Effect of soluble fiber on glycaemic index

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ABSTRACT

Aim: This study was aimed at evaluating the glycaemic index (GI) values of some foods in Jaffna, Sri Lanka such as cooked white rice, brown rice, parboiled rice, 'Pittu', 'string hopper', cassava, boiled green gram and chick pea. The results will be helpful to physicians and public to decide on the consumption of foods particularly by the diabetic and coronary heart disease patients.

Methods: Healthy volunteers (n=22) were selected with their written consent. After overnight fasting, 75g glucose and each test food containing 75g digestible carbohydrate were administered and blood glucose levels were measured half hourly for two hours. The glycaemic responses and GI values were calculated and analyzed by Randomized Complete Block Design using SAS analytical package.

Results: The mean (SD) glycaemic response values of cooked white rice, brown rice, parboiled rice, 'Pittu', 'string hopper', boiled cassava, green gram and chick pea were 41.71 (6.71), 37.72 (5.11), 35.05 (3.77), 27.39 (5.69), 31.32 (4.42), 49.26 (4.57), 19.68 (4.36) and 20.83 (3.90) mg/dL, respectively. The mean (SD) GI values of cooked white rice, brown rice, parboiled rice, 'Pittu', 'string hopper', boiled cassava, green gram and chick pea were 66.61 (9.86), 60.24 (8.16), 55.97 (6.01), 43.74 (9.09), 50.01 (7.06), 78.67 (7.30), 31.43 (6.96) and 33.27 (6.23)%, respectively. The GI values of cooked white rice differed significantly ($P<0.05$) from brown rice and parboiled rice. The GI values of 'Pittu' differed significantly ($P<0.05$) from string hopper. The GI values of boiled cassava differed significantly ($P<0.05$) from boiled green gram and chick pea. The GI value of boiled green gram did not differ significantly ($P>0.05$) from chick pea.

Conclusions: 'Pittu', 'string hopper', boiled green gram and chick pea were low GI diets. Cooked white rice, brown rice and parboiled rice were intermediate GI diets. Cassava was a high GI diet. As low GI diets are good for diabetic and coronary heart disease patients, precaution has to be taken when selecting the correct diets.

Keywords: Glycaemic index, glycaemic response, rice flour, legumes, fiber, diabetes

Introduction

Glycaemic index (GI) is defined as the incremental area under the blood glucose response curve elicited over a two-hour period by a 75g carbohydrate portion of a food, expressed as a percentage of the response to the same amount of carbohydrate from a standard food taken by the same subject (1). It is an important parameter which compares the hyperglycaemic effect of a tested meal with pure glucose (2). It measures the rate at which the carbohydrate in certain food is digested and absorbed into blood stream as glucose, i.e. GI of food represents its blood-glucose raising potential (3). It ranks carbohydrates according to their effects on blood glucose levels. The blood glucose response to a food is reflected by its glycaemic index. It ranks foods on a scale from 0-100 according to their actual effect on blood glucose level. Food with a GI value of 70 or more are considered to be high GI diet, with an index value between 55 to 69 as medium GI diet and less than 55 as low GI diet (4).

A lower glycaemic index suggests slower rates of digestion and absorption of the sugars and starches in the foods and may also indicate greater extraction from the liver and periphery of the products of carbohydrate digestion. Reducing the glycaemic index of carbohydrate rich foods in diet may decrease the metabolic risk (5). High glycaemic index is also associated with liver steatosis (6). A lower glycaemic response is often thought to equate to a lower insulin demand, better long-term blood glucose control and a reduction in blood lipids. Prolonged exposure to hyperglycemia can promote macro-and microvascular diseases (7,8). Dietary glycaemic index is inversely associated with total Moos Menstrual Distress Questionnaire (MDQ) score in the premenstrual phase (9) and Parkinson's disease (10).

