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RESEARCH ARTICLE

ESTIMATION OF GLYCEMIC INDEX OF RAGI RECIPES INCORPORATED WITH CURRY LEAF POWDER

Santhi Sirisha, K. and Vijaya Lakshmi, V.

Department of Foods & Nutrition, College of Home Science, Professor Jayashankar Telangana State Agricultural University, Saifabad- Hyderabad, 500004

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ABSTRACT

The present study was undertaken to determine the glycemic index (GI) of ragi rotis incorporated with curry leaf powder. Two ragi varieties viz. SRICHAITHANYA (brown ragi) and HIMAJA (white ragi) were selected. Ragi rotis were evaluated for glycemic response. The glycemic index of rotis ranged from 56.2 to 67.3. White ragi roti had the highest GI with 67.3 followed by White ragi roti incorporated with curry leaf powder with 62.5. Brown ragi roti had GI Value of 61.0 and the least was for Brown ragi roti incorporated with curry leaf powder with 56.2. Brown ragi roti incorporated with curry leaf powder had lowest GI whereas white ragi roti got highest GI. The GI of curry leaf powder incorporated ragi rotis of brown and white ragi was significantly less compared to plain ragi rotis. It was found that all the ragi rotis have intermediate glycemic index. Curry leaf powder can be incorporated in the traditional breakfast items to enhance nutritional composition while at the same time help in reducing the GI value.

INTRODUCTION

Glycemic index (GI) is a measure of the food power to raise blood glucose concentration after a meal. The concept was initially coined by Jenkins *et al*. (1981). For healthy eating particularly in persons with diabetes, obesity foods with low GI are recommended as low GI food produces lower and gradual glucose response. Dietary fibre improves glycemic response by reducing rate of glucose absorption in small intestine, hence lowering the GI value. Presently, there is also an increase interest in GI from many public health and industrial entities.
Finger millet (Ragi, Eleusine Coracana) is an important staple food in the eastern and central Africa as well as some parts of India (Majumder *et al*., 2006). Ragi provides highest level of calcium, antioxidants properties, phytochemicals, which makes it easily and slowly digestible. Hence it helps to control blood glucose levels in diabetic patients very efficiently. The bulkiness of the fibre and the slower digestion rate makes us feel fuller on, fewer calories and therefore may help to prevent us from eating excess calories. Therefore, ragi is considered to be ideal food for diabetic individuals due to its low sugar content and slow release of glucose/sugar in the body (Kang *et al*., 2008; Lakshmi and Sumathi, 2002). Certain spices used commonly in Indian cooking have been mentioned to possess antidiabetic properties.

Corresponding author: Santhi Sirisha, K.
Department of Foods & Nutrition, College of Home Science, Professor Jayashankar Telangana State Agricultural University, Saifabad- Hyderabad, 500004

Murraya koenigii is known as 'Curry Leaf' is widely used as a spice and condiment in India and other tropical countries.Ayurveda mentions its use in the treatment for diabetics (Satyavati *et al*.1987). Several authors evaluated the hypoglycemic effect of ragi recipes and curry leaf powder and presented their benefits. In the present study a combination of both curry leaf and ragi is used to achieve additional benefits. In view of the above consideration the present study was undertaken to estimate the GI of Curry leaf powder incorporated ragi rotis made with two varieties of ragi viz. SRICHAITHANYA (Brown ragi) and HIMAJA (White ragi).

MATERIALS AND METHODS

Procurement of raw materials: Two ragi varieties viz. SRICHAITHANYA (brown ragi) and HIMAJA (white ragi) were obtained from the Regional Agricultural Research Station, Vizianagaram, Andhra Pradesh and processed into flour. Curry leaves were purchased from local market, cleaned, dried and made into powder.

Standardization and preparation of rotis using brown and white ragi flour with and without incorporation of curry leaf powder (CLP): Flours from the two varieties of ragi (SRICHAITHANYA and HIMAJA) were blended with 5g of CLP separately and these flours were utilized to make rotis so as to give 50 g of carbohydrate. The proportion of ingredients in the product BRR (brown ragi roti) was 69.44g of ragi flour, 2.5g salt and 45 ml of water and same quantity of ingredients was used for WRR (white ragi roti) replacing brown ragi flour with white ragi flour. But for the BRCR (brown ragi roti incorporated with CLP) and WRCR (brown ragi roti incorporated with CLP) 64.58g of ragi flour and 5g of CLP, 2.57g salt and 45 ml water were used.

