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Full Length Research Paper

Glycemic index of Iranian rice

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The glycemic index (GI) is an important parameter of food quality which compares the hyperglycemic effect of a tested meal with pure glucose. For most foods in the Middle East, the glycemic index has not been defined yet. The aim of this study is to determine the GI of Iranian rice and to evaluate the type of cooking method on GI value. To determine the GI, measured portions of food containing 50 g of carbohydrates were eaten by 10 healthy volunteers (5 men and 5 women) after an overnight fast. Capillary blood samples were taken at 0 (fasting), 30, 60, 90 and 120 min after