GLYCEMIC INDEX OF SPLIT PEAS, RICE (BINAM), KIDNEY BEANS, GREEN PEAS, "LAVASH" BREAD AND BROAD BEAN KERNELS IN NIDDM SUBJECTS

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Abstract - *Equal amounts of carbohydrates from various foodstuffs do not increase blood glucose to the same extent. This study was carried out, therefore, in 1996 at the National Nutrition and Food Technology Research Institute in Tehran to determine the glycemic index of split peas, rice (Binam), kidney beans, green peas, "Lavash" bread and broad bean kernels. Diabetic subjects were studied in a clinical trial. The exact amount of cabohydrate in foodstuffs was determined using AOAC methods. White Bread was used as the reference food. After a 12-hour overnight fast on seven separate days each subject was given the test food in an amount to provide 25 g of carbohydrate. Blood glucose was determined after 0,60,120 minutes using orthotolouidine method. Glycemic response in each individual was calculated as the area under the 2- hour glucose curve and the glycemic index was expressed as the mean area under the test food glucose curve as a percentage of the mean area under the whith bread glucose curve. Glycemic indices of the test foods were 31 ± 8.5 for split peas, 42.9 ± 3 for rice, 44 ± 9 for kidney beans, 57 ± 7 for green peas, 69 ± 8.5 for "Lavash" bread, and 96 ± 14 for broad bean kernels. Legumes and rice (Binam) can be used efficiently in meal planning for the diabetic subjects.*

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Key Words: Glycemic index, test foods, NIDDM

INTRODUCTION

Epidemiological studies have establishted that prevalence of diabetes mellitus is increasing in different countries (1). Also in Iran the findings show the incidence of diabetes to be on the rise (2).

Reducing the glycemic impact of the diet by using low-glycemic index (GI) foods has shown to improve overall blood glucose control in patients with diabetes mellitus, delay the development, and slow the progression of short and long-term effects. Previously dietary recommendations for patients with diabetes mellitus were mainly based on a restriction of dietary carbohydrate. However, during the last two decades recommendations for these patients have aimed at a diet with a rather high content of carbohydrates with a low GI (4). Different carbohydrate foods produce different blood glucose responses, which are independent of their constituent carbohydrate. So classifying foods according to their glycemic response may be useful in planning diets for diabetic patients. A number of studies have demonstrated that reducing the GI of the diet will improve the glycemia and lipid control in diabetes (5).

Few foods, traditionally consumed by the Iranian population, have been tested for their glycemic responses. The present study was planned to determine the GI of six starch foods, which are important in the diet of Iranisns.

MATERIALS AND METHODS

This study was a clinical trial. Ten NIDDM volunteers (7 men and 3 women) aged 39-73 y (X ± SD, 51±10.5) with a body mass index (BMI) of 22-34.5 (27±3.5) were included in the study. All subjects were in good general health except for having diabetes. Seven subjects were being treated by diet alone and three by oral hypoglycemic agents.

On the first visit the subjects were subjected to an oral glucose tolerance test using a 50 g glucose load. The subjects were given a test food containing 25 g available carbohydrate, which was ingested with a glass of water during a 5-10 minute interval. Venous blood glucose was determined by the o-tolouidine method in the fasting state and 1-hour and 2 hours postprandial. The test was repeated on a subsequent visit (after 2-3 days).

The test foods were split peas (Tabriz), rice (Binam, grade II), kidney beans (Shabestar), green peas (Varamin), "Lavash" bread, broad bean, and broad bean kernels. A 2% salt solution was used for boiling the food items: split peas and kidney beans were boiled for 1.5 and 2 hours, respectively, and rice for 40 minutes followed by steaming for 10 minutes. Green peas and broad beans were peeled and boiled for one hour. The standard food was white bread. Exact amounts of carbohydrate, protein, fat, crude-fiber, and water were determined in all the food items using AOAC methods (6).

As mentioned above, blood glucose responses were determined in the fasting state and 1 and 2 hours postprandial. The response curves for both the white bread and the test foods were plotted and GI was calculated in each case using the method described by Jenkins et al. (1981), in which the ratio of the area under the glucose response curve for the test food was compared with that of white bread.

The Student's t-test and paired t-test were used for statistical analysis.

The protocol was reviewed and approved by the Human Ethics Committee of the National Nutrition and Food Technology Research Institute.

