Glycemic Index of Selected Indian Rice Varieties

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ABSTRACT

Aims: For prevention and management of type II diabetes among rice eating population, consumption of rice with lower Glycemic Index (GI) is highly desirable as low GI food decreases plasma glucose levels and plasma insulin demand. As there is paucity of information on the GIs of commonly consumed rice varieties in India, the aim of this study was to determine GI of selected five rice varieties, and to find relationship of GI with their cooking and eating quality traits.

Study Design, Place and Duration: In vivo experiment was conducted at PG&RC, PJTS Agricultural University, Hyderabad, India, during March, 2017 to February, 2018. During this period, cooking and eating quality traits of selected rice varieties were determined in ICAR- Indian Institute of Rice Research, Hyderabad, India.

Methodology: GIs were determined by feeding 10 fasted human subjects a fixed portion of foods and subsequently measuring plasma glucose of their blood samples at specific interval of time and GIs were calculated using standard formula. Cooking and eating quality traits were determined using standard procedure.

Results: The estimated GI values were 56.38(SEM 1.57), 59.23(SEM 1.02), 71.73 (SEM 1.75), 87.40 (SEM 1.90), and 94.05 (SEM 1.21), respectively for Sampada, Dhanrasi, DRR Dhan 42, DRR...
1. INTRODUCTION

With a national diabetes prevalence of 10.4%, India is home to the second largest number (77 million) of adults with diabetes worldwide which is expected to reach 101.0 million by 2030 [1]. India needs to implement preventive measures to reduce the burden of diabetes as the annual cost of diabetes care would be very huge. The estimated annual expenditure in 2019 for treatment of diabetic population in India was 7053.2 million USD [1]. The cost of treatment will further increase in future due to escalating cost of treatment, hospitalization and management of complication and increasing number of patients.

The reasons for the increase in the number of diabetic patients have been attributed to changes in diet and physical activity levels wrought by economic development, industrialization, and urbanization [2]. Among dietary factors, the role of dietary carbohydrates, particularly the quantity and quality of the staple cereal, has received widespread attention. Carbohydrate foods, based on glycemic response, foods are categorized as low (GI value ≤ 55), medium (GI value 56-69) or high GI foods (> 70) [3]. Diets high in GI have been shown to increase the risk for chronic diseases like cardiovascular disease and type 2 diabetes because of their impact on blood glucose and insulin levels [4]. In contrast, low GI diets have several health benefits such as decreasing plasma glucose levels, plasma insulin demand, and levels of inflammatory markers [5]. Thus, for prevention and management of diabetes and other related problems, food with a low glycemic index is to be favored.

Rice is the staple food of more than 65% population of India with per capita consumption of 103 kg/year which is higher than the world average of 79.7 kg/year in 2017 [6]. Among the rice varieties in the world, Glycemic index have been found to vary from as low as 48 of white rice of the Australian Doongara variety to a GI of 109 for Thailand Jasmine white rice [7,8]. Like high GI foods, high GI white rice [9,10] has also been found to be associated with the metabolic syndrome and type 2 diabetes in cross-sectional and longitudinal studies in several Western and Asian populations [11,12,13]. Therefore, for prevention and management of type II diabetes and other related problems among rice eating population, consumption of rice with lower GI values is highly desirable.

Although, India has developed more than one thousand varieties and hybrids during the period from 1965 to 2014, for various ecosystems [14], there is lack of published data on glycemic index of these varieties and hybrids. Therefore, the present study aims to analyze some selected commonly consumed rice varieties to generate information on their GIs and identify the varieties with lower GI values. The analyzed rice varieties include Sampada, Dhanrasi, DRR Dhan 42, DRR Dhan 43, and Jarava. It was also aimed to find relationship between GI and cooking and eating quality traits of these varieties if any. This information may be of importance to health practitioners who have the responsibility of advising diets which give controlled glycemic response.

2. MATERIALS AND METHODS

2.1 Materials

Rough rice samples (Sampada, Dhanrasi, Jarava, Dhan 42, Dhan 43) were obtained from Plant Breeding Department of Indian Institute of Rice Research, Hyderabad, India.

