EVALUATION OF HONEY INCORPORATED FOOD PREPARATION ON THE BASIS OF GLYCEMIC INDEX AND THEIR ADVOCACY IN IMPAIRED GLUCOSE TOLERANCE
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ABSTRACT
Honey is a natural sweetener and it is a nature’s gift to mankind. Honey is important edible substance, which contains small amounts of proteins, enzymes, amino acids, minerals, trace elements, vitamins and sugars as major constituents. Honey is frequently used in the Ayurvedic system of medicine as variety of the Ayurvedic preparations are taken along with or in combination with honey. The present study was conducted to determine the glycemic index of food products made with different natural sweeteners including honey. Normal healthy subjects (n = 10) and subjects with impaired glucose tolerance (n = 10) were included in the study and administered with equicalorohydrate quantity of glucose and a food preparation ‘sweet roll’ containing different sweeteners at fasted state on various days. Monitoring of blood glucose in normal healthy subjects and subjects with impaired glucose tolerance at 0, 30, 60, 90 and 120 minutes indicated a significant difference in incremental area under the curve (IAUC) of glucose and food preparations made with different sweeteners. The mean incremental area under the curve of food preparations was significantly lower (p < 0.01) than that of glucose in subjects with impaired glucose tolerance as well as normal healthy subjects. At the same time honey incorporated sweet rolls were found to have lower glycemic index when compared to rolls prepared with cane sugar and jaggery. This indicated honey incorporated foods may be occasionally consumed by subjects with impaired glucose tolerance.

Keywords: Honey, Glycemic Index, Impaired Glucose Tolerance

INTRODUCTION
Honey is a sweet food made by bees using nectar from flowers. Honey has a long history of human consumption, and it is used in various foods and beverages as a sweetener and flavoring agent. It contains mainly carbohydrates. The glycemic index (GI) of honey varies from 32 to 87, depending on botanical origin and on fructose content. Low glycemic index foods, by virtue of the slow digestion and absorption of their carbohydrate content, produce a more gradual rise in blood sugar and insulin levels and are increasingly associated with health benefits. Low glycemic index foods have thus been shown to improve the glucose tolerance in diabetic subjects. The glycemic index concept was developed in human nutrition in an attempt to characterize foods according to their postprandial glycemic response rather than their chemical composition. Although the GI ranking compares standard carbohydrate portions (usually 25 or 50 g) and the amount of food tested to derive the GI may not reflect usual amounts consumed. The glycemic effect of a food in humans is influenced by the nature, the type of carbohydrates, the physical form of the food and processing. Sugar, Jaggery and honey are traditional sweeteners. The traditional use of honey in food preparations has been substituted in most cases by sugar and more recently by various sugar syrups derived from starches. At the same time, as part of the increasing appreciation of more natural products in many countries, honey has been "rediscovered" as a valuable food. It contains up to 38.2 % fructose, 31.3 % glucose, 0.7 % sucrose and approximately 25 % other nutrients. Jaggery is a concentrated product of cane juice without separation of the molasses and crystals. It can vary from golden brown to dark brown in color. Jaggery contains up to 50 % sucrose, up to 20 % invert sugars with some other insoluble matter such as ash, proteins and bagasse fibers. It is directly consumed by humans and used in animal feed mixtures. Jaggery is often called the medicinal sugar and possesses nutritive properties of high order. The study was undertaken to evaluate glycemic response, determine the glycemic index (GI) and acceptability of the products made with different natural sweeteners so that their beneficial health effect with reference to GI may be understood.

MATERIAL AND METHODS
A food preparation “sweet roll” was prepared with Bengal gram flour, wheat flour, ghee and different sweeteners like honey, cane sugar and jaggery. All the three combinations of rolls i.e. RH (rolls prepared with honey), RCS (rolls prepared with cane sugar) and RJ (rolls prepared with jaggery) were subjected to organoleptic evaluation for various attributes like appearance, texture, colour, flavour and softness. A 9 point hedonic scale determined organoleptic qualities of various combinations of sweet rolls.

Sensory evaluation of rolls
The rolls thus prepared were tested by the panel of 10 judges for the organoleptic quality and acceptability. Distinct codes were allotted to the products. The judges were requested to taste the food preparations and award a
score with reference to a number of attributes viz. appearance, texture, colour, flavour and softness during the testing session and scores were obtained for various organoleptic qualities. This procedure was repeated two more times. Similar scores obtained for sensory attributes in both replications were considered acceptable.

Collection of baseline data and determination of glycemic index
Subjects in the age group of 35 - 45 years were enrolled in the study. The criterion for screening of the subjects in normal health and subjects with impaired glucose tolerance (IGT) was WHO, 2006. On the basis of this criterion fasting blood sugar (FBS) of about 70 - 110 mg/dl was considered as normal and FBS of about 111 - 125 mg/dl was considered as impaired glucose tolerance. Among the selected subjects 10 subjects were in normal health and 10 subjects had impaired glucose tolerance (IGT). The subjects were explained the study protocol and a written consent for voluntary participation was obtained. All the subjects were asked to attend the testing session after a 10 h overnight fast on the basis of carbohydrate content of food items given in Nutritive value of Indian foods. The following formula was used:

\[
GI = \frac{IAUC \text{ for tested food}}{IAUC \text{ for Reference Food}} \times 100
\]