Previous reports indicate the changes in blood glucose response to Sri Lankan diets and the effects of different curries on glycaemic index (11,12). The objective of this study was to find out the GI values of common foods recommend to patients with diabetes mellitus, obesity and coronary heart disease. The evaluation of GI values will help the local public to decide on the diets which have to be consumed. Hence, in this study the GI values of frequently consumed foods such as different varieties of rice (*Oryza sativa*) such as cooked white rice ('Bg-11-11'), brown rice ('At-402') & parboiled rice ('Mottaikarupan'), traditional foods such as 'Pittu', 'string hopper', *Manihot esculenta* (boiled cassava) and legumes like *Vigna radiata* (boiled green gram) and *Cicer arietinum* (boiled chick pea) were determined. The local people in the study area consume different types of rice for lunch and 'Pittu' and 'string hopper' for breakfast or dinner. Boiled cassava is consumed as an evening snack or dinner while boiled legumes are consumed for breakfast or as an evening snack.

Methods and Materials

Materials

Glucose (Royal pure glucose, SmithKline Beecham Pvt Ltd, Moratuwa), different varieties of rice (*Oryza sativa*) such as white rice ('Bg-11-11'), raw brown rice ('At- 402'), parboiled rice ('Mottaikarupan') and raw 'Mottaikarupan' rice, wheat flour and *Manihot esculenta* (boiled cassava) and legumes like *Vigna radiata* (boiled green gram) and *Cicer arietinum* (boiled chick pea) were purchased from local market.

Preparation of foods

The white rice, brown rice and parboiled rice were washed well with tap water. The white rice and brown rice were cooked in excess volume of water for 30 min, while parboiled rice was cooked in excess volume of water for 40 min. The excess water was drained off and the water retained was dried off.

The wheat flour was steamed for 30 min and whole raw 'Mottaikaruppan' rice washed, dried, milled to powder and roasted for 30 min. The boiled wheat flour and roasted rice flour were mixed in 2:1 ratio. Small amount of salt water was added, mixed well after addition of hot water and cut into small pellets. The mixture was steamed in a 'Pittu' maker for 15 min.

The boiled wheat flour and roasted rice flour were mixed in 2:1. By adding hot water and small amount of salt water, the flour was mixed well to attain suitable consistency that the dough is moist enough and non-sticky. Using wooden string hopper maker, dough was laid on the bamboo frame and steamed for 15 min.

The top and bottom portion of cassava root were cut. The middle portion was cut into small pieces and was boiled for 40 min in excess boiling water. Excess water was drained off.

The green gram and chick pea were washed well in water and boiled in excess water for 25 and 40 min respectively. Excess water was drained off.

Analysis of foods

All foods were analyzed for moisture, fat, soluble dietary fiber (SDF), insoluble dietary fiber (IDF) (14) & total dietary fiber (TDF) contents (13,14).

Selection of participants

A group of 22 healthy volunteers between 20 to 24 years of age was selected and the weight and height were measured and their BMI were calculated. The volunteers who had abnormal glucose tolerance, underweight or overweight, dieting or restricting their carbohydrate intake, suffering from any illness or food allergy were excluded from the study.

The blood samples were collected and blood glucose levels were measured using the Semi-automated biochemical analyzer (TC 3300). GI and glycaemic response values were calculated (15).

Ethical clearance

The ethical clearance for this study was obtained from the 'Ethical Review Committee', Faculty of Medicine, University of Jaffna.

Statistical analysis

Glycaemic response and GI values of different types of foods were analyzed by Randomized Complete Block Design (RCBD) using SAS analytical package.

Results

Mean (SD) age, weight, height and body mass index of the participants were 24.62 (1.43) years, 63.42 (10.50) kg, 170 (0.70) cm, 21.90 (2.75) kg/m^2, respectively. When 75g of glucose was orally administered to the volunteers, the blood glucose level reached the peak value at 30min. The mean (SD) fasting blood glucose level was 84.81 (4.37) mg/dL and the mean (SD) blood glucose level at 30 min was 147.43 (11.67) mg/dL. The mean (SD) peak glycaemic response [is the measure of the impact of food on blood glucose, calculated as the increase in blood glucose level after the intake of the food] for pure glucose was 62.62 (11.45) mg/dL. After overnight fasting (12 h) 75g digestible carbohydrate containing test foods were administered to volunteers on separate days. All foods exhibited peak glycaemic response at 30min except the boiled green gram and boiled chick pea. These two foods exhibited peak glycaemic response at 60min.