2.2 Methods

2.2.1 Sample preparation

Samples were sun dried to a grain moisture content of 12-14%. All dried rough rice samples were cleaned, dehulled, and milled for 120 seconds following standard laboratory procedure.
tolerance and without medical history of diabetes
2.2.4.1
were estimated using XRF method
the difference between the total carbohydrate
of each sample was obtained from
carbohydrate in rice grain was estimated using
using the method of Prosky et al.
extracted using the oven drying method, ash
methods (moisture, ash, fat content) as per AOAC
Raw milled rice were ground to fine powder and
recorded in millimeter (mm).
Movement of the gel was measured and
rice samples after powdering was measured
following the method of Cagampang et al. [18].
Movement of the gel was measured and recorded in millimeter (mm).

2.2.3 Chemical composition

Raw milled rice were ground to fine powder and
analyzed in triplicate for proximate composition
(moisture, ash, fat content) as per AOAC
methods [19]. The moisture content was analyzed using the oven drying method, ash
content was determined using dry ashing method and fat content was determined using soxhlet extraction method. Dietary fiber was measured using the method of Prosky et al. [20]. Total carbohydrate in rice grain was estimated using the method of DuBois et al. [21]. Available carbohydrate of each sample was obtained from the difference between the total carbohydrate and dietary fiber values. Iron and zinc contents were estimated using XRF method [15]. Amylose content was analyzed using the method described by Juliano [22].

2.2.4 Glycemic response

2.2.4.1 Selection of subjects

A total of 15 healthy adults with normal glucose
tolerance and without medical history of diabetes
mellitus formed the subjects of the study. Inclusion criteria for subjects were as follows:
men or non-pregnant women, aged between 18 to 30 years (average age, 22.6±1.2 years),
normal body mass index (BMI) (19 - 24.9 kg/m², Mean: 23±0.4 kg/m²) and with fasting blood
glucose (FBG) of < 100 mgdL⁻¹ (Mean: 84.7±7.1
mgdL⁻¹). The study was conducted as per wolver methodology [3] at Post Graduate & Research
Center.

2.2.4.2 Preparation of foods

Dextrose (D (+) Glucose monohydrate, Merck
KGaA, Germany) was used as reference food. It
was served by dissolving 50 g of pure glucose
powder in a glass of 250 ml of water. Test
foods were prepared fresh, shortly before being
fed for testing. The required portions of white
rice samples ( Sampada, 65.6 g; Dhanrasi, 65.0
g; DRR Dhan 42, 67.3 g; DRR Dhan 43, 66.0 g;
and Jarava, 65.4 g) containing 50 g available
carbohydrate, were cooked in electric rice cooker
(420 W) using two volumes of water for each
weight of rice.

2.2.4.3 Experimental protocol

GI testing was carried out on seven occasions
(one test of each test samples and two repeated
tests for reference food) with each subject. The
subjects ate a regular evening meal and then
fasted for 10 - 12 h overnight before the start of
their test session the next morning. The next
morning, the subjects under fasting condition
reported to the research centre. After 10 - 15
min, baseline blood glucose levels were obtained by collecting two finger-prick
capillary blood samples (0.5 ml), taken 5 min
apart (–5 min, 0 min). After the fasting blood
samples were obtained, subjects were given a
fixed portion of a test food or reference food,
which they consumed with additional plain water
(200 ml) at a comfortable pace within 10 min. The
subjects were then required to remain
seated at the research centre and refrain from
additional eating and drinking during the next
2 hours of blood collection. Finger-prick blood
samples were taken 15, 30, 45, 60, 90 and
120 min after eating had commenced.