IAUC – Incremental area under the blood glucose response curve

Table 1: Nutritional composition of the sweet rolls

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>RH</th>
<th>RCS</th>
<th>RJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (Kcal)</td>
<td>199.74</td>
<td>199.665</td>
<td>200.08</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>3.78625</td>
<td>3.75875</td>
<td>3.79075</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>25.00325</td>
<td>25.00575</td>
<td>25.04075</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>9.40175</td>
<td>9.40175</td>
<td>9.41225</td>
</tr>
</tbody>
</table>

Abbreviation: RH-roll honey, RCS-roll cane sugar, RJ-roll jaggery

Table 2: Sensory evaluation of sweet rolls with three different sweeteners

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Combination</th>
<th>Appearance</th>
<th>Texture</th>
<th>Color</th>
<th>Flavor</th>
<th>Softness</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RH</td>
<td>8.60</td>
<td>8.10</td>
<td>8.30</td>
<td>8.50</td>
<td>8.30</td>
<td>8.36</td>
</tr>
<tr>
<td>2</td>
<td>RCS</td>
<td>8.60</td>
<td>8.20</td>
<td>8.40</td>
<td>8.60</td>
<td>8.40</td>
<td>8.44</td>
</tr>
<tr>
<td>3</td>
<td>RJ</td>
<td>8.60</td>
<td>8.10</td>
<td>8.30</td>
<td>8.50</td>
<td>8.30</td>
<td>8.36</td>
</tr>
</tbody>
</table>

Values are given in mean, Abbreviation: RH-roll honey, RCS-roll cane sugar, RJ-roll jaggery

Table 3: IAUC and GI in subjects with IGT and normal healthy subjects

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Products</th>
<th>NHS</th>
<th>IGT</th>
<th>NHS</th>
<th>IGT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Glucose</td>
<td>175.91</td>
<td>319.16</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>RH</td>
<td>79.16*</td>
<td>120.00**</td>
<td>45.00</td>
<td>37.59</td>
</tr>
<tr>
<td>3</td>
<td>RCS</td>
<td>114.16</td>
<td>121.66*</td>
<td>64.89</td>
<td>38.11</td>
</tr>
<tr>
<td>4</td>
<td>RJ</td>
<td>108.33*</td>
<td>121.66*</td>
<td>61.58</td>
<td>38.11</td>
</tr>
</tbody>
</table>

Values are given in mean (mg/dl), *Significant change P<0.01, Abbreviation: IAUC-incremental area under the curve, GI-glycemic index, NHS-normal healthy subjects, IGT-impaired glucose tolerance, RH-roll honey, RCS-roll cane sugar, RJ-roll jaggery

Table 4: Mean (%) reduction in IAUC of roll varieties compared with IAUC of glucose

<table>
<thead>
<tr>
<th>% Reduction compared to glucose</th>
<th>NHS</th>
<th>IGT</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH</td>
<td>55.00</td>
<td>62.40</td>
</tr>
<tr>
<td>RCS</td>
<td>35.10</td>
<td>61.88</td>
</tr>
<tr>
<td>RJ</td>
<td>38.42</td>
<td>61.88</td>
</tr>
</tbody>
</table>

Values are given mg/dl, Abbreviation: IAUC-incremental area under the curve, NHS-normal healthy subjects, IGT-impaired glucose tolerance, RH-roll honey, RCS-roll cane sugar, RJ-roll jaggery
Statistical Analysis
Statistical analysis was performed by using a Paired t test. Significance level considered was P < 0.05. Statistics was performed by Sigma stats software package (3.5).

Institutional ethical committee
The study design and experimental protocol was approved by ethical committee serial no JU/IHEC/2013-A/18.

RESULTS
The mean plasma glucose responses after the consumption of glucose and the test foods in normal healthy subjects and IGT (Impaired Glucose Tolerance) are shown in Table 3. The mean IAUC of glucose was 175.91 mg/dl and IAUC of RH, RCS and RJ was 79.16 mg/dl, 114.16 mg/dl and 108.33 mg/dl respectively. The mean IAUC of all the variety of rolls was considerably lower than glucose. It was observed that maximum reduction (55.00 %) in IAUC was exhibited by RH. When the mean reduction in IAUC of all the varieties roll was compared with glucose a highly significant reduction (p = < 0.002) of IAUC was noted in case of RH. The mean reduction in IAUC of all the varieties of rolls was compared with glucose. It was observed that maximum reduction (62.40 %) in IAUC was exhibited by RH (Table 4). GI of rolls was calculated and it was noted that GI values obtained for RH, RCS and RJ were 45.00, 64.89 and 61.58 respectively in case of normal healthy subjects. The mean GI of RH, RCS and RJ were found to be 37.59, 38.11 and 38.11 respectively in subjects with IGT. RH exhibited lowest GI values in normal as well as subjects with IGT.

DISCUSSION
A comparison of IAUC of RH with glucose in normal healthy subjects and subjects with IGT revealed a significant reduction of 55 % and 62.40 % respectively indicating that honey had no adverse effect on glycemic response and was well tolerated by subjects with IGT. These results suggest and support the statement that honey could be better than products made with cane sugar, which is a common sweetener in use. Yet another study reported that honey has a gentler effect on blood sugar levels on a per gram basis, and tastes sweeter than sucrose so that fewer grams would be consumed, it would
It is important to use foods grading based on physical and chemical constituents. Maharashtra sugar 1983; 8(12): 39-43.


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CONCLUSION
Honey incorporated food preparation having considerably low GI appear to be an alternative to sweet preparations usually made with cane sugar. Therefore it may be suitable for consumption, by people with impaired glucose tolerance and other health problems associated with poor blood glucose control in line with their dietary requirements in controlled amounts.

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