Different varieties of cooked rice

The mean (SD) glycaemic response values of cooked white rice, brown rice and parboiled rice were 41.71 (6.71), 37.72 (5.11) and 35.05 (3.77) mg/dL, respectively (Table 1). The mean (SD) GI values of cooked white rice ('Bg- 11-11'), brown rice ('At-402') and parboiled rice ('Mottaikarupan') were 66.61 (9.86), 60.24 (8.16) and 55.97 (6.01)%, respectively (Table 2). The glycaemic response and GI values of cooked white rice vs brown rice; brown rice vs parboiled rice and cooked white rice vs parboiled rice, were significantly different ($p<0.05$).

Foods prepared from cereal flour

The mean (SD) glycaemic response values of 'Pittu' and 'string hopper' were 27.39 (5.69) and 31.32 (4.42) mg/dL, respectively (Table 1). The mean (SD) GI values 'Pittu' and 'string hopper' were 43.74 (9.09) and 50.01 (7.06)%, respectively (Table 2). The glycaemic response and GI values of 'Pittu' and 'string hopper' were significantly different ($p<0.05$). The glycaemic response and GI values of 'Pittu' and 'string hopper' significantly differed ($p<0.05$) from that of cooked white rice, brown rice and parboiled rice.

Boiled Cassava

The mean (SD) glycaemic response value of cooked cassava was 49.26 (4.57) mg/dL (Table 1). The mean (SD) GI value of cooked cassava was 78.67 (7.30)% (Table 2). The glycaemic response and GI values of cassava significantly differed ($p<0.05$) from that of cooked white rice, brown rice, parboiled rice, 'Pittu' and 'string hopper'.

Boiled Legumes

The mean (SD) glycaemic response values of boiled green gram and chick pea were 19.68 (4.36) and 20.83 (3.90) mg/dL, respectively (Table 1). The mean (SD) GI values of boiled green gram and chick pea were 31.43% (6.96) and 33.27% (6.23), respectively (Table 2). The glycaemic response and GI values of the boiled green gram and chickpea did not differ significantly ($p>0.05$). The glycaemic response and GI values of boiled green gram and chickpea significantly differed ($p<0.05$) from that of cooked white rice, brown rice and parboiled rice, 'Pittu', 'string hopper' and cassava.

Table 1: Glycaemic response of different basic foods obtained at 30 and 60/90 min.

Type of Food	Food items	Glycaemic response (mg/dL)		
		30 min	60min	90 min
Rice	White rice	41.71 (±6.17)	25.34 (±4.16)	
	Brown rice	37.72 (±5.11)	23.66 (±4.11)	
	Parboiled rice	35.05 (±3.77)	22.67 (±0.94)	
Foods from cereal flour	'Pittu'	27.39 (±5.69)	22.33 (±1.15)	
	'String hopper'	31.32 (±4.42)	22.0 (±1.63)	
Tuber	Cassava	49.26 (±4.57)	32.0 (±5.57)	
Legumes	Green gram	10.0 (±1.0)	19.68 (±4.36)	12.66 (±0.58)
	Chickpea	9.33 (±2.08)	20.83 (±3.90)	11.33 (±2.52)

Table 2: Exact amount different basic foods consumed and their glycaemic index values.

Type of Food	Food items (Amount g)	Total digestible carbohydrate (g)	TDF (g)	SDF (g)	IDF (g)	Total protein (g)	Glycaemic Index (%)
Rice	White rice (286.04)	75.00	3.46	Trace	3.46	4.38	66.61 (±9.86)
	Brown rice (338.0)	75.00	7.06	0.71	6.35	6.02	60.24 (±8.16)
	Parboiled rice (324.67)	75.00	7.46	1.36	6.10	7.08	55.97 (±6.01)
Foods from cereal flour	'Pittu' (166.55)	75.00	3.35	0.75	2.6	7.33	43.74 (±9.09)
	'String hopper' (200)	75.00	3.76	0.86	2.90	7.34	50.01 (±7.06)
Tuber	Cassava (232.56)	75.00	6.16	1.09	5.07	1.05	78.67 (±7.30)
Legumes	Green gram (294.92)	75.00	27.10	1.26	25.83	22.38	31.43 (±6.96)
	Chickpea (253.2)	75.00	19.22	1.01	18.21	15.21	33.27 (±6.23)

Discussion

Different varieties of cooked rice

When the glycaemic response after the consumption of three cooked varieties of rice were considered, the cooked parboiled rice gave less glycaemic response followed with cooked white rice and brown rice. The glycaemic index of cooked parboiled rice was the lowest followed with cooked white rice and brown rice. These three cooked rice varieties are medium GI diets.