2.2.4.4 Blood glucose analyses and Glycemic
index calculation

Blood glucose was measured using glucometer
(Accu-Chek ® Active, Roche Diagnostics GmbH,
Mannheim, Germany) which was calibrated using
the control solutions. The GI value of the rice
samples was calculated based on the method
described by Wolever [3]. The blood glucose
responses for every point of time over 2-hours were used to calculate the incremental area under the curve (IAUC) for the test rice samples and reference food. The incremental area under the curve (IAUC) was calculated geometrically using the trapezoid rule, for each food in every subject separately and termed as glucose response by the subject [3]. The following equation was used for the calculation of GI [3].

\[
GI = \left[ \frac{IAUC_t}{IAUC_r} \right] \times 100
\]

Where,

\(IAUC_t\) = incremental area under the blood glucose response curve for the test food

\(IAUC_r\) = incremental area under the blood glucose response curve for the reference food (glucose).

The GI for each tested food was calculated as the mean from the respective GIs of the 10 subjects. The variability of GI for each tested food was assessed according to standard deviation of the mean.

### 2.3 Statistical Analysis

Statistical analyses were performed with Microsoft Office Excel 2007. Data are shown as mean with SE unless otherwise stated. For any subject, GI values that were greater than 2 SD plus the group mean GI, were considered to be outliers (n=2) and were excluded from the analysis. Moreover, those with intra-individual variability (CV%) of >30% for reference glucose were considered as outliers and not included for the GI of test food calculation (n=3). Hence, the data from a total of 10 volunteers were considered for the calculation of GI. The correlations between the GI of test foods and their cooking and eating quality traits were computed using free statistics software offered by Wessa [23].

### 3. RESULTS AND DISCUSSION

#### 3.1 Results

The nutrient composition, AC, GC, ASV, & WU of un-cooked test samples are presented in Table 1. The carbohydrate content of all the rice varieties ranged from 74.29% to 76.45%. Iron content in these uncooked polished rice samples varied from 7.1 mg/Kg to 8.4 mg/Kg while zinc content in these samples varied from 10.9 mg/Kg to 13.9 mg/Kg.

Amylose content in these rice varieties ranged from 22.82% in Sampada to 26% in Dhanrasi. Amylose contents in DRR Dhan 42, DRR Dhan 43 and Jarava were 24.3%, 23.6% and 25.02%, respectively. Based on the amylose content classification [22], rice varieties Sampada, DRR Dhan 42 and DRR Dhan 43 were included in the intermediate amylose rice group (amylose content, 20-25 %), while Dhanrasi (26%) and Jarava (25.02%) were grouped under high amylose rice (amylose content, >25%).

Alkali spreading value (ASV) of these five varieties ranged from 4 to 6. ASV of Sampada (5) and Dhanrasi (4) indicated that their GT comes under intermediate temperature category (70-74 °C) while GTs of remaining three varieties (DRR Dhan 42, DRR Dhan 43 and Jarava) which have above five ASV values come under low GT values (55-69 °C) [17]. Gel consistency among these varieties ranged from 22 mm in Jarava to 54.5 mm in Sampada. In terms of classification Sampada (54.5 mm) and DRR Dhan 42 (42 mm) have medium GC, while remaining three varieties (Dhanrasi, 37 mm; DRR Dhan 43, 34.0 mm; and Jarava, 22.0 mm) have hard GC. Water uptake values of these varieties ranged from 80 ml/100 g in Sampada to 255 ml/100 g in DRR Dhan 43 and Jarava.

Table 2 shows the mean blood glucose of the subjects at different time points observed after consuming the test foods (rice) and reference food (glucose). Although there was individual variations in blood glucose levels among ten subjects both before and after consuming rice, there was no significant difference at time 0 (fasting) among the subjects for each test rice and the reference food (p>0.05). There was a significant increase in fasting blood glucose (p<0.001) after ingestion of each test rice and the reference food and the blood glucose reached the peak values at 30 minutes.

