Low GI rice for rice consumers suffering from diabetes mellitus

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According to the WHO, the number of diabetes mellitus (DM) cases increased from 108 million in 1980 to 422 million in 2014, and this is considered as one of the major causes of blindness, kidney failure, heart attack, stroke and lower-limb amputation. In 2019, DM caused 1.5 million deaths across the world. India is known as the diabetes capital of the world with above 77 million adults suffering from diabetes, this number is expected to increase to 134 million by 2045.

The reason for the occurrence of DM is genetic and also a shift towards sedentary lifestyle, including dietary habits which lead to obesity. Further, DM in Indians can occur at lower body mass index (BMI) compared to Europeans[1,2]. DM is of two types – 1 and 2. Type-1 DM is due to the absence or lower levels of insulin hormone in the body. Insulin is secreted in type-2 DM; however, it is ineffective.

Cereals like rice and wheat are mostly used in food preparations. They contain a large amount of starch. In healthy human beings, starch digestion in the mouth is minimal since the food is swallowed and reaches the stomach wherein proteins are digested. The starch is digested to glucose in the small intestine. Most of this glucose is absorbed into the blood leading to increase in its level above normal (80–120 mg/100 ml of blood). In response, insulin hormone is secreted into the blood from pancreatic β-cells.

The function of insulin is to decrease blood glucose to normal level. Insulin makes the body to store the extra glucose (glucose above normal level) as glycogen in various parts like liver, muscles, etc. Some of this extra glucose is also converted into fats and other molecules. Between two meals or during fasting, glucose can decrease below 80 mg/100 ml of blood. In response, glucagon hormone is secreted into the blood from pancreatic α-cells. Glucagon makes the body to release glucose from glycogen and also to make glucose from fats and other molecules. Thus, insulin and glucagon help to maintain normal blood glucose level.

Human beings have around 4.5–5.5 litre (4500–5500 ml) of blood which contains liquid (plasma) and cells[3]. Blood is continuously filtered in the nephrons of kidneys with a normal filtration rate of 180 litre/day (ref. 4). During this process, some molecules or ions of the plasma first leave the blood and are later reabsorbed based on their respective threshold value which is

Table 1. Glycemic index (GI), glycemic load (GL) and available starch in rice varieties

Variety	Available carbohydrate in 100 g rice	GI	GL for 100 g raw rice	GL for 50 g raw rice	GL for 25 g raw rice
Sampada	75.28	51.17*	38.52	19.26	9.63
Lalat	75.84	53.17*	40.32	20.16	10.08
Dhana rasi	72.68	66.74	48.51	24.25	12.13
Savitri	76.52	68.85	52.68	26.34	13.17
Chittimutyalu	71.15	73.64	52.39	26.20	13.10
DRR Dhan 38	71.85	75.07	53.94	26.97	13.48
Jaya	78.53	75.58	59.35	29.68	14.84
Akshaya Dhan	77.81	75.72	58.92	29.46	14.73
DRR Dhan 39	72.44	75.97	55.03	27.52	13.76
IR 44	75.63	76.19	57.62	28.81	14.41
Sasyasri	82.36	76.36	62.89	31.45	15.72
PA 6444	76.26	76.52	58.35	29.18	14.59
VRB MS	73.72	77.45	57.09	28.55	14.27
Tellahamsa	75.13	77.48	58.21	29.11	14.55
Varadhan	74.47	77.49	57.71	28.85	14.43
PR 113	78.97	77.54	61.23	30.62	15.31
Mandya Vijaya	74.92	77.80	58.29	29.14	14.57
CRHR 32	79.77	77.83	62.08	31.04	15.52
NDR 97	80.45	78.02	62.77	31.38	15.69
DRR H2	74.82	78.24	58.54	29.27	14.63
DRR H3	78.38	78.27	61.35	30.67	15.34
PHB 71	78.81	78.38	61.77	30.89	15.44
Varalu	79.50	78.41	62.34	31.17	15.58
Jaya	75.97	78.43	59.58	29.79	14.90
US 312	77.54	78.83	61.12	30.56	15.28
Salivahana	77.77	79.18	61.58	30.79	15.39
MTU 7029	76.07	80.74	61.42	30.71	15.35
Rasi	72.71	81.06	58.94	29.47	14.74
MTU 1010	70.55	81.86	57.75	28.88	14.44
Triguna	76.13	82.03	62.45	31.22	15.61

*Reported to be low in GI.

