



Research Article

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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 an 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 a 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 an equicarbohydrate quantity of glucose and a food preparation 'sweet roll' containing different sweeteners at a 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 a 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 content¹. 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 consumed². The glycemic effect of a food in humans is influenced by the nature, the type of carbohydrates, the physical form of the food and processing³. 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 nutrients⁴. 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 fibers⁵. 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 rolls⁶.

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 were obtained. All the subjects were asked to attend the testing session after a 10 - 12 h overnight fast on the day when test was to be performed. They have been instructed not to consume unusually large meals, drink alcohol or exercise vigorously on the previous day, and to avoid cycling or walking to the laboratory. On the first day subjects were given the standard or reference carbohydrate i.e. 25 g glucose dissolved in 150 ml of

water. Blood glucose level was measured in capillary whole blood obtained by finger prick (Accu-Chek Roche Diagnostics India Pvt. Ltd, Mumbai, India) in the fasted state at 0 and after 30, 60, 90 and 120 minutes on consumption of the reference (glucose) food. Blood glucose curves were constructed and the incremental area under the curve (IAUC) was calculated for reference food (glucose) by the trapezoidal rule⁷. Similar procedure was repeated with all the varieties of test foods (rolls). The rolls in different combinations (25 g carbohydrates) were given during testing sessions against the standard or reference carbohydrate on the following three consecutive days at fasted state. Equicarbohydrate portion of roll was calculated on the basis of carbohydrate content of food items given in Nutritive value of Indian foods⁸.

Calculation of glycemic index

The Glycemic Index (GI) values were calculated by the method of Jenkins *et al*². The glycemic index was calculated by dividing the IAUC for the test food by the IAUC for the reference food and multiplying by 100 for each individual. The following formula was used:

$$GI = \frac{\text{IAUC for tested Food}}{\text{IAUC for Reference Food}} \times 100$$

IAUC – Incremental area under the blood glucose response curve

Table 1: Nutritional composition of the sweet rolls

Nutrients	RH	RCS	RJ
Energy (Kcal)	199.74	199.665	200.08
Protein (g)	3.78625	3.75875	3.79075
Carbohydrate (g)	25.00325	25.00575	25.04075
Fat (g)	9.40175	9.40175	9.41225

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

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

S. No.	Combination	Appearance	Texture	Color	Flavor	Softness	Overall acceptability
1	RH	8.60	8.10	8.30	8.50	8.30	8.36
2	RCS	8.60	8.20	8.40	8.60	8.40	8.44
3	RJ	8.60	8.10	8.30	8.50	8.30	8.36

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

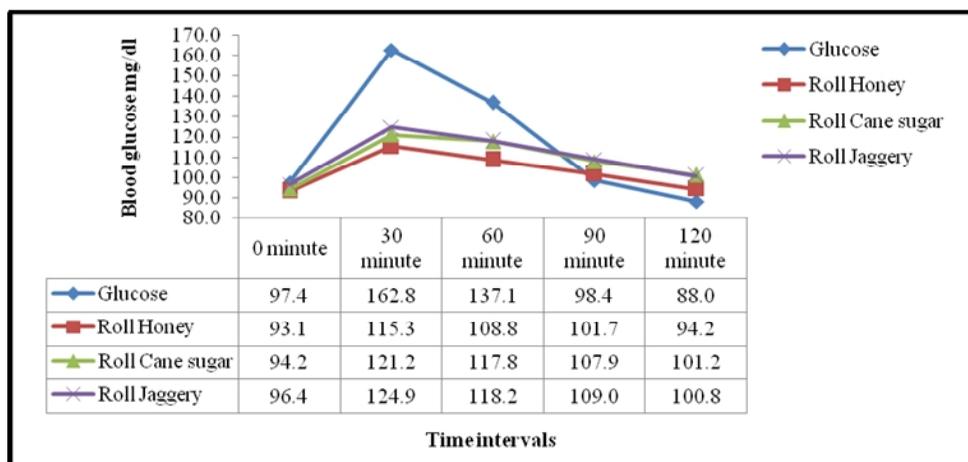
S. No.	Products	IAUC		GI	
		NHS	IGT	NHS	IGT
1	Glucose	175.91	319.16	-	-
2	RH	79.16*	120.00*	45.00	37.59
3	RCS	114.16	121.66*	64.89	38.11
4	RJ	108.33*	121.66*	61.58	38.11