The blood glucose response curves are shown in Fig. 1 wherein blood glucose values (mg/dL) are plotted against time (min). It was observed that reference glucose curve had the maximum average peak of 163.8±3.34 mg/dL while all the test rice samples had lower peak values (125.36±3.36 mg/dL, Sampada; 135.30±2.91 mg/dL, Dhanrasi; 139.32±1.70 mg/dL, DRR Dhan 42; 155.16±2.68 mg/dL, DRR Dhan 43;
and 158.76±2.41 mg/dL, Jarava). Table 3 summarizes the results of the mean IAUC and GI values for all rice varieties. The mean blood glucose incremental area under the curve for reference food (glucose) was 4956.38 mins. mg/dL (SEM 107.43) and the values for test foods were 2794.5 mins. mg/ dL (SEM 83.83), 2935.5 mins. mg/dL (SEM 78.17), 3554.7 mins. mg/dL (SEM 41.23), 4331.85 mins. mg/ dL (SEM 45.65), and 4661.55 mins. mg/ dL (SEM 72.06), respectively, in Sampada, Dhanrasi, DRR Dhan 42, DRR Dhan 43, and Jarava. The Statistical data analysis of the IAUC values indicates that the difference between Sampada and Dhanrasi was non-significant while differences among the remaining three rice varieties were strongly significant (p < 0.001). Estimated GI values for Sampada, Dhanrasi, DRR Dhan 42, DRR Dhan 43, and Jarava, were 56.38 (SEM 1.57), 59.23 (SEM 1.02), 71.73 (SEM 1.75), 87.40 (SEM 1.90), and 94.05 (SEM 1.20), respectively (Table 3). There was no statistically significant difference in GIs between Sampada (56.38 ± 1.57) and Dhanrasi (59.23± 1.02). But the GIs of other varieties were significantly different (p < 0.001) from each other.

On the basis of classification of carbohydrate foods described by Wolover [3], Sampada (56.38 ± 1.57) and Dhanrasi (59.23± 1.02) which had significantly lower GI than the reference food (glucose; GI=100) can be categorized as intermediate GI food (56 to 69). GI of remaining three varieties (DRR Dhan 42, 71.73±1.75; DRR Dhan 43, 87.40 ± 1.90; and Jarava, 94.05 ±1.21) will come under the category of High GI food (>70).

3.2 Discussion

3.2.1 Glycemic index

This study reports the GI of milled rice of five Indian rice varieties. Two varieties were found to have intermediate GI (Sampada, 56.38 ± 1.57; Dhanrasi, 59.23± 1.02). The remaining 3 varieties DRR Dhan 42, DRR Dhan 43 and Jarava had high GI values. This information is of great value as Asian Indians have higher susceptibility to type 2 diabetes, CVD and central obesity. Hence, being informed about the GI is important for population where rice is consumed in considerable quantities.

Very few Indian rice varieties have been studied for the estimation of GIs. Shobana et al. [9] studied three commonly consumed Indian rice varieties and found that all the three varieties (Sona Masuri, 72.0 ± 4.5; Ponni, 70.2 ± 3.6; and Surti Kolam, 77.0 ± 4.0) had high GI values. Another set of three rice varieties studied by Deepa et al. [24] were also found to have high GI values (Njavara, 74.8±0.41; Jyothi, 73.1±2.19; IR 64, 73.2±1.40).

Only few Indian rice varieties have shown low GI/intermediate GI value. Those varieties were RNR 15048 with GI value of 51.72 [25], Pradhyumna (GI=51.3) and Anjana (GI=52.7) [26], and Improved Samba Mahsuri (GI= 50.99) [27]. Some basmati rice samples collected from markets have also shown low GI values [28] but name of the varieties of the samples collected from market is not known. Identified rice varieties (Sampada and Dhanrasi), in the present work, with moderate GI values will improve the availability of low GI diet.

3.2.2 Relationship between GI and Cooking and eating quality traits

There are very limited studies on relationship of cooking and eating quality traits of rice with glycemic index (GI). ASV, AC, GC, WU are the traits which influence the cooking and eating quality of rice. These traits are extensively analyzed in rice breeding program to develop rice cultivar with desired eating and cooking quality of the rice. ASV is the indirect measure of Gelatinization temperature (GT). ASVs of 1–2, 3–4, and 5–6 correspond to high, high-intermediate, intermediate and low GT types, respectively [15,17].