Method for Glycemic Index

Ten young adult volunteers between of 22-24 years were selected for the study. The study was conducted in line with the procedure recommended by the Food and Agriculture Organization/ World Health Organization (FAO/WHO, 1998) to determine the GI of the rotis made from brown and white ragi with and without incorporation of CLP. 50g of Glucose mixed in 250 ml of water was used as a Reference food. Plain and curry leaf incorporated ragi rotis of brown and white ragi were used as test food. In order to obtain/get 50 g of carbohydrate, 69.44g brown and white ragi flour was used for plain rotis, whereas for the CLP incorporated rotis 64.58 ragi flour and 5g CLP was taken. On the first day, the subjects were given the standard reference food (Glucose 50 g) followed by experimental / test food containing 50g of carbohydrate and 250 ml of water was provided. Blood glucose levels were measured using "One touch Ultra soft" Glucometer by finger prick method in the fasting state and at 30, 60, 90 and 120 minutes after consumption of the reference and test food and 2 hour glucose response curves were drawn.

Determination of glycemic index of brown and white ragi rotis with and without incorporation of curry leaf powder (CLP)

The Glycemic Index (GI) values were calculated by the method of Jenkins *et al.* (1981). The glycemic index of each individual was calculated by dividing the incremental area under curve (IAUC) for the test food by the IAUC for the reference food and multiplying by 100. Glycemic index of brown and white ragi rotis with curry leaf powder / without curry leaf powder was calculated by the formula.

$$GI = \frac{\text{IAUC for tested food}}{\text{IAUC for reference food}} \times 100$$

Statistical analysis

All the results were statistically analysed to test the significance of the results using percentages, means, SD and analysis of variance (ANOVA) (Snedecor and Cochran, 1983).

RESULTS

Glycemic index for rotis made with two varieties of ragi with and without addition of CLP

Ragi rotis prepared with and without addition of CLP from both the varieties were consumed by the selected 10 subjects between 22-24yr after an overnight fast. The fasting glucose levels for all five tests namely reference (glucose), test foods (rotis-BRR, BRCR,WRR and WRCR) were nearly similar before all the test meals were taken, which ranged between 77.7± 6.25 to 83.2±3.04 mg/dl. For reference food the peak rise was observed after 30 min which gradually came down with an increase in time. The peak rise for all the ragi rotis was observed to be at 30 min and lower than glucose.

Area Under Curve (AUC) of Reference food and Test food

The area under the curve has been calculated geometrically by applying the trapezoid rule ignoring the area below fasting level. The AUC for Reference, Brown ragi roti (BRR), Brown ragi roti incorporated with CLP (BRCR), White ragi roti (WRR) and white ragi roti incorporated with CLP (WRCR) was given in the Figure 1. The AUC for reference and test foods ranged from 646.1 to 1125.8 the AUC calculated for Glucose, Brown ragi roti (BRR), brown ragi roti incorporated with CLP (BRCR) was 1125.8, 687.0, 646.1 respectively whereas, for white ragi roti (WRR), white ragi roti incorporated with CLP (WRCR) was 757.8 and 703.9 respectively (Figure 2).

