

## Glycaemic Index of Sri Lankan Meals

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### Abstract

Glycemic Index (GI) is the measure of increase in blood glucose level after intake of food rich in carbohydrate related to glucose. There are many research projects have been carried out in several countries. There were no studies conducted for analyzing GI of Northern traditional food items in Sri Lanka. This study was aimed to determine the GI values of our traditional foods alone and mixed meals. When dietary advices are given to diabetic and coronary heart disease patients, not only the basic foods have to be considered but also the side dishes to be consumed. Consumption of food containing fiber diet will significantly reduce the rise in blood sugar level. However recommendation of the foods should be made after analyzing the glycemic index, glycemic load and energy contents of the foods. Lower GI diets are better choices for the diabetes and coronary heart disease patients. Further studies have to be carried out on the prediabetes and diabetes. This study will be useful to Physicians and public to decide on the consumption of fruits particularly by the diabetic and coronary heart disease patients in Sri Lanka.

**Keywords:** Blood glucose; Meals; Coronary heart disease; Carbohydrates; Diabetics

### Introduction

Glycemic Index (GI) is the measure of increase in blood glucose level after intake of food rich in carbohydrate related to glucose. i.e. GI of food represents its blood-glucose raising potential [1]. It is a ranking system for carbohydrates based on their effect on blood glucose levels [2]. The concept was invented by Dr. David, J. Jenkins et al. in 1981 at the University of Toronto [3]. Glycemic Index is defined as “the incremental area under the blood glucose response curve of 75 g carbohydrate portion of a food Expressed as a percent of response to same amount of carbohydrate from a standard food taken by same subject” [1].

It ranks foods on a scale from 0-100, according to their actual effect on blood glucose level [4]

On GI scale, glucose is taken as 100, because it causes greatest and most rapid rise in blood glucose. All other foods related in comparison to glucose. Foods with an index number of 70 (or) more are considered to be of high GI, with index number between 55-70 as medium GI, and 55 (or) less as low GI [5]. Low GI diets help people to lose and control body weight [6], improve diabetic control and heart disease [7], increase body sensitivity to insulin [8], reduce blood glucose level [9] and prolong physical endurance [10].

### Sri Lankan Meals

The different varieties of rice (*Oryza sativa*) such as (white rice ('Bg-11-11'), raw brown rice ('At- 402') and parboiled rice ('Mottaikarupan') and raw mottaiarupan rice were main lunch time meals. 'Pittu', String hoppers', 'Thosai', 'Idly' are mainly consumed as breakfast/dinner meals. 'Pittu' are usually prepared from wheat flour, rice flour, 'atta' flour (whole wheat flour) and 'kurakkan' (*Eleusine*

*coracana*). These meals are eaten with either green leaf curry (*Amaranthus sp.*) or soya meat gram gravy or 'Sambol' or 'Sampar' made of ravae vegetables such as tomatoes, carrot, drum strict, bringoles and yellow dhal. *Manihot esculenta* (boiled cassava) and legumes like *Vigna radiata* (boiled green gram) and *Cicer arietinum* (boiled chick pea), bakery products (bread, normal bun, butter cake, hard bun and rusk) are also consumed as snack meals. The fruits like different varieties of plantain (*Musa spp*) Tamil-'Kathali' (Sinhala-'Embul'), Tamil-'Kappal' (Sinhala-'Kolikuttu') and Tamil-'Itharai' (Sinhala-'Poo kesel'), jack fruit and papaya are consumed. All foods were analyzed for their total sugar [11], total protein [11], moisture [11], and soluble dietary fiber [12], insoluble dietary fiber [12], and total dietary fiber contents [12]. The GI values of popular traditional meals alone and mixed meals in Northern Sri Lanka were determined in Jaffna [13,14]. These results will be useful to Physicians and public to decide on the consumption of meals particularly by the diabetic and coronary heart disease patients in Sri Lanka.

### Glycemic Index Values of Sri Lankan Meals

#### Glycemic index of different varieties of rice [15-21]

The glycemic index (GI) values of cooked white rice, brown rice and parboiled rice were 66.61 ( $\pm 9.86$ ), 60.24 ( $\pm 8.16$ ) and 55.97 ( $\pm 6.01$ ) % respectively (Table 1). When fiber contents of the three cooked rice varieties were considered the cooked parboiled rice contained more soluble dietary fibers (0.42%), insoluble dietary fibers (1.88%) and total dietary fibers (2.3%), than the cooked brown rice (0.21, 1.88 and 2.09%) and cooked white rice (trace, 1.21 and 1.21%). The available carbohydrate in the foods for absorption might be made unavailable due to its soluble dietary fibers (SDF), insoluble dietary fibers (IDF) and total dietary fibers (TDF) contents. The monosaccharides released by the hydrolysis and available for absorption might be made unavailable. This could be due to the tendency of the fibers to absorb sugars and absorbed sugar released slowly. A soluble fiber slows down

the digestion of starches and absorption of the glucose in to blood stream. The total dietary fiber content of cooked parboiled rice was higher than that of the other cooked rice. When the insoluble dietary fiber is considered, the cooked parboiled rice contained same amount (1.88%) and the cooked white rice contained lower (1.21%) than other varieties. However the total dietary fiber contents of cooked parboiled rice and brown rice varieties were closer to each other. Thus the parboiled rice variety is a better choice for the diabetics and coronary heart disease patients [15].