In the present study, significantly strong positive correlation was observed between GI and ASV (r=0.833, p=0.039). The rice varieties having lower ASV (Sampada, 5; Dhanrasi, 4) have lower GI values (Sampada, 56.38±1.57; Dhanrasi, 59.23±1.02) while the varieties having higher ASV (DRR Dhan 43, 5.5; Jarava, 6) have higher GI values (DRR Dhan 43, 87.40±1.90; Jarava, 94.05±1.20). Finding of the present work is in agreement with the previous works [29] where it was found that food comprising starch with a low gelatinization temperature has a higher GI than food comprising starch with a high gelatinization temperature. Thus, gelatinization temperature is inversely linked to GI. In other words, GI is positively associated with ASV.

Previous studies have shown negative relationship between amylose content and GI
value [30] implying that rice with low amylose content have high GI value and the high amylose rice had a lower GI than the normal-amylose and waxy-rice varieties. The authors concluded that only high amylose (28%) varieties are potentially useful in low GI diets.

In the present study, amylose content did not show any correlation with the glycemic index of the rice variety. Despite of lower amylose content (22.82%), the rice variety Sampada was found to have low GI (56.4) and the rice variety Jarava (AC= 25.05%) which comes under high amylose category (≥25%), has highest GI value (94.04) among the five rice varieties. This is in agreement with Panlasigui et al. [31] who reported that amylose content in rice is not a good predictor for starch digestibility and glycemic response and there was no correlation between amylose content and GI. Rice varieties high in amylose have been shown to have lower [32], higher [31], or similar [33] starch-digestion rates and glycemic responses than have rice varieties low in amylose.

Other studies have also supported that Low amylose rice variety can also come under low GI or moderate GI food category. An Indian rice variety RNR 15048 having intermediate amylose content (20.72%) was found to have low GI value of 51.72 [25].

The reported conflicting results can be explained on the basis of molecular weight and chain length of their amylose and amyllopectin. It has been found that the varieties having ≥10 % long chain amylose (DP>1000) and > 10% long chain amyllopectin (DP 121-1000), will come under low GI (<55) category. If the proportion of short chain amyllopectin (DP-6-36) is ≥50%, the variety will have either intermediate GI or high GI [31,34,35].

Significant negative association was observed between GI and Gel consistency ($r=-0.834$, $p=0.039$). Jarava which has highest GI (94.05) was found to have lowest GC (22 mm) while Sampada having lowest GI (56.38) has highest GC value (54.5 mm). Negative relationship of GI with gel consistency has also been reported by earlier workers [31].

Association between GI and the percent water uptake of the varieties was significantly positive ($r=0.879$, $p=0.0246$). Water uptake of Sampada which has lowest GI (56.38) is lowest (80 ml/100 g rice) while the varieties having very high GI (Jarava, 94.05; DRR Dhan 43, 87.40) have highest water uptake (255 ml/ 100 g rice). Total carbohydrate content, ash content, fat content, crude fat content, iron and zinc etc did not show any correlation with GI of the rice varieties.

