Glycemic and Lipemic Response to Various Regional Meals and South Indian Snacks

UV Mani, IU Mani, UM Iyer, B Prakash, T Manivannan, S Campbell, S Chandalia.

ABSTRACT

The glycemic index (GI) and the triacyglycerol response were determined in ninety normal subjects given 75g carbohydrate portions of various South Indian snacks and regional Indian meals. The glycemic and lipemic responses obtained varied considerably. Certain fast-moving South Indian snacks (such as Idli with chutney and Dosai with Podi) showed higher GI's as compared to other traditional South-Indian snacks. The South Indian whole meal had the lowest glycemic and lipemic response amongst all regional meals. Differences in glycemic and lipemic indices between traditional and fast-moving South Indian snacks and between regional meals may be attributed to leguminous (pulse) starch and amylose content, protein and fat content, fiber (soluble) content, method and duration of processing and cooking and process of fermentation. The effective use of this information will permit prescription of mixed meals with low GI in the diabetic diet, thus contributing significantly towards optimal control of diabetes.

INTRODUCTION

Diet has a pre-eminent role among the various modalities of treatment used in the management of diabetes mellitus, because it is unlikely to produce any adverse effects. Unfortunately only about 10% of diabetics can be controlled by diet alone. Diabetics on oral hypoglycemic agents (OHA) and insulin also require meal planning to achieve metabolic control. Reduction of post-prandial glycemia is now considered a desirable goal for the control and management of diabetes mellitus. Dietary therapy can be singularly effective in controlling post-prandial hyperglycemia [1,2,3]. In addition, it can effectively control hyperlipidemia and abnormal protein metabolism [4,5,6,7,8].

The pioneering work of Jenkins et al [9] popularised the concept of Glycemic Index (GI) of foods as a method of ranking foods on the basis of the blood glucose response they produce. This concept emerged as ph`ysiological basis for ranking carbohydrate foods according to the blood glucose response they produce on ingestion. The same weight of carbohydrate in different foods on the basis of the blood glucose response they produce. This concept emerged as a physiological basis for ranking carbohydrate foods according to the blood glucose response they produce on ingestion. The same weight of carbohydrate in different foods can produce widely different glucose responses. Our earlier studies with various foods have described varied glycemic indices. In this respect it is of importance to examine the glycemic response of mixed meals versus individual foods for effective therapeutic application. A number of foods have been tested for their GI, but many Indian foods still need to be examined to be applicable to Indian populations. Few traditional and conventional Indian foods have been studied, yet the data is scanty, except for foods evaluated by Dilawari et al [10], Akhtar et [11] and Mani et al [1,2]. They studied the glycemic response to cereals, legumes and dals. Lipid abnormality is a prominent feature of the NIDDM syndrome and is a major contributing factor in the development of secondary complications. Hence, determination of the lipemic response also is equally important in ranking the foods. With increasing acculturation, unhealthy dietary trends are likely to set in developing countries. This has led to the need for scrutinising traditional diets versus current diets for their GI's. Hence, the present study was undertaken to determine the glycemic and lipemic responses to various regional meals and South Indian snacks.

MATERIAL AND METHODS

Three separate sets of experiments were performed with normal volunteers in broad groups of thirty each.

Meals were equicarbohydrate (75 gms) and most recipes were cereal-pulse combinations. Meals selected and standardised were:

South Indian Meals : South Indian whole meal, Bisibelle Bhat, Sambar Rice, Rasam rice with papad and Curd rice with curry leaves chutney.

South Indian Snacks : Adai with chutney, Idli with chutney, Uthapam with chutney, Dosai with Podi and Pongal with Sambar.

Current Regional Diets : Punjabi Meal, Gujarati meal and Bengali meal

Dept. of Foods & Nutrition, M.S. University of Baroda, Gujarat, India.

The composition of the above recipes was calculated using food tables compiled by Gopalan et al [12] (Table 1).