### Food items prepared from rice flour [15-21]

The mean glycemic index values of 'Pittu' and 'string hopper' were 43.74 ( $\pm 9.09$ ) and 50.01 ( $\pm 7.06$ )% respectively (Table 1). When the fiber content of 'pittu' and string hopper were considered 'pittu' contained more soluble dietary fibers than (0.45%), insoluble dietary fiber (1.56%) and total dietary fiber (2.01%) and string hopper contained soluble dietary fibers 0.43%, insoluble dietary fiber 1.45% and total dietary fiber 1.88%. The total dietary fiber of 'pittu' was higher than that of string hopper. 'pittu' and string hoppers are made out of roasted rice flour and steamed wheat flour. When the rice flour is roasted heat might have initiated the Mailard reaction and caramelization. With steaming the starch exposed to moist heat may undergo gelatinization and subsequently they may have retrograded causing a lowering effect on glycemic index. This might be the reason for the lower glycemic index values for 'pittu' and string hoppers when compared with cooked rice.

### Glycemic Index values of some tubers and legumes [15-21]

The glycemic index (GI) values of cassava (*Manihot esculenta*), potato (*Solanum tuberosum*, *Nuwara Elia*), boiled green gram (*Vigna radiata*) and chick pea (*Cicer arietinum*) were determined (Table 1).

When boiled potato or cassava, which contained 75 g digestible carbohydrate, was administered to the volunteers the peak blood glucose level was obtained at 30 min. The mean glycemic index values of potato and cassava were 65.2 ( $\pm 6.56$ ) and 78.7 ( $\pm 7.3$ %). When the

fiber contents of boiled potato and cassava are considered, the soluble dietary fiber (0.48%, 0.47%), insoluble dietary fiber (1.21%, 2.18) and total dietary fiber (1.69%, 2.65) respectively. the mean glycemic response to boiled potato and boiled cassava were 40.8 ( $\pm 4.11$ ) and 49.3 ( $\pm 4.57$ ) mg dl-1 respectively. These values could not be due to the effect of soluble dietary fiber or insoluble dietary fiber in these two food items [15]. Because the boiled potato and cassava contained almost same amount of SDF and the boiled cassava contained higher IDF than boiled potato. Hence the fiber content did not affect the glycemic response of boiled potato and boiled cassava. Cooking also has shown to exert a differential effect on GI of a carbohydrate - rich food, particularly one that is high in starch. In the boiled and cooled potato the processing could have formed the resistant starch. Thus the variation in the glycemic index of boiled potato from boiled cassava could be due to more resistant starch formation in during boiling and cooling of potato and cassava. Thus cassava is a high GI diet.

When boiled green gram or chickpea, which contained 75 g digestible carbohydrate, was administered to the volunteers the peak blood glucose level was obtained at 60 min. The mean glycemic index values of boiled green gram and boiled chickpea were 31.4 ( $\pm 6.96$ ) and 33.3 ( $\pm 6.23$ %). When the fiber contents of boiled green gram and chickpea are considered, the soluble dietary fiber (0.43%, 0.4%), insoluble dietary fiber (8.8%, 7.2%) and total dietary fiber (9.2%, 7.6%) respectively. The mean glycemic response to boiled green gram and boiled chickpea were 19.7 ( $\pm 4.36$ ) and 20.8 ( $\pm 3.9$ ) mg dl-1 respectively. Boiled green gram contained more soluble dietary fibers, insoluble dietary fiber and total dietary fiber than chickpea. Due to higher fiber content of boiled green gram and chickpea the glycemic response was delayed ad were less [15,18]. Boiled green gram and chickpea are low GI diets and are good for diabetic and coronary heart disease patients.

### Glycemic Index values of some bakery products [22]

The glycemic index of the bakery products such as bread, normal bun, butter cake, hard bun, and rusk available in Jaffna was determined (Table 1).