Table 1. Physico-chemical characteristics of selected varieties

<table>
<thead>
<tr>
<th></th>
<th>Sampada</th>
<th>Dhanrasi</th>
<th>DRR Dhan 42</th>
<th>DRR Dhan 43</th>
<th>Jarava</th>
<th>$r^*$ (GI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Carbohydrate #</td>
<td>76.21</td>
<td>76.92</td>
<td>74.29</td>
<td>75.75</td>
<td>76.45</td>
<td>-0.115 (P=0.426)</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>10.5</td>
<td>10.1</td>
<td>11.6</td>
<td>10.8</td>
<td>11.5</td>
<td>0.5174 (P=0.186)</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.45</td>
<td>0.39</td>
<td>0.36</td>
<td>0.29</td>
<td>0.30</td>
<td>-0.5217 (P=0.1836)</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>0.7</td>
<td>1.01</td>
<td>0.62</td>
<td>0.55</td>
<td>0.8</td>
<td>-0.369 (p=0.273)</td>
</tr>
<tr>
<td>Crude fiber content (%)</td>
<td>0.82</td>
<td>0.80</td>
<td>0.90</td>
<td>1.02</td>
<td>0.7</td>
<td>0.052 (p=0.466)</td>
</tr>
<tr>
<td>Iron (mg/kg)</td>
<td>7.10</td>
<td>8.5</td>
<td>7.7</td>
<td>8.4</td>
<td>7.8</td>
<td>0.2748 (P=0.3273)</td>
</tr>
<tr>
<td>Zinc(mg/kg)</td>
<td>13.9</td>
<td>13.4</td>
<td>10.9</td>
<td>12.3</td>
<td>12.9</td>
<td>-0.3715 (P=0.2691)</td>
</tr>
<tr>
<td>Amylose (%)</td>
<td>22.82</td>
<td>26</td>
<td>24.3</td>
<td>23.6</td>
<td>25.02</td>
<td>0.0743 (p=0.905)</td>
</tr>
<tr>
<td>ASV</td>
<td>5</td>
<td>4</td>
<td>5.2</td>
<td>5.5</td>
<td>6.0</td>
<td>0.833** (p=0.039)</td>
</tr>
<tr>
<td>GC (mm)</td>
<td>54.5</td>
<td>40</td>
<td>42</td>
<td>34</td>
<td>22</td>
<td>-0.8394** (p=0.044)</td>
</tr>
<tr>
<td>Water uptake</td>
<td>80</td>
<td>140</td>
<td>245</td>
<td>255</td>
<td>255</td>
<td>0.8797** (p=0.0246)</td>
</tr>
<tr>
<td>Glycemic Index (GI)</td>
<td>56.38</td>
<td>59.23</td>
<td>71.73</td>
<td>87.40</td>
<td>94.05</td>
<td>1</td>
</tr>
</tbody>
</table>

*Correlation coefficient between the physicochemical properties and glycemic index (GI); ** Significant at p<0.05; # g/100 g
Table 2. Serum glucose responses (mg/dL) of the subjects (n =10) at different time points after consuming the test foods

<table>
<thead>
<tr>
<th>Subject</th>
<th>0 min</th>
<th>15 min</th>
<th>30 min</th>
<th>45 min</th>
<th>60 min</th>
<th>90 min</th>
<th>120 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>84.70±2.25</td>
<td>104.33±2.35</td>
<td>163.80±3.34</td>
<td>150.80±2.81</td>
<td>138.63±2.86</td>
<td>120.80±2.96</td>
<td>97.20±2.55</td>
</tr>
<tr>
<td>Sampada</td>
<td>84.70±2.25</td>
<td>101.44±2.64</td>
<td>125.36±3.37</td>
<td>119.40±2.42</td>
<td>112.50±2.70</td>
<td>105.60±2.35</td>
<td>95.40±2.64</td>
</tr>
<tr>
<td>Dhanrasi</td>
<td>84.70±2.25</td>
<td>102.00±2.78</td>
<td>135.30±2.91</td>
<td>124.40±2.48</td>
<td>116.30±2.92</td>
<td>100.20±2.84</td>
<td>94.40±2.36</td>
</tr>
<tr>
<td>DRR Dhan 42</td>
<td>84.70±2.66</td>
<td>102.60±2.52</td>
<td>139.45±1.70</td>
<td>130.24±2.07</td>
<td>121.00±2.26</td>
<td>111.92±2.02</td>
<td>94.60±2.58</td>
</tr>
<tr>
<td>DRR Dhan 43</td>
<td>84.70±2.25</td>
<td>103.68±3.14</td>
<td>155.16±2.68</td>
<td>141.20±2.61</td>
<td>130.00±2.36</td>
<td>115.00±2.77</td>
<td>99.00±1.98</td>
</tr>
<tr>
<td>Jarava</td>
<td>84.70±2.25</td>
<td>103.78±2.32</td>
<td>158.76±2.41</td>
<td>149.58±2.68</td>
<td>133.60±3.63</td>
<td>120.20±2.14</td>
<td>93.10±2.59</td>
</tr>
</tbody>
</table>