Table 1 : Nutrient Composition of Recipes

Sr. No.	Recipe	Energy (Kcal)	Cabohydrate (gm)	Protein (gm)	Fat (gm)	Fibre (gm)
1	Pongal with Sambar	530	77.55	16.24	17.42	1.37
2	Bisibelle Bhat	575	77.86	17.95	20.89	3.82
3	Uthapam with Chutney	530	77.74	12.88	28.26	1.92
4	South Indian Meal	612	74.2	15.19	28.12	2.95
5	Curd Rice with Curry leaves Chutney	505	76.54	16.00	15.28	2.63
6	Punjabi Meal	585	76.60	17.30	21.90	4.09
7	Adai with chutney	580	75.80	24.80	24.80	1.29
8	Bengali Meal	634	75.80	24.80	24.80	1.29
9	Rasam rice with Papad	400	73.60	11.10	6.97	0.87
10	Gujarati Meal	573	76.00	12.60	24.50	1.02
11	Sambar Rice	420	77.30	11.54	7.58	1.69
12	Dosai with Podi	562	75.40	14.59	22.43	1.28
13	Idli with Chutney	595	74.99	14.64	26.60	1.48

A total of ninety normal subjects were selected from the Department of Foods and Nutrition. Enrollment of subjects was done by selecting randomly individuals free from any apparent complications. Enrolled subjects were within the age group of 18 to 24 years. Each broad group contained thirty volunteers each. They were further randomly sub-divided into five groups comprising six subjects each. Each group was fed the test recipe. Anthropometric measurements such as height (cm) and weight (kg) were recorded.

Collection of blood samples was done in the following manner: On the first visit, an oral glucose tolerance test (OGTT) was carried out for all the individuals using 75 gms glucose. Blood glucose was estimated in the fasting and post-prandial (1 and 2h) samples by the o-toluidine method [13]. Plasma triglyceride response was determined in fasting and two hour pp blood samples using Foster and Dunn method [14]. Within seven days, the subjects were given the test meal or snack containing 75 grams carbohydrate which was eaten in 8-10 minutes. Blood glucose and plasma triglyceride were estimated as described for OGTT.

Analysis was done on the blood samples by calculating the glycemic index of the foods using the methods described by Jenkins et al [9]. This was done by determining the ratio of the area under the glucose response curve for the food and the area for the OGTT. Triacylglyceral response was calculated from the percentage rise or fall in the mean triglycerol response was calculated from the percentage rise or fall in the mean triglyceride level compared with the mean fasting values for each meal.

Stastical analysis was conducted for the glycemic and lipemic responses of the meals by calculating the sample mean and standard deviation.

RESULTS

The GI values for the regional meals and south Indian snacks are given in Table 2. Among the

South-Indian snacks, Bisbelle Bhat and Pongal with Sambar elicited the lowest glycemic response, whereas current fast moving South-Indian snacks like Dosai with Podi and Idli with chutney showed the highest glycemic response. Among regional meals, the South- Indian whole meal displayed the lowest GI as compared to the Gujarati meal which showed the highest GI. The lipemic response for the various regional meals and South-Indian snacks are given in Table 3. The lipemic response was lowest showing a fall in triglyceride levels with the South-Indian whole meal (-6.3); whereas it was highest with the Gujarati meal (+18.5), although the fat content of the recipes were similar (28.1 gm, 24.5gm).

Table 2 : Glycemic Responses to Various Regional Meals and South-Indian Snacks

Sr. No.	Food Item	Glycemic Indice (%) (Mean ± SD)
1	Pongal with Sambar	53.6 ± 2.4
2	Bisibelle Bhat	58.0 ± 5.5
3	Uthapam with Chutney	63.0 ± 3.0
4	South Indian Meal	63.3 ± 4.3
5	Curd Rice with Curry leaves Chutney	65.4 ± 5.1
6	Punjabi Meal	68.0 ± 19.2
7	Adai with chutney	69.6 ± 8.1
8	Bengali Meal	69.9 ± 16.5
9	Rasam rice with Papad	77.5 ± 6.5
10	Gujarati Meal	83.0 ± 11.4
11	Sambar Rice	83.1 ± 5.2
12	Dosai with with Podi	91.3 ± 2.5
13	Idli with Chutney	101.5 ± 7.5

Table 3 : Lipemic Responses to Various Regional Meals and South-Indian Snacks

Sr. No.	Food Item	Lipemic Response (% rise / fall in Triglyceride) Mean
1	Pongal with Sambar	- 6.3
2	Bisibelle Bhat	+ 2.2
3	Uthapam with Chutney	+ 6.4
4	South Indian Meal	+ 7.1
5	Curd Rice with Curry leaves Chutney	+ 8.5
6	Punjabi Meal	+ 8.6
7	Adai with chutney	+ 9.5

