dL had a family history of diabetes, were on any special diet, had food allergies or were on medications.

Ninety healthy subjects participated i.e. thirty for each centre, out of which eighty three completed the study and seven were lost to follow up. Of the eighty three completed subjects, thirteen were found to be outliers and hence, were not included in the final analysis. Thus, data of seventy subjects was included for arriving at final GI number.

#### Foods

The portion size of the Indian basmati rice sample was calculated such as each serve translates to 50 g of available carbohydrate. The analysis was carried out at an independent laboratory and per serving, pre weighed rice sample pouches were provided to the trial site by Marico Ltd., India. Rice was cooked using electric cooker such as to minimise any variability due to cooking methodology. The cooking method was standardised and rice samples were cooked in separate vessels on per serve basis. Content of each vessel was served to every volunteer. Rice: water ratio was kept constant at 1:1.5. The palatability and likability of the volunteers was taken into consideration. 55.5 g of dextrose (glucose monohydrate powder) was taken as the reference food (Glucon-D® glucose powder, Heinz India Pvt. Ltd., India.). It was prepared by dissolving 200 mL of water.

#### **Study Protocol**

After obtaining the patient's informed consent, a general clinical examination and dietary recall was taken to ensure their participation. Anthropometric measurements were taken in fasting state using standardised techniques. The protocol used to measure GI was as per recommendation of FAO/ WHO.5 On the day prior to the visit, subjects were asked not to smoke or, consume alcohol or to undertake any vigorous activity for 24 h, and not to eat or drink after 21.00 hours on the night before the visit, although water was allowed in moderation. The subjects were requested to consume their usual meal of similar diet and composition the night before each visit session. This was verified by taking a 24 h dietary recall and a brief behavioural questionnaire. Subjects not familiar with blood sampling by finger-

Table 1: Demographic characteristics of the subjects

| No. of Cases | 83              |
|--------------|-----------------|
| Age (yrs.)   |                 |
| Mean         | 26.38           |
| SD           | 5.03            |
| SE           | 0.55            |
| Range        | 18 – 37 yrs     |
| Weight (kg)  |                 |
| Mean         | 59.30           |
| SD           | 7.42            |
| SE           | 0.81            |
| Range        | 44.0 – 74.0 kg. |
| Sex (%)      |                 |
| Male         | 64 (77.1)       |
| Female       | 19 (22.9)       |

pricking (capillary blood sampling) were given a practice session on the day of screening to acquaint them with the procedure to control for the possible effects of anxiety on blood glucose responses.

The reference food was consumed on three occasions and the test food was consumed on one occasion in a random order on separate days. Subjects were given 200 mL of water along with the test/reference food and an extra 200 mL was given during the subsequent 2 hours. Subjects were encouraged to keep physical activity to a minimum during the testing period. Subjects visited the centre in the morning after 10 to 12 hours overnight fast.

Fasting blood samples were obtained by collecting finger-prick capillary blood samples, at -5 min and 0 min before consumption of the test / reference food and the baseline value was taken as the mean of these two values. The subjects were asked to consume the test meal / reference food within 10-12 mins. Further blood samples were obtained at 15, 30, 45, 60, 90 and 120 mins. Capillary blood sample was used because sensitivity of measurement is greater with capillary blood.<sup>5</sup> Blood glucose was measured using glucometer (Accu-Chek<sup>®</sup> Active, Roche Diagnostics GmbH, Mannheim, Germany) which was calibrated using the control solutions.

#### **Calculation of Glycemic Index**

GI values of volunteers were calculated according to the methodology recommended by FAO/WHO.<sup>5</sup> The incremental area under the blood glucose response curves (iAUC) of test and reference foods was calculated geometrically using the trapezoid rule, using the area above baseline (fasting glucose) only. Levels of intra individual variation of the three reference test were assessed by determining CV%. For each subject, a GI value for each test food was calculated by expressing each subject's iAUC after the test food as a percentage of the same subject's mean reference iAUC. The mean of the resulting values was the GI of the food. GI values that were greater than two standard deviations for the mean of the group



Fig. 1 : Blood glucose response curves of reference and test food

were considered to be outliers and were excluded from the data set.

#### **Statistical Analysis**

Statistical analyses were performed with SAS software (version 9.1; SAS institute, Cary, NC, USA). Data are shown as means with their standard errors unless otherwise stated. Analysis of covariance (ANCOVA) was used to test the significance of difference between the three centres before combing their data.