RESULTS

The general information and diabetes status of the NIDDM volunteers are presented in Table I, the compositions of the test foods, as well as of the standard food (white bread) in Table II, and that of the cooked foods supplying 25 g of carbohydrate in Table III. Also, the serum glucose response curves are shown in Figure I. In all cases the highest mean value in the postprandial curves was observed 1-hour after the start of ingestion. Ingestion of broad bean kernels led to a sharp rise in glucose concentration, whereas "Lavash" bread and green peas had a moderate effect on glucose response

Table 1. General information and diabetes status in NIDDM patients

Case No.	Age (yr)	Diabetic duration	Sex (M/F)	Height (Cm)	Initial weight(Kg)	Final weight(Kg)	Body mass index (Kg/M^2)	Fasting plasma glucose (mg/dl)	Treat-ment
1	47	17	Female	158	58.5	58.5	23.5	150	Gliben Clamide
2	50	1	Male	159	65	66.5	26	126	Diet
3	43	2	Male	177	87	86	28	128	Diet
4	49	1	Female	155	82.5	82	34	105	Diet
5	43	5	Male	162	70	68.5	27	143	Diet
6	60	7	Male	175	68	68.5	22	99	Gliben Clamide
7	73	9	Male	165	73	72.5	27	142	Diet
8	61	1	Male	160	65.5	66	26	104	Diet
9	44	1	Male	169	75	74	26	148	Gliben Clamide
10	39	3	Female	152	70.5	71.5	30.5	142	Diet
X-±SD	50.9±10.58	4.7±5.16	-	163.2±8.3	71.5±8.42	71.4±7.96	27±3.37	128.7±19.57	-

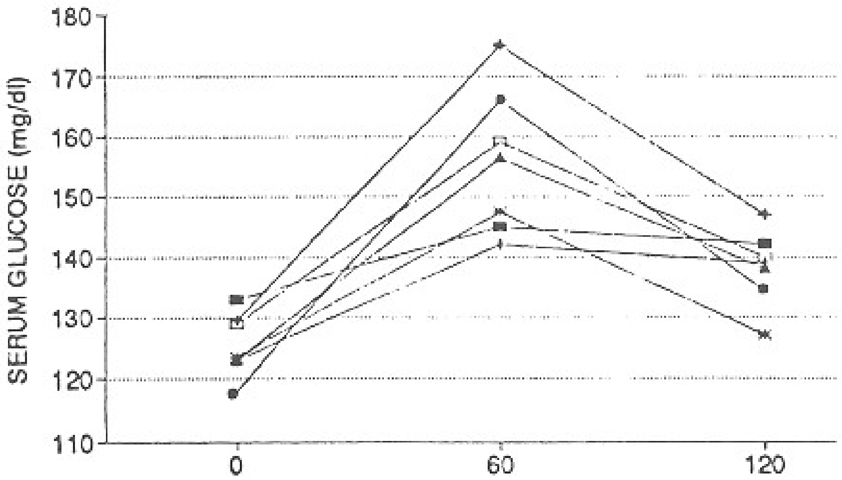

Fig. 1. Mean serum glucose responses after ingestion of the standard and test foods
■ split peas rice (Binam) * kidney beans □ green peas ▲ "Lavash" bread + broad bean kernels ● white bread standard