* Mean ± standard Error of Mean (SEM); # Glucose

Table 3. Incremental area under the blood glucose response curve (IAUC) and glycemic index (GI) values of rice samples (test food/IAUCt) and reference food (glucose/IAUCr) (Glucose GI= 100) (n=10)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Reference Food</th>
<th>Sampada</th>
<th>Dhanrasi</th>
<th>DRR Dhan 42</th>
<th>DRR Dhan 43</th>
<th>Jarava</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IAUCr</td>
<td>IAUCt</td>
<td>GI</td>
<td>IAUCt</td>
<td>GI</td>
<td>IAUCt</td>
</tr>
<tr>
<td>1</td>
<td>4446.75</td>
<td>2912.25</td>
<td>65.49</td>
<td>2683.5</td>
<td>60.35</td>
<td>3570.75</td>
</tr>
<tr>
<td>2</td>
<td>5573.25</td>
<td>3112.5</td>
<td>55.85</td>
<td>3180</td>
<td>57.06</td>
<td>3473.25</td>
</tr>
<tr>
<td>3</td>
<td>5207.25</td>
<td>2918.25</td>
<td>56.04</td>
<td>2966.25</td>
<td>56.96</td>
<td>3595.5</td>
</tr>
<tr>
<td>4</td>
<td>4716</td>
<td>2317.5</td>
<td>49.14</td>
<td>2689.5</td>
<td>57.03</td>
<td>3300</td>
</tr>
<tr>
<td>5</td>
<td>5110.5</td>
<td>3168.75</td>
<td>62.00</td>
<td>3255.75</td>
<td>63.71</td>
<td>3731.25</td>
</tr>
<tr>
<td>6</td>
<td>5043.75</td>
<td>2739.75</td>
<td>54.32</td>
<td>3040.5</td>
<td>60.28</td>
<td>3619.5</td>
</tr>
<tr>
<td>7</td>
<td>4647</td>
<td>2735.25</td>
<td>58.86</td>
<td>2944.5</td>
<td>63.36</td>
<td>3744</td>
</tr>
<tr>
<td>8</td>
<td>5250</td>
<td>2760.75</td>
<td>52.59</td>
<td>3204</td>
<td>61.03</td>
<td>3525</td>
</tr>
<tr>
<td>9</td>
<td>4732.5</td>
<td>2440.5</td>
<td>51.57</td>
<td>2516.25</td>
<td>53.17</td>
<td>3485.25</td>
</tr>
<tr>
<td>10</td>
<td>4836.75</td>
<td>2839.5</td>
<td>58.71</td>
<td>2874.75</td>
<td>59.44</td>
<td>3502.5</td>
</tr>
<tr>
<td>Average*</td>
<td>4956.38</td>
<td>2794.5</td>
<td>56.38</td>
<td>2935.5</td>
<td>59.23</td>
<td>3554.7</td>
</tr>
<tr>
<td>SEM(±)</td>
<td>107.43</td>
<td>83.86</td>
<td>1.57</td>
<td>78.17</td>
<td>1.02</td>
<td>41.23</td>
</tr>
</tbody>
</table>

*IAUC and GI values with unlike superscript letters differ significantly. *Glucose Values with superscripts of different small alphabets are significantly different (p<0.05)
Fig. 1. Plasma glucose response curves of reference and test foods

4. CONCLUSION

Glycemic Index (GI) of five rice varieties studied in this work ranged from 56.38 to 94.05. Two varieties have been identified with moderate GI values (Sampada, 56.38; Dhanrasi, 59.31) which can form part of low GI diet and may also reduce the glycemic load when incorporated in a meal. Due to high prevalence of diabetes in India such low GI alternatives can prove to be a healthier option to incorporate in nutritional therapeutic diets. This study also showed that lower Alkali Spreading Value, higher gel consistency, lower water uptake upon cooking are good predictors for lower GIs of rice varieties. As the cooking and eating quality traits are either positively or negatively associated with GI, these relationships may be used for screening or preliminary selection of low GI rice cultivars.

CONSENT AND ETHICAL APPROVAL

The study was approved by Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, India, after approval of the ethics committee of the Department, the study was conducted. The purpose and protocol of the study were explained to the subjects and participant’s written consent was obtained.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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