During cooking, heat, amount of water and cooking time affect the GI of foods. During cooking, water and heat expand the starch granules to varying degrees. Foods containing starch that has swollen to the bursting point, like boiled or baked potatoes are more easily digested and therefore have high GI than the foods containing starch granules that are less gelatinized e.g. oatmeal, brown rice, etc. Cooked white rice has higher gelatinization degree than of other varieties of rice.

When fiber contents of the three cooked varieties of rice were considered, the cooked parboiled rice contained more SDF (0.42%), IDF (1.88%) and TDF (2.30%) than the cooked brown rice (0.21, 1.88 and 2.09%) and cooked white rice (trace, 1.21 and 1.21%), (Table 3). Due to the higher SDF content, the cooked brown rice gave lower GI value when compared with cooked white rice. The mean (SD) total protein contents of cooked white rice, brown rice and parboiled rice were 1.53 (0.02), 1.78 (0.11) and 2.18 (0.10)%, respectively (Table 3). Thus the influence of protein content on the glycaemic response after the consumption of these three varieties of cooked rice did not show a direct relationship.

Three varieties of rice (IR 42, IR 36 & IR 62) with similar chemical composition of high amylose content cooked under the same conditions showed the mean glycaemic response at 30 min (16). The mean (SD) glycaemic index of Ir42, IR36 and IR62 varieties of rice were 75.0 (4.0), 78.0 (5.0) and 81.0 (5.0)%, respectively. The mean glycaemic response of different varieties of Indonesian rice varieties also reported to be 30 min (17). Glycaemic index value of white rice (66.61%) selected in this study was closer to that of a variety of white rice from India (18). Glycaemic index value of brown rice (60.24%) considered in this study was lower than that of a brown rice from Canada (66.0%) (18). The glycaemic index values of instant rice, white rice and brown rice were 69.0%, 64.0% and 55.0%, respectively (19). The mean glycaemic index value for the cooked parboiled rice (55.97%) in this research was slightly higher than that of a variety of cooked parboiled rice (48.0%) from Canada and was lower than that of a variety of parboiled rice from USA (72.0%) (18).

Foods prepared from cereal flour

When fiber content of the 'Pittu' and 'string hopper' were considered, the 'Pittu' contained more SDF-(0.45%), IDF (1.56%) and TDF (2.01%) than 'string hopper' (0.43, 1.45 and 1.88%), (Table 3). The TDF of 'Pittu' was higher than 'string hopper'. However the SDF of 'Pittu' and 'string hopper' were closer to each other, although, the IDF and TDF contents of 'Pittu' and 'string hopper' appeared to be different. The mean glycaemic response of 'Pittu' and 'string hopper' was 27.39 and 31.32 mg/dL, respectively (Table 1). This might be due to the effect of IDF and TDF in these two foods. The 'Pittu' contained higher amount of TDF (2.01%) than 'string hopper' (1.88%).

'Pittu' and 'string hopper' contained more SDF (0.45 and 0.43%), less IDF (1.56 and 1.45%) and total dietary fiber (TDF-2.01 and 1.88%) than the cooked brown rice (0.21, 1.88 and 2.09%) and cooked parboiled rice (0.42, 1.88 and 2.30 %), respectively (Table 3), while they contained more SDF (0.45 and 0.43%), IDF (1.56 and 1.45%) and TDF (2.01 and 1.88%) than the cooked white rice (SDF-Trace, IDF-1.21% and TDF- 1.21%), (Table 3). Due to the higher SDF content, the 'Pittu' and 'string hopper' gave lower GI values than the other three varieties of rice. The total protein contents of 'Pittu', 'string hopper', cooked white rice, brown rice and parboiled rice were 4.40, 3.67, 1.53, 1.78 and 2.18, respectively (Table 3). Thus the influence of protein content on the glycaemic response after consumption of 'Pittu' and 'string hopper' showed a significant relationship with these three cooked varieties of rice.