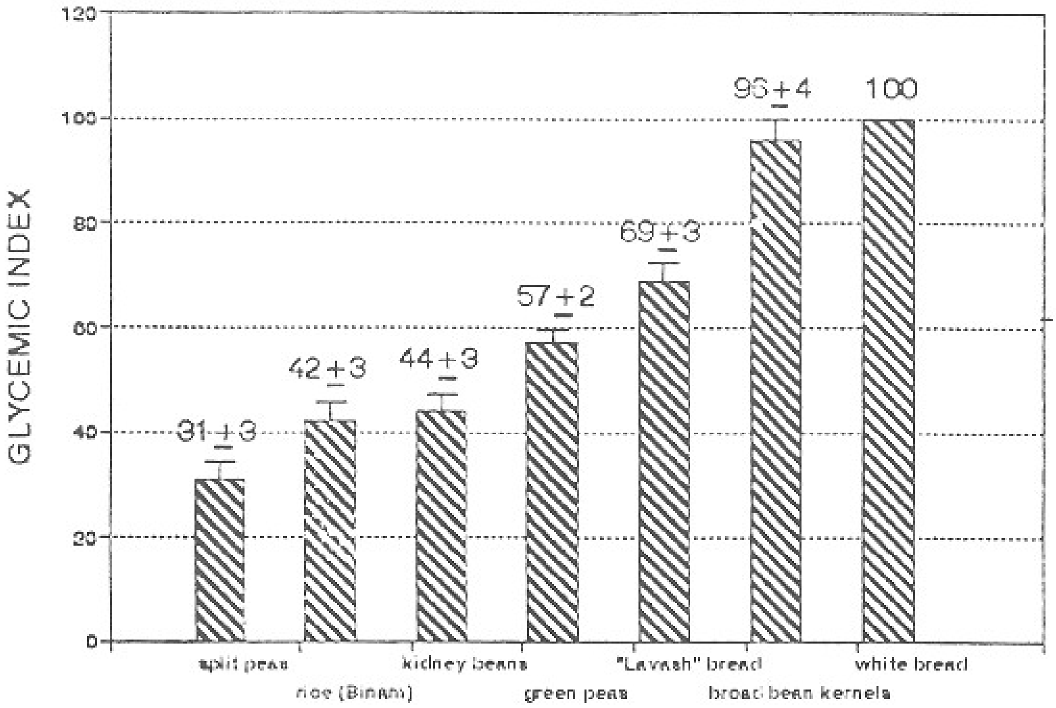

Fig. 2. Means (SEM) glycemic indices of the test foods compared with that of the standard (white bread)

Glycemic index of foods

Glucose curve after rice ingestion was lower than that after kidney beans, but there were no statistical differences between them. Split peas elicited the lowest glucose response. All the test foods produced a lower incremental area under the glucose curve compared with white bread. The glycemic index values obtained for the test and standard foods are given in Figure 2.

Table 2. Composition (%) of the standard and test foods

Food items						
White bread(standard)	29±0.01	55.7±0.05	2.8±0.02	9.7±0.04	1.5±0.01	1.2±0.02
Split peas (Tabriz)	9.7±0.14	61.6±0.1	3±0.01	21.9±0.25	2.2±0.005	1.9±0.03
Rice (Binam, grade I)	8.8±0.08	79.4±0.24	0.8±0.02	9.1±0.15	0.6±0.02	1.4±0.03
Kidney beans (Shabestar)	8±0.09	59.4±0.07	1.7±0.04	23.4±0.03	3.3±0.005	4.2±0.03
Green peas (Varamin)	67.4±0.18	17.8±0.2	0.7±0.2	9.9±0.04	1.2±0.00	2.9±0.02
"Lavash" bread	26.9±0.04	56.1±0.09	1.4±0.02	10.5±0.03	3.7±0.06	1.2±0.04
Broad bean kernels (Kashan)	78.1±0.07	10.5±0.05	0.25±0.03	9.6±0.1	0.9±0.005	0.5±0.02

Table 3. Composition of coocked carbohydrate standard and test foods supplying 25g of carbohydrate

Males

	Water (g)	Carbohydrate (g)	Fat(g)	Protein (g)	Ash(g)	Fiber (g)	Weight(g)	Energy (kcal)
White bread(standard)	13	25	1.3	4.4	0.7	0.6	45	129
Cooked split peas	80	25	1.3	9	0.9	0.8	117	147.7
Cooked rice	65	25	0.3	2.9	0.2	0.4	93	114.3
Cooked kidney beans	110	25	0.7	9.9	1.4	1.8	148	145.9
Cooked green peas	146	25	1	14	1.6	4.1	192	165
"Lavash" bread	12	25	0.6	4.7	1.7	0.6	45	124.2
Coocked broad bean kernels	251	25	0.6	22.9	2.1	1.3	3.3	197