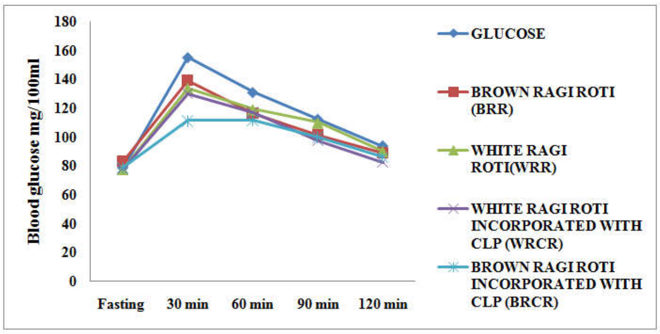

Figure 1. Area under curve for Glucose and Experimental rotis

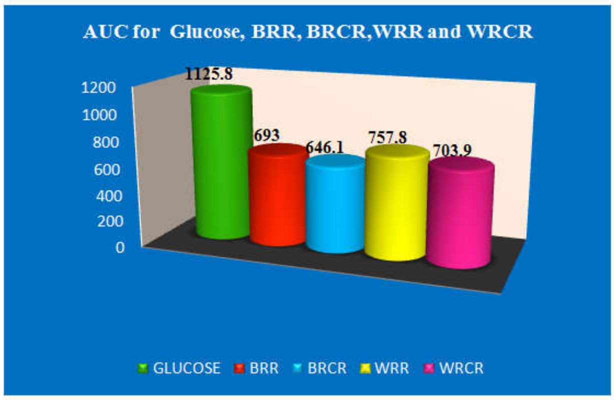

Figure 2. Comparison of AUC of glucose and experimental rotis

Determination of Glycemic Index (GI)

The GI is defined as the incremental area under the blood glucose response curve (AUC) after consumption of a 50 g available-carbohydrate portion of a food expressed as a percentage of that after 50 g oral glucose.GI indices of test foods Brown ragi roti (BRR), Brown ragi roti incorporated with CLP (BRCR), White ragi roti (WRR) and white ragi roti incorporated with CLP (WRCR) were obtained by calculating mean AUC for reference glucose and test foods for ten selected subjects and given in the Table 1. The GI of rotis ranged from 56.2±5.56 to 67.3±2.78 (Table 4.4). WRR had the highest GI with 67.3±2.78 followed by WRCR with 62.5±4.23. BRR had GI Values of 61.0±5.77 and the least was for BRCR with 56.2±5.56. The BRCR resulted in significantly lower GI than BRR, WRR and WRCR. There was no significant difference between the GI of BRR and WRCR ($p<0.05$).

Table 1. Glycemic index of BRR, BRCR, WRR and WRCR

Product	Glycemic index
Brown ragi roti (BRR)	61.0±5.77[b]
Brown ragi roti incorporated with CLP (BRCR)	56.2±5.56[c]
White ragi roti (WRR)	67.3±2.78[a]
White ragi roti incorporated with CLP (WRRC)	62.5±4.23[b]
CD Value	4.26263

Note: Values are mean ± standard deviation of ten determinations (n=10)

Mean values with similar superscripts within a column/row do not differ significantly ($p<0.05$).

DISCUSSION

The difference shown by the tested ragi rotis of two varieties in GI values may be due to differences in the rate of digestion, absorption and utilization of the grain CHO. The digestion of CHOs is mainly dependent upon the structure and composition of the starches and other non starchy components. The difference in the physical as well as the chemical nature of polysaccharides and their physical distribution in the grain which differ from genotype to genotype apparently seem to alter their response to amylase action, resulting in slower digestion and absorption, there by resulting in low GI. The lower GI for BRR may be explained on the basis of its fibre content. The dietary fibre content of BRF used for the preparation of BRR was 12.2 g/100g whereas, WRF had 10.2 g/100g. The beneficial effect of fibre is usually attributed to the slower gastric emptying or formation of un-absorbable complexes with available carbohydrates in the gut lumen. Apart from carbohydrates, protein, fat and fibre in diet, anti-nutritional factors like polyphenols, phytic acid and enzyme inhibitors are known to reduce the starch digestibility and absorption. They either form complexes with carbohydrates to prevent them from enzymatic attack or inhibit the activity of enzymes there by reducing the rate of hydrolysis of starch to maltose. This lowers the rate of maltose transport and glucose absorption. When the GI of BRR compared to WRR, BRR was found to be much lower. This might be due to a noticeable difference in the polyphenols in the brown (1.2- 2.3 %) and white (0.3-0.5%) varieties which could be due to the presence of the red pigments, which are generally polymerized phenolics present in brown cultivars (Ramachandra *et al.* 1977).