Table 3: Proximate compositions of different basic foods

Type of Food	Food items	Composition (%)					
		Moisture (%)	Total protein (%)	SDF (%)	IDF (%)	TDF (%)	Total digestible carbohydrate (%)
Rice	White rice	62.41(±0.63)	1.53 (±0.02)	Trace	1.21 (±0.03)	1.21 (±0.03)	26.22 (±0.20)
	Brown rice	70.28 (±0.78)	1.78 (±0.11)	0.21 (±0.01)	1.88 (±0.10)	2.09 (±0.10)	22.19 (±0.17)
	Parboiled rice	65.54 (±0.48)	2.18 (±0.10)	0.42 (±0.04)	1.88 (±0.05)	2.30 (±0.06)	37.50 (±2.00)
Foods from cereal four	'Pittu'	47.43 (±0.08)	4.40 (±0.10)	0.45 (±0.01)	1.56 (±0.04)	2.01 (±0.05)	45.30 (±0.07)
	'String hopper'	53.67 (±0.48)	3.67 (±0.08)	0.43 (±0.03)	1.45 (±0.02)	1.88 (±0.03)	37.50 (±2.00)
Tuber	Cassava	64.09 (±0.86)	0.45 (±0.08)	0.47 (±0.01)	2.18 (±0.08)	2.65 (±0.08)	32.25 (±0.17)
Legumes	Green gram	57.79 (±0.07)	7.59 (±0.11)	0.43 (±0.03)	8.76 (±0.13)	9.19 (±0.13)	25.43 (±0.34)
	Chickpea	56.37 (±0.09)	6.01 (±0.07)	0.40 (±0.03)	7.19 (±0.09)	7.59 (±0.10)	29.62 (±0.05)

To make 'Pittu' and 'string hopper', the rice flour was roasted for 30min. Roasting of flour under high temperature might have initiated the Maillard reaction and caramalization (18). The 'Pittu' and 'string hopper' were prepared by mixing the dough with boiling water and followed with steaming. The time of steaming was 15 min. With steaming, the starch exposed to moist heat may undergo gelatinization and subsequently they may have retrograded causing a low GI (18). This might be another reason for the low GI values of 'Pittu' and 'string hopper 'when compared with the GI values of different varieties of cooked rice and cassava.

The mean glycaemic index value of 'Pittu' (43.74%) was closer to that of 'Pongal' [Rice and roasted green dhal pressure cooked, 45.0%] from India (18). The mean glycaemic index value of string hopper (50.01%) was closer to that of 'dhosai' (55.0%) (Parboiled and raw rice, soaked, ground, fermented and toasted) with 'chutney' from India (18).

Boiled Cassava

The boiled cassava contained more SDF (0.47%), IDF (2.18%) and TDF (2.65%) than cooked brown rice (0.21, 1.88 and 2.09%), parboiled rice (0.42, 1.88 and 2.30 %), white rice (trace, 1.21 and 1.21%), and 'Pittu' (0.45, 1.56 and 2.01%) & 'string hopper' (0.43, 1.45 and 1.88 %), (Table 3). However the total protein content of cassava (0.45 %) was lower than that of cooked white rice, brown rice & parboiled rice, and 'Pittu' and ‘string hopper' (1.53, 1.78 2.18, 4.40 and 3.67 % respectively), (Table 3). The boiled cassava gave higher glycaemic response (49.26mg/dL) than cooked white rice, brown rice & parboiled rice, and 'Pittu' & 'string hopper' (41.71, 37.72, 35.05, 27.39 and 31.32 mg/dL, respectively, Table 1). These results showed that dietary fiber had no significant direct relationship on glycaemic responses of those foods. This may be due to the effect of lower protein content of cassava than cooked white rice, brown rice & parboiled rice, and 'Pittu' & 'string hopper'. Thus the influence of protein content showed significant direct relationship on the glycaemic response after consumption. Boiled cassava gave higher GI value of 78.67%.

The mean glycaemic index of boiled cassava (78.67%) was much higher than that of a variety of the boiled cassava (46.0)% from Kenya (18). It was reported that the glycaemic index values for 50.0g available carbohydrate portion of boiled cassava was 94.0%, where white bread was used as reference food (20) and when glucose was used as the reference the glycaemic index value of boiled cassava was 65.8%. It was lower than the glycaemic index value of boiled cassava (78.67%) recorded in this study.