DISCUSSION

The rise in blood glucose after a carbohydrate load dose or meal has been reported to vary with the food source of the carbohydrate (7-14). Differences are attributed to various factors such as dietary fiber content of the food, food processing methods, other food components such as anti-nutrients and the chemical nature of the starchy polysaccharides (15). In the present study, the GI values of split peas and kidney beans were found to be 31 ± 3 and 43 ±3, respectively (Figure 2). These results confirm those reported by Indar-Brown et al (16), and Jenkins et al (17) for these foods. Legumes are a good source of fiber and proteins. Fiber content appears to make a difference in the observed GI. The fiber source forms either a physical barrier to the hydrolytic enzymes limiting access to the starch or a barrier slowing absorption of digested materials (18). Another factor is amylose. A high percentage of starch in legumes is in the form of amylose (30-40%), as compared to the 15-30% level found in most other carbohydrate sources (18, 19). This high-amylose starch has been shown to be digested far more slowly than the high amylopectin starch. Thus, the nature of starch in leguminous seeds may influence their starch digestibility. Furthermore, legumes are an abundant source of antinutrients. They contain enzyme inhibitors, lectins, saponins, phytates, and tannins (4, 20). These antinutrients, alongside with the starch, can delay digestion. Finally, physical form may affect the digestibility of leguminous seeds, the cellulose and uronic acid content of legumes tending to be higher than that in cereal products, thus legumes have lower glycemic response than other foods. However, if the cell structure is destroyed, as in bean products (with free starch), the rate of hydrolysis will be much more rapid (4). The data shows that the GI for kidney beans, require a longer cooking time than smaller dehulled seeds, such as split peas. More time may be required for heat and water to penetrate the large hulled seed and gelatinize the starch. For these reasons the GI value of kidney beans is much higher than that of split peas (4). The GI value of rice (Binam) was found to be 42 ± 3 (Figure 2). Rice with a high-amylose content elicits a lower glycemic response in comparison with low-amylose rice. Behall et al. (1986) made the reflection that "the development of a more rigid gel after starches are cooked and cooled may make the amylose less accesible to hydrolytic enzymes". In vitro , the firm resilient amylose gels obtained may require cooking temperatures as high as 120 °C to reverse gelation. Gelation of amylopectin occurs at a slower rate and forms softer gel. It requires higher concentrations to form gel, and the gel may be thermally reversed at temperature ranges of 50-85 °C. The branched structure of amylopectin may prevent hydrogen bonding between straight chains that can occur in amylose. The branching in amylopectin also increases the surface area per molecule and potentially increases the area available for amylolytic attack (18). Goddard proposed that the amylose-lipid complexes slowed the digestion or absorption of the high-amylose rice (13). Juliano and Goddard concluded that amylose content rather than other factos, including the amylose-lipid complex or the gelatinization temperatures, influenced glucose response postprandially (14). Most rices contain 20% amylose, but varieties that contain a higher proportional amylose (e.g., Doongara rice: 28% amylose) have been shown to have a slower rate of digestion and produce lower glycemic response (21). Rice (Binam) has a lower GI than Doongaa rice and may be assumed .to have a higher amylose content, too. In our study the GI values of green peas and boran bean kernels were 57±2 and 96±4, respectively (Figure 2). These results confirm those reported by Jenkins et al. (17,22). Green peas have a lower GI than board bean kernels. Green peas contain a higher proportion of fiber than broad bean kemels (Table II). Broad bean kernels are also a good source of calcium, which is known to catalyze amylase activity and influence starch digestibility; so broad bean kernels demonstrate an increased digestion rate and higher blood glucose response in comparison with green peas.

Due to the importance of bread in the diet, attempts were made to determine the GI of "Lavash" bread. The GI value of "Lavash" bread (69±3) is lower than that of white bread. Several factors have been implicated in the different glucose responses of breads, such as water availability, temperature, and lengh of cooking. White bread was baked (25-30 minutes) from equal amounts of flour and water, i.e., 100 kg white wheat fluor and 100 kg water, while "Lavash" brea was baked from 100 kg wheat flour and 65 kg water. So the gelatinization of starch granules of white bread is higher than that of "Lavash" bread. According to Taleban et al. The GI values of Sangak and Barbari breads were 47±11 and 35±13, respectively (23). "Lavash" bread is very thin so all the starch granules are subjected to heat, and therefore gelatinizatoin of starch is higher than in Sangak and Barbari breads. The amount of baker's yeast in "Lavash" bread is higher than that in Sangak and Barbari bread, so the phytic acid content of "Lavash bread is lower than that of Sangak and Barbari (24). Phytic acid could affect the starch digestibility through combination with proteins, which are structurally closely associated with starch and/or through combination with the digestie enzymes, which are themselves proteins. In addition, phytic acid can bind minerals such as calcium, whose halogen salts are known to catalyze amylose enzyme. Teast fermentation is known to reduce the phytates concentration (40.

It is concluded that the GIs of legumes and Binam rice are low, therefore these food items can be used efficiently in meal planning for diabetic patients.

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