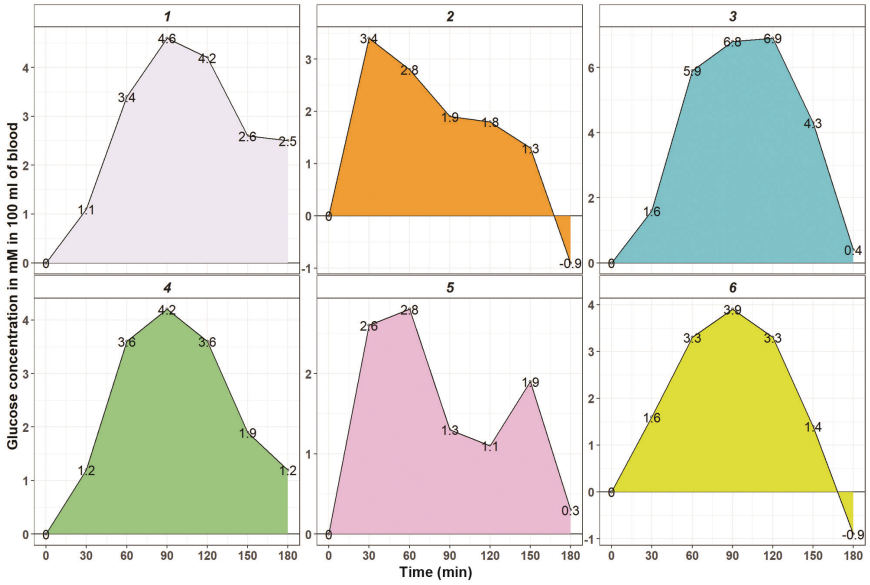

Figure 1. Change in blood glucose with time after taking 50 g of standard glucose. The numbers 1–6 indicate six different subjects.

the maximum concentration of a substance that can be reabsorbed into the blood. Any amount beyond this level leaves the body along with the urine. For glucose, it is around 180 mg/100 ml (10 mM) of blood[5,6].

Rice feeds more than half of the global population and it is difficult to replace this cereal among the rice-eating human population. Thousands of rice germplasms/land races/varieties that vary in properties are available in India and across the globe. Considering the preference of rice in South and Southeast Asia, various research groups across the world started classifying the cereal based on glycemic index (GI)[7] into low (GI ≤ 55), medium (GI 56–69) and high (GI ≥ 70). In India, the average daily consumption of uncooked (raw) rice is 226 and 162 g/day/person in rural and urban population respectively[8].

The estimated clinical GI values using glucose as a standard and total available carbohydrate values in rice samples were used to derive the glycemic load (GL) (Table 1)[9]. Although these varieties contain similar available carbohydrate content, Lalat and Sampada have recorded low GI. They give high, medium and low GL for 100, 50 and 25 g raw rice used for each meal respectively. Generally, a normal healthy person consumes one cup of raw rice per meal (142 g, including 15% moisture) and this varies among individuals.

$$\text{GI} = (\text{iAUC test food}/\text{iAUC reference food}) \times 100,$$

GL = (GI × available carbohydrate in the given amount of food)/100 (ref. 10).

After taking 50 g of standard glucose[9], the six normal (non-diabetic) subjects showed varied patterns of incremental area under the curve (iAUC). The ranges of peak blood glucose were 2.8–6.9 mM/100 ml of blood at 30–90 min (Figure 1). The peak blood glucose level in the subjects was below 140 mg/100 ml (7.8 mM), and renal glucose threshold value was 180 mg/100 ml (10 mM). Similarly, the blood glucose response curves varied among the subjects with cooked rice (equivalent to 50 g of glycemic carbohydrate) as test sample.

In general, 100 g of raw (uncooked) rice becomes 300 g (three times) on cooking due to absorption of water. Hence, it is essential to conduct feeding trials with varied amounts of cooked low-GI rice involving healthy and diabetic subjects of different age groups. Such studies will be useful to determine the peak blood glucose levels contributed by low-GI rice and the safe amount of a specific low-GI rice in each meal, to guide research programmes on low-GI rice.

As low-GI rice is available in the market, it is important for those with diabetes to check the GI and available carbohydrate value on the label (if provided), before deciding the approximate amount of low-GI rice per meal, to maintain safe blood glucose levels following their routine day-to-day activities. Paddy procured from the farmers is processed to milled rice and sold in the market under various brand names, and often the varietal purity is compromised. Hence, it is equally important to indicate the original name of the variety, GI value and available carbohydrate value on the label to translate the advantages of this research to society. Also, considering increased shift towards sedentary lifestyle in majority of the population, necessary policy changes are to be made at various levels to increase the cultivation of low-GI rice in the country.

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