8	Bengali Meal	+ 10.2
9	Rasam rice with Papad	+ 10.7
10	Gujarati Meal	+ 12.5
11	Sambar Rice	+ 15.4
12	Dosai with with Podi	+ 16.2
13	Idli with Chutney	+ 18.0

DISCUSSION

The concept of GI of various foods has emerged as a boon to dietary therapy of diabetes mellitus, indicating the beneficial aspect of foods consumed both individually and as mixed meals. Studies conducted by O'Dea et al [15], Jenkins et al [16], Thorne et al [17] and Mani et al [1] have shown that foods providing equicarbohydrate portion elicit different post-prandial glycemic responses. The differences observed in GI are attributable to a number of factors such as nature of source of starch, structure of starch granules, content of leguminous (pulse) starch and amylose, dietary fiber content, protein and fat content, the physical form of foods, the method and duration of processing (polishing, grinding etc) and cooking (baking, roasting, steaming, etc) and their anti-nutrient content. Considering all the factors affecting GI, it is essential that many more foods, meals and snacks should be screened for their glycemic response and their usefulness in planning diabetic diets. Several studies have determined the glycemic responses to foods consumed in Indian dishes [10] and common Pakistani dishes [11]. Determination of GI for most commonly used single foods and mixed meals in the region of Baroda (India) was also done [1,2]. The results of the above studies showed varied glycemic and lipemic responses.

Krezowski et [18] studied the effect of starch structure on the glucose and insulin response in both normal and diabetic subjects. Starch granules in cereal grains are structurally different from those in leguminous seeds. Differences in particle size and surface area result in altered digestion by hydrolytic enzymes. Rice starch granules are small and angular, probably resulting in a higher GI. The ratio of amylose to amylopectin content and the amylopectinbranching pattern affects the physical characteristics of starch with regard to its cooking quality and digestibility Legumes and dals have a higher amylose content (30-40%) which is more resistant to cooking and digestion than amylopectin. Rice has a higher amylopectin content which may partially explain the higher GI of rice. As all the recipes were cereal-pulse combinations, the difference in GI among South-Indian snacks may be attributed to the type, amount and proportion of pulse (dal) used. Bisibelle Bhat and Pongal with sambar contained cereal-pulses ratio of 3:1. The lower GI of the former two recipes may be explained by presence of grater proportion of pulse-starch and amylose content. Among regional meals, the South-Indian whole meal showed the lowest GI as compared to the Gujarati meal probably due to the type and amount of protein i.e. pulse-starch present.

Dietary fiber, due to its viscous nature inhabits starch digestion and absorption. The fiber in pulses known as guar or galactomannan is more viscous than that in cereals and may be responsible for more pronounced hypoglycemic effect as compared to cereals [19,20]. Animal and human studies have revealed that cereal fiber per se had no direct effect on glycemic response. Studies on the effect of supplementation with wheat bran on the blood glucose response to different breads showed little effect in decreasing hyperglycemic and no significant effect in decreasing hyperlipidemia [4,5,6,7,21,22]. The GI of selected cereal and cereal-green leafy vegetables combinations were determined in NIDDM patients. Recipes with cereal and green leafy vegetable elicited a lower GI than those with cereal alone. This could be attributed to the presence of dietary fiber in vegetables, known to have an inhibitory effect on starch digestibility. The crude soluble fibers which release the sugars slowly by increasing viscosity between the food and the brush border [3].

The low GI shown by Bisibelle Bhat may be due to a higher amount of crude fiber present in this recipe as compared to other recipes. The crude fiber content of all other recipes was more or less similar,

however they displayed a varied GI. This may be due to the type of fiber present. Bisibelle Bhat and Pongal with sambar have a higher legume content and therefore a higher soluble fiber content as compared to Idli with chutney and Dosai with Podi.

Among the Regional meals, the South-Indian whole meal showed the lowest GI as compared to the Gujarati meal probably due to higher soluble fiber content obtained from pulses and vegetables.