## Results

The mean age group of eighty three volunteers was  $26.38 \pm 5.03$  years and mean weight was observed to be  $59.30 \pm 7.42$  kg. Demographic profile of these volunteers is presented in Table 1. In this study, out of eighty three volunteers, thirteen were considered as outliers. Out of thirteen outliers one showed CV% of more than 30% and twelve volunteers had GI beyond the range of Mean  $\pm 2$  S.D and were not included for stating the final GI.

The blood glucose response curves were plotted wherein blood glucose values (mg/dL) are plotted against time (min) as presented in Figure 1.

It was observed that reference glucose curve had the maximum average peak of 166.37 mg/dL while the basmati sample had a lower peak (136.22 mg/dL).

The mean blood glucose incremental area under the curve for reference food was 5969.64 mins.mg/ dL (SEM 95.94) and for rice it was 3267.81 mins.mg/ dL (SEM 76.21).

After estimation the GI value of the Indian basmati rice was established to be 54.93 (SEM 1.07) and from these results we can conclude that the test food belongs to lower GI category.

## Discussion

This study reports the GI of an Indian basmati rice sample. This information is of great importance as Asian Indians have higher susceptibility to type 2 diabetes, CVD and central obesity. Carbohydrate foods especially rice and wheat form the major sources of energy in Indian diet. Hence, being informed about the GI is also important for population where rice being a staple is consumed in considerable quantities and affects the glycaemic load of the meal.<sup>22</sup>

Different rice varieties cultivated in different geographical regions may exhibit different physicochemical characteristics such as grain morphology, water absorption, cooking time, macronutrients, dietary fibre and amylose content<sup>18,23</sup> and hence may have different GI.<sup>24,25</sup>

Rice has exhibited a wide range of GI values from as low as 54 to as high as 121. The variation in GI depends on region. The GI of the Indian basmati rice sample in this study was found to be 54.93 (SEM 1.07) thus, placing it in low GI category.

Another study carried by Brand -Miller *et al* estimated GI of 12 rice varieties on healthy subjects of which 11 belonged to high GI group and 1 belonged to a moderate GI group. The study suggested that rice whether white, brown or parboiled belonged to high GI category.<sup>18</sup> In another study a short grain rice (*Japonica*) usually sold in Japan was classified as moderate GI food having GI of 68.<sup>26</sup>

A study carried by Henry and his colleagues on commercially available food products in UK tested four basmati rice varieties of which, three samples fell in the medium GI category.<sup>27</sup> The dissimilarities among the published studies and the low GI of the Indian basmati rice found in this trial can be attributed to various reasons such as, the variety of rice used; the amylose content of rice and to the thermal treatment the Indian branded basmati rice used in the trial is subjected to.

High amylose content is known to result in lower GI rice. Studies indicate that the relationship between amylose content and GI could be exponential. The influence of amylose content that is an inherent property of a variety of rice to the GI could be of potential use in the low GI diets.<sup>18</sup> Certain processes such as thermal treatment are also known to lower GI of a product.<sup>20</sup> Parboiled rice is known to elicit lower glycaemic responses (depends on the severity of parboiling) compared to the non-parboiled raw rice<sup>28-30</sup> due to the retrogradation and resistant starch formation.<sup>31</sup> Moreover, lipids are known to complex with amylose and they re-associate readily on cooling of cooked rice and contribute to retrogradation.<sup>32</sup>

The Indian branded basmati rice tested in this study was subjected to thermal treatment at specific time and temperature and this could have been one of the major contributors of low GI of the rice sample.

The Indian branded basmati rice being low in GI can form part of low GI diet and may also reduce the

glycaemic load when incorporated in a meal. Due to high prevalence of diabetes in India,<sup>13</sup> such low GI alternatives can prove to be a healthier option to incorporate in nutritional therapeutic diets.

The present study is unique because it is the first study to the best of our knowledge in which GI of a food was estimated using such high subject number and across three centres in India. In addition the intraindividual variability for repeated tests of references was found to be 10.7% which is much lower than that recorded in other studies.<sup>33</sup>

Low Glycaemic Index (GI) foods are being looked upon as a possible alternative to prevent lifestyle related conditions<sup>34</sup> as well as help the society to maintain a healthy life. Mounting evidence suggests that foods low in GI improve glycaemic control<sup>6</sup> and reduce insulin demand.<sup>14</sup> They also help in prevention of coronary heart diseases,<sup>35</sup> obesity<sup>2</sup> and cardiovascular diseases.<sup>36</sup>

# Conclusion

The Indian branded basmati variety was found to be lower in GI having a GI of < 55. Hence, this rice can prove to be beneficial when incorporated in Indian diets to replace high GI rice alternatives. Selecting these rice alternatives can further reduce the overall glycaemic load of the meal which could impart positive health benefits.

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