It was suggested that phytates probably affect the starch digestibility through interaction with amylases, proteases and/or binding salivary minerals such as calcium which is essential for amylase activity. Thus it decreases the digestion and absorption of carbohydrates resulting in lowered post-prandial glycemia (Yoon *et al*., 1983). Lower AUC and GI observed on consumption of CLP added ragi rotis of both the varieties which may be due to higher fibre and bioactive compounds content of CLP added ragi flour compared to normal ragi flour without CLP. The beneficial effect of fibre is usually attributed either to slower gastric emptying or formation of un-absorbable complexes with available CHO in the gut lumen. Therefore it has been suggested that these two properties might result both in delayed absorption of carbohydrate and in the reduction of absolute quantity absorbed (Rasmussen *et al*. 1991). Fibre may act as a barrier for diffusion of nutrients from the gut lumen to gut mucosa and result in slower absorption from fibre rich foods than fibre free foods. Hence high fibre foods would result in improved glucose control due to delayed digestion and absorption and also increase transit time from mouth to cecum (Kiehm *et al*., 1976). Wolver (1990) investigated the relationship between the glycemic index and the dietary fiber content and composition of 25 foods. Results revealed that total dietary fibre was significantly related to GI. Soluble fibre was not significantly related to GI but uronic acids in insoluble fibre were most closely associated to GI. More variation in GI was explained by nature of uronic acids in insoluble fiber which is 34 per cent when compared to total dietary fibre alone (21%). The combination of pentoses, hexoses and uronic acids in soluble and insoluble fiber explained 50 per cent of GI variability.

Bawden *et al.* (2002) explained the alpha amylase inhibitory activity of cold hexane extract of curry leaves. The aqueous extract of curry leaves contains a range of active pharmacological agents, which include carbazole alkaloids, flavonoids and tannins (Wang *et al*., 2003) known to be bioactive for the management of diabetes (Oliver-Bever, 1986). It is known that certain alkaloids and flavonoids exhibit hypoglycemic activity (Ahmad *et al*., 2000) and also known for their ability of beta cell regeneration of pancreas (Chakravarti *et al*., 1981). Tannins have also shown to decrease blood sugar in experimental animal models (Suba *et al*., 2004). Thus, the significant hypoglycemic effect of CLP added rotis may be due to the presence of more than one hypoglycemic principle and/or their synergistic effects. Yadav *et al*. (2002) reported that feeding of diet containing various doses of curry leaf powder (5, 10 and 15%) to normal rats for 7 days as well as to mild and moderate diabetic rats for 5 weeks showed varying hypoglycemic and anti-hyperglycemic effect.

Lower AUC and GI observed on consumption of CLP added ragi rotis of both the varieties which may be due to higher fibre and bioactive compounds content of CLP added ragi flour compared to normal ragi flour without CLP. The beneficial effect of fibre is usually attributed either to slower gastric emptying or formation of un-absorbable complexes with available CHO in the gut lumen. Therefore it has been suggested that these two properties might result both in delayed absorption of carbohydrate and in the reduction of absolute quantity absorbed (Rasmussen *et al*. 1991). Jenkins *et al.* (1982) have reported that if maximal benefit (lowest blood glucose level) is to be realized from low glycemic foods, attention must be paid to the amount of heat used in the preparation as it affect on digestibility and hence glycemic response to a food. It is possible that prolonged heat might alter the relationship between starch and fibre, making the starch more readily available and resulting in abolishing the effect on glycemia. The lesser time for the preparation of ragi roti may have been responsible for the lesser or no fracturing the starch granules, resulting in lower glycemic response.

Conclusion

From the present study, it is therefore concluded that brown ragi roti incorporated with CLP had lowest GI whereas white ragi roti got highest GI. The GI of CLP incorporated ragi rotis of brown and white ragi rotis is less compared to plain ragi. From this study it is evident that ragi roti/CLP incorporated ragi roti of both the varieties have intermediate glycemic index making ragi roti a good breakfast for diabetics in general. Curry leaf powder can be incorporated in the traditional breakfast items to enhance nutritional composition while at the same time help in reducing the GI value.

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