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

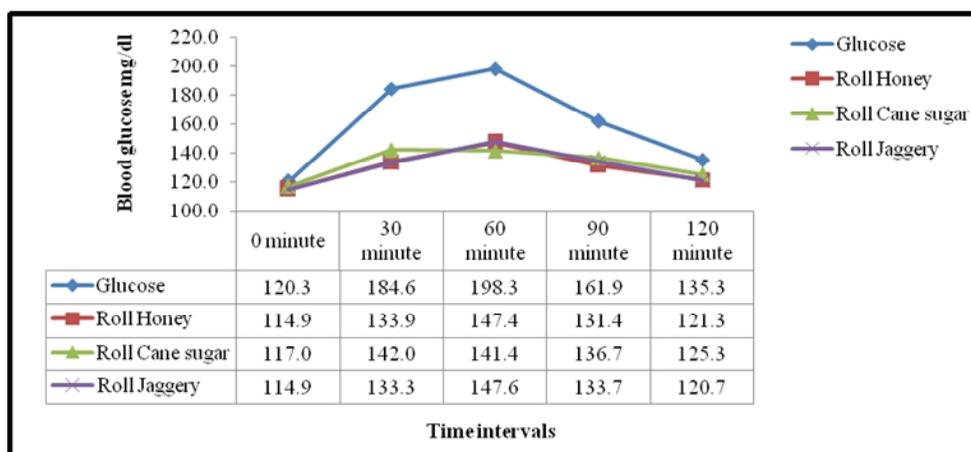
Table 4: Mean (%) reduction in IAUC of roll varieties compared with IAUC of glucose

% Reduction compared to glucose		
	NHS	IGT
RH	55.00	62.40
RCS	35.10	61.88
RJ	38.42	61.88

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



Graph 1: Blood glucose response curve in normal healthy subjects administered with sweet roll varieties



Graph 2: Blood glucose response curve in subjects with IGT administered with roll varieties

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 IAUC of glucose was 319.16 mg/dl and the IAUC values observed for RH, RCS and RJ were 120.00 mg/dl, 121.66 mg/dl and 121.66 mg/dl respectively. The mean IAUC of

all the variety of rolls was significantly lower than glucose but a highly significant reduction ($p = < 0.002$) 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 use⁹. 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

seem prudent to recommend honey over sucrose¹⁰. In this study consumption of all the varieties of sweet rolls by subjects with IGT as well as normal healthy subjects showed that rolls made with honey had lowest GI (GI value 37.59 and 45.00 In subjects with IGT and normal healthy subjects). This finding is supported by a study which reported that honey has lower glycemic index compared to many other carbohydrates¹¹. According to the international table of glycemic index, honey has a GI value ranging between 32 and 87¹². Most researches relating to the glycemic Index and health indicate the clinical usefulness of low GI in the treatment of diabetes and hyperlipidaemia. As the GI concept claims to predict the role of carbohydrates in the development of obesity¹³, low GI honeys might be a valuable alternative to high GI sweeteners. In the dietary management of diabetes or in proposing any food suitable for diabetic individual the grading of different foods in terms of a GI has been suggested to be very useful¹⁴. It is important to use foods that produce the least postprandial blood glucose variation and this has been observed with honey incorporated rolls in this study. IGT has been linked with an increased risk of cardiovascular events, and some analyses have demonstrated an increased mortality risk as compared to patients with normal glucose tolerance. IGT has been associated with other features of insulin resistance, including dyslipidaemia, hypertension, and abdominal obesity. It is also reported to be linked with micro albuminuria, endothelial dysfunction and markers of inflammation and hypercoagulability, traits collectively referred to as the metabolic syndrome. Analysis of combinations of these components have also been associated with progression to Type 2 Diabetes Mellitus, cardiovascular disease and increased mortality¹⁵. Therefore honey may be beneficial as sugar substitute for subjects with impaired glucose tolerance.

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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