Foods	GI
<b>Low Glycemic Index Foods; (GI&lt;55)</b>	
Pittu (Rice flour: Wheat flour=2:1)	43.74
String hopper (Rice flour: Wheat flour=2:1)	50.01
Greengram	31.43
Chickpea	33.27
Papaya	34.80
'Kathali' plantain	54.45
'Kappal' plantain	50.43
'ltharai' plantain	48.47
Hard bun	50.30
Rusk	52.78
<b>Intermediate Glycemic Index Foods (GI 55-70)</b>	

'Idly'	58.37
'Thosai'	63.57
White rice	66.61
Red rice	60.24
Parboiled rice	55.97
Semi boiled potato	65.16
Jack fruit	65.16
Wheat flour bread	68.57
Buns	67.30
Butter cake	64.72
<b>High Glycemic Index Foods (GI&gt;70)</b>	
Boiled cassava	78.67

**Table 1:** Glycemic index of Northern Sri Lankan meals.

When fiber contents of the bread and normal bun were considered, bread contained less soluble dietary fiber (0.5%) and more insoluble dietary (2.73%) and total dietary fibers (3.23%), than the normal bun (0.56, 2.43 and 2.99% respectively). The SDF, IDF and TDF of wheat bread and normal bun did not show much difference. Even though, bread contains higher IDF, the mean glycemic response to bread is higher ( $43.0 \pm 2.32 \text{ gL}^{-1}$ ) than the normal bun ( $42.2 \pm 3.15 \text{ gL}^{-1}$ ). It could be due to the less amount of SDF in wheat bread.

When fiber contents of the normal bun and hard bun were considered, hard bun contained more soluble dietary fiber (0.76%), insoluble dietary fiber (2.99%) and total dietary fibers (3.75%), than the normal bun (0.56, 2.43 and 2.99% respectively). The mean glycemic response to normal bun ( $42.2 \pm 3.15 \text{ gL}^{-1}$ ) is higher than the hard bun ( $33.1 \pm 3.39 \text{ gL}^{-1}$ ). This could be due to the effects of SDF, IDF and TDF in these buns.

The soluble dietary fiber (0.6%), insoluble dietary fiber (2.57%) and total dietary fibers (3.17%), of butter cake were higher than the bread and normal bun. The mean glycemic response to butter cake was  $40.5 (\pm 4.03 \text{ gL}^{-1})$  and this was lower than those of bread and normal bun and this could be due to the higher dietary fiber content while the fat content did not influence.

Rusk contained more soluble dietary fiber (0.87%), insoluble dietary fiber (3.18%) and total dietary fiber (4.05%) than other bakery products. Among all the bakery products, rusk gave the lowest glycemic response ( $31.1 \pm 3.03 \text{ mgdL}^{-1}$ ). Here the soluble dietary fiber highly influenced the glycemic response than insoluble dietary fiber. The hard bun and rusk are lower GI diets (GI values <55%). Bread, normal bun and butter cake are medium GI diets (GI values between 55-70%).

### Glycemic Index values of some fruits [23]

This glycemic index (GI) values of fruits such as 'Kathali' (Yellow plantain), 'Kappal' (Golden plantain), and 'Itharai' (Green plantain) varieties of plantains, jackfruit and papaya were studied. The mean GI values of the 'Kathali', 'Kappal', 'Itharai' varieties of plantains, jack

fruit and papaya were  $54.45 (\pm 9.26)$ ,  $50.43 (\pm 5.79)$ ,  $48.47 (\pm 10.13)$ ,  $65.36 (\pm 8.00)$  and  $34.80 (\pm 12.78)\%$  respectively (Table 1). The three varieties of plantains and papaya were low GI fruits, and jackfruit was found to be an intermediate GI fruit. The presence of dietary fiber, esp. soluble fiber, reduces the glycemic response and glycemic index of foods. Thus among the different types of plantain varieties, ripped 'ithari' is best followed by kappal. However among the fruits, papaya is the best followed by 'Ithari' variety of plantain [23].

### Effect of side dishes on Glycemic Index [24-31]

The mean GI values of parboiled rice ('*Mottaikarupani*'), '*kurakkan pittu*' (*Eleusine coracana*) and '*atta pittu*' (whole wheat grain flour) either with green leaf curry (*Amaranthus*) or gravy (soya meat) or green leaf curry and gravy were determined (Table 2) [24-27]. The mean GI values of 'Thosai'/'Idly' either with 'sambol' or 'sambol' and plantain ('itharai') or 'sampar' or 'sampar' and plantain or 'sambol' and 'sampar' or 'sambol', 'sampar' and plantain were also determined (Table 2) [28-31].