Many foods contain anti-nutrients such as enzymeinhibitors, phytates, tannins and lectins which have been found to influence starch digestibility and correlate negatively with glycemic response. Amylose inhibitors are present in many raw foods, including legumes. They have been found to improve blood glucose control in diabetics. [9,23,24] Phytates are
structurally capable of combining via phosphate linkage with starch. It could affect the digestibility of starch through combination with those proteins closely associated with starch and with digestive enzymes.

Low GI of Pongal with Sambar and Bisibelle Bhat may be attributed to the presence of anti-nutrient namely phytin – P present in green gram dal. More information is required before any conclusions can be reached about the effect of anti-nutrients on GI of foods.

The physical form of food, method of cooking and preparation also affect starch digestion and thereby post-prandial glycemic response [25,26]. Grinding and cooking (gelatinisation) disrupts starch granules so that they are rendered available for hydrolysis in the intestine. Collings et al [27] found that raw and cooked starches produced significantly different responses in-vivo with greater response on cooking. High amylose containing starch granules are less easily distributed and hydrolysed at a slower rate by digestive enzymes. Thus, the higher GI of rice alone maybe attributed also to the process of pressure cooking [18,23,26]. Decreasing the particle size by grinding greatly increases the surface area and results in rapid digestion and absorption. O'Dea et al [15] noted that cooking ground rice resulted in significantly higher glycemic and lipemic responses than that seen with whole grained rice in normal and diabetic subjects. Similar results were noted with lentils [25]. Grinding raw foods and then cooking increases the degree of starch gelatisation, rate of starch digestion and enhances the glycemic response.

Bisibelle Bhat and Pongal with Sambar elicited lower GI's as compared to Idli with chutney and Dosai with Podi probably due to use of whole grain rice and dal rather then ground rice and dal in cooking. The later two recipes displayed the highest GI's compared to other ground cereals-pulse based recipes such as Idli with chutney and Uthapam with chutney. This could be due to the extent of grinding of the grains in the extent of grinding of the grains in the last two recipes which contained coarser paste. Although the Dosai batter is a finer paste than even the Idli batter, it elicited a lower GI due to the combination of Dosai with Podi, a pulse based preparetion.

Bisibelle Bhat and Pongal with Sambar, prepared by pressure-cooking displayed lower GI's compared to other recipes which were ground and then prepared by shallow frying. Idli chutney though steamed showed the highest GI probably due to other influencing factors.

Fermentation is said to improve the digestibility of foods as micro-organisms involved in this process synthesize and secret enzymes which bring about partial degradation of starch and protein [28]. Higher GI values of Idli with chutney and Dosai with Podi may be attributed to the process of fermentation.

Diabetes mellitus causes not only disturbance in carbohydrate metabolism but also brings about changes in lipid metabolism, especially cholesterol and triglyceride which promote secondary complications [29, 30]. In view of this finding, friglyceride response of the meals was also monitored in the present study.

In the study conducted on the GI of certain conventional carbohydrate meals, the triacylgycerol responses did not correlate with the fat content of the meal [2]. Yet another study done on the GI of traditional Indian carbohydrate foods indicated no correlation between the triglyceride and glycemic responses [1]. The hypocholesterolemic effect of dietary fiber from common pulses has been studied [31]. A high fiber, high carbohydrate diet was said to prevent a hypertriglyceridemic response to a highcarbohydrate diet [32].

The lowest lipemic response was seen as a fall in triglyceride levels with the South Indian whole meal as compared to the highest response, in the Gujarati meal, inspite of similar fat content. This could be attributed to the amount and type of fiber present in the two recipes (2.95gm, 1.02gm) originating from pulses. Inspite of comparable protein and fat content

of all receips, a wide range of lipemic responses were observed. This could be attributed additionally, to other factors like the physical form, method and duration of cooking.

Jenkins et al [19] showed that low GI diets may be useful in the management of lipid abnormalities associated with hypertriglyceridemia by reducing the LDL cholesterol, total cholesterol and serum triglyceride levels, but no change in HDL cholesterol. For NIDDM patients, foods that evoke a low triglyceride response may have value in the dietary management of the disease. Further studies are necessary to verify preliminary findings on the effect of each factor influencing GI. It can be concluded that the information obtained on the GI of traditional and current mixed meals is an effective clinical tool in formulating the diabetic diet.

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