Boiled legumes

The mean GI value of boiled green gram and chickpea were 31.43 and 33.27%, respectively (Table 2). Boiled green gram contained more SDF (0.43%), IDF (8.76%) and TDF (9.91%) than boiled chick pea (0.40, 7.19 and 7.59% respectively), (Table 3). The TDF content of boiled green gram was higher than boiled chick pea. However, the TDF, SDF and IDF of boiled green gram (9.19, 0.43 and 8.76%) and chick pea (7.59, 0.40 and 7.19%) were closer to each other. When compared with other foods, the boiled green gram and chick pea contained higher TDF contents. Due to their higher fiber contents the blood glucose level peaked at 60 min.

The total protein content of boiled green gram and chick pea were 7.50 and 6.01% respectively (Table 1). When compared with other foods, these two foods contained higher amount of protein. Stomach emptying is slow if foods containing high amount of proteins are consumed (21). Due to the higher protein content the glycaemic response of boiled green gram and chick pea might have been affected. Presence of legumes in the diet has reduced the glycaemic response to carbohydrate diet (11).

Boiled green gram and chick pea contained more IDF (8.76 and 7.19%) and TDF (9.91 and 7.59%) than the cooked brown rice (1.88 and 2.09%), parboiled rice (1.88 and 2.30 %), white rice (1.21 and 1.21%), 'Pittu' (1.56 and 2.01%), 'string hopper' (1.45 and 1.88%) and cassava (2.18 and 2.65%) (Table 3). The SDF of green gram (0.43%) and chickpea (0.40%) were higher than the cooked brown rice (0.21%) and white rice (Trace), and were lower than 'Pittu' (0.45%) and cassava (0.47%). The SDF of green gram (0.43%) was equal to 'string hopper' (0.43%) and was higher than parboiled rice (0.42%). The SDF of chickpea (0.40%) was lower than 'string hopper' (0.43%) and parboiled rice (0.42%). The total protein contents of green gram,

chick pea, cooked white rice, brown rice and parboiled rice were 7.59, 6.01, 1.53, 1.78 and 2.18%, respectively (Table 1). Due to the high contents of protein and SDF, boiled green gram and chick pea gave lower glycaemic response than cooked white rice, brown rice and parboiled rice (Table 1).

The total protein contents of green gram (7.59%) and chick pea (6.01%) were higher than 'Pittu', 'string hopper' and cassava (4.40, 3.67 and 0.45% respectively), (Table 3). The SDF of green gram, chick pea, 'Pittu', 'string hopper' and cassava (0.43, 0.40, 0.45, 0.43 and 0.47%) appeared to be similar (Table 3). The mean glycaemic response of green gram and chickpea (19.68, and 20.83 mg/dL) were lower than 'Pittu', 'string hopper' and cassava (27.39, 31.32, and 49.26 g/dL) respectively. SDF has no much effect on glycaemic response of 'Pittu', 'string hopper', cassava, green gram and chick pea because SDF of these foods appeared to be almost same. These may be due to the effect of high protein contents of green gram and chick pea on glycaemic response of those foods. Thus the influence of protein content on the glycaemic response after the consumption of green gram and chickpea showed significant relationship with 'Pittu', 'string hopper' and cassava.

The glycaemic index values of chickpea, channa dhal, kidney bean, mash bean, mung bean and peas were 36.0, 13.0, 32.0, 43.0, 42.0 and 25.0%, respectively (22). The mean glycaemic index value for the boiled chickpea (33.67%) used in this situation was closer to that of a variety of boiled chickpea (36.0%) from Canada and was higher than that of a variety of chickpea from Philippines (21).

Conclusion

In conclusion, this study reveals that the diets which contained high dietary fiber contents have reduced GI value. In addition it was also observed that the diets which contained more proteins showed reduced GI value. Thus it could be concluded that both fibers and legumes positively reduce the GI value.