The GI of parboiled rice or '*kurakkan pittu*' or '*atta pittu*' with green leaf curry differed significantly ( $p < 0.05$ ) from other combined foods. The GI of parboiled rice or '*kurakkan pittu*' or '*atta pittu*' with gravy or green leaf curry and gravy did not differ significantly ( $p > 0.05$ ) among them. '*Kurakkan pittu*' is inferior to '*atta pittu*' and parboiled rice [24]. Including curries to basic foods altered the GI. Therefore, when dietary advice is given to diabetic patients, not only the basic foods, but also the curries to be consumed have to be considered. From the findings it could be concluded that among the starch sources '*atta flour*' pittu was the best followed by parboiled rice [24,25]. Even though we have had believed that 'kurakan' and its flour are good starch based diets for diabetics and CVD patients, and obese and overweight persons. The results indicated that the foods made out of 'kurakan flour should not be recommended for diabetics [24].

The GI values were decreased when the foods were consumed with 'sambol' [28,29]. Addition of 'Itharai' variety of plantain to above basic foods was significantly decreased Glycemic index of each mixed meals ( $P < 0.05$ ) [30]. This was due high fiber content of plantain (TDF-3.7%,

SDF-0.7%, IDF-2.9%). An increase in the fiber content of food can delay the glycemic response [24,28,30,31]. Fiber delays the digestion of starch in the stomach, transition time of the stomach contents to the duodenum, delay the diffusion of different saccharides in the duodenum, delay the hydrolysis of polysaccharides in the duodenum and delay the absorption of monosaccharides through the microvillai of the epithelial cells of the jejunum and the upper part of the ileum. Total dietary fiber content has a significant negative correlation with GI.

The composition of the food or meal will influence the blood glucose response. Further foods within the same classification can have different glycemic indices. Furthermore processing of the food influences the GI. During cooking gelatinization of starch takes place, the cell walls are ruptured and the starch molecules are released. Therefore structural integrity of cell wall and starch granules also determine the glycemic index. Thus, when consuming the basic foods with different side dishes, the GI values would be altered.

Foods		Glycemic Index
Main food items	Side dishes	
Parboiled Rice	Green leaf curry	47.47
	Soya meat gravy	56.30
	Green leaf curry+Soya meat gravy	54.67
'Kurakkan' Pittu	Green leaf curry	57.51
	Soya meat gravy	63.25
	Green leaf curry+Soya meat gravy	50.25
'Atta' Pittu	Green leaf curry	44.40
	Soya meat gravy	50.80
	Green leaf curry+Soya meat gravy	46.28
'Thosai'	Sambol	67.93
	Sambol+'ltharai'plantain	60.17
	Sambar	71.90
	Sambar+'ltharai'plantain	68.59
	Sambol+Sambar	65.63
	Sambol+Sambar+'ltharai'plantain	63.0
'Idly'	Sambol	56.85
	Sambol+'ltharai'plantain	51.10
	Sambar	70.32
	Sambar+'ltharai'plantain	67.45
	Sambol+Sambar	63.09
	Sambol+Sambar+'ltharai'plantain	61.30

**Table 2:** Glycemic Index values of mixed meals in Northern Sri Lanka.

## Conclusions

'Pittu', 'string hopper', green gram and chick pea, hard bun, rusk, three varieties of plantains and papaya are lower GI diets (GI values <55%). White rice, brown rice, parboiled rice, bread, normal bun, butter cake and jack fruit are medium GI diets (GI values between 55-70%). Cassava is high glycemic index diet (GI value>70%).

Parboiled rice either with green leaf curry or green leaf curry and gravy, '*atta pittu*' either with green leaf curry or gravy, or green leaf curry and gravy are lower GI diets (GI values<55%). Parboiled rice with gravy, '*kurakkan pittu*' either with green leaf curry or gravy or

green leaf curry and gravy are medium GI diets (GI values between 55 to 70%).

'Thosai' either with 'sambol' or 'sambol' and plantain or 'sambar' and plantain or 'sambol' and 'sambar' or 'sambol', 'sambar' and plantain are medium GI foods (the GI values between 55 to 70%). The 'Thosai' either with 'sambar' is high GI food (the GI values are more than 70 %).

'Idly' with 'sambol' and plantain ('ltharai') is lower GI food. The 'Idly' either with 'sambol' or 'sambar' and plantain ('ltharai') or

'sambol' and 'sampar' or 'sambol', 'sampar' and plantain ('Itharai') are medium GI foods. The 'Idly' with 'sampar' are high GI foods.

Low glycemic index diets (GI<55%) are advisable for patients with diabetes and coronary heart disease 'Atta pittu' is the best choice for them followed by parboiled rice. Even though 'kurakkan pittu' was thought to be a good meal for these patients, it is inferior to 'atta pittu' and parboiled rice. Consumption of soluble fiber rich diets such as green leaf curry or 'Itharai' variety of plantain with main meals significantly reduces the rise in blood sugar level. Therefore, when dietary advices are given to diabetic patients, not only the basic foods have to be considered but also the side dishes to be consumed. However recommendation of the foods should be made after analyzing the glycemic index, glycemic load and energy contents of the foods.

Further studies have to be carried out on the prediabetes and diabetes.

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