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References

1. Wolver TMS. Dietary recommendations for diabetes: high carbohydrate or high monounsaturated fat? *Nutrition Today*, 1999; **34** (2): 73-77.
2. Chlup R, Bartek J, Reznickova M, et al. Determination of glycaemic index of selected foods (white bread and cereal bars) in healthy persons. *Biomed Papers,* 2004; **148**(1): 17-25.
3. FAO/WHO Carbohydrates in human Nutrition: report of a joint FAO/ WHO expert consultation; 1998.
4. Mendosa D. Glycaemic Index. [2010-10-21]. http://www.mendosa.com/gi:htm.
5. Vrolix R, Van Meijl LEC, Mensink RP. The metabolic syndrome in relation with the glycaemic index and the glycaemic load. *Physiology and Behavior,* 2008; **90**: 293-299.
6. Valtuena S, Pellegrini N, Ardigo D, et al. Dietary glycaemic index and liver steatosis. *The American Journal of Clinical Nutrition,* 2006; **84**: 136-142.
7. Berra B, Rizzo A M. Glycaemic index, glycaemic load, wellness and beauty: the state of the art. *Clinical Dermatology*, 2009; **27:** 230-235.
8. Mursu J, Virtanen JK, Rissanen TH, et al. Glycaemic index, glycaemic load, and the risk of acute myocardial infarction in Finnish men: The Kuopio ischaemic heart disease risk factor study. *Nutrition Metabolism Cardiovascular Disease*, 2009; **20:** 1-6.
9. Murakami K, Sasaki S, Takahashi Y, et al. Dietary glycaemic index is associated in the decreased premenstrual symptoms in young Japanese women. *Nutrition,* 2008*;* **24**: 554 561.
10. Murakami K, Miyake Y, Sasaki S, et al. Dietary glycaemic index is inversely associated with the risk of Parkinson's disease: A case control study in Japan. *Nutrition,* 2009; **25**:1-7.
11. Hettiaratchi UPK, Ekanayake S, Welihinda J. Do Sri Lankan meals help decrease blood glucose response? *Ceylon Medical Journal*, 2009, **54(2)**: 39-45.
12. Pirasath S, Thayaananthan K, Balakumar S, Arasaratnam V. Effect of dietary curries on the glycaemic index. *Ceylon Medical Journal*, 2010, **55(4):** 118-122.
13. Pearson D, Ed. The Chemical analysis of foods. 7th Ed. Edinburgh, London, Churchill. Livingstone, 1976.

14. Megazyme: Total dietary fibre assay procedure. [2009-06-17]. Http://www.megazyme.com/ booklets/KTDFR.pdf.

15. Wolever TMS, Jenkins DJA, Jenkins AL, Josserg RG. The Glycemic Index: Methodology and Clinical Implications. *The American Journal of Clinical Nutrition,* 1991; **54**:846-854.

16. Panlasigui NL, Thomposon UL, Juliano OB, Perez MC, Yiu HS, Greenberg RG. Rice varieties with similar amylase content differ in starch digestibility and glycaemic response in humans. *The American Journal of Clinical Nutrition,* 1991; **54:871**-877.

17. Widowatia S, Astawan M, Muchtadi D, Wresdiyati T. Hypoglycaemic activity of some Indonesian rice varieties and their physicochemical activities. *Indonesian Journal Agricultural Science,* 2006; **7**(2):57-66.

18. Foster-Powell K, Holt SHA, Brand-Miller JC. International table of glycaemic index and glycaemic load values. *The American Journal of Clinical Nutrition,* 2002; **76**:5-56.

19. Williams S. Stubbs P. The glycaemic index. [2004- 04-01]. http://extension.usu.edu/files/ publications/factsheet/FN2004-01.pdf

20. Ramdath DD, Isaacs CLR, Teelucksingh S, Wolver SMT. Glycaemic index of selected staples commonly eaten in the Caribbean and the effects of boiling and crushing, 2004; **91**: 971- 977.

21. Beals KA. The glycaemic index: Research meets reality. [2005-10-01]. http://www.framezart.net/potatoesgoodness/Content/pdf/Whitepages/GlycaemicIndex. White Paper.pdf, 2007

22. Khan I, Tabassum F, Khan A. Glycaemic Indices and Glycaemic Loads of various types of pulses. *Pakistan Journal Nutrition,* 2008; **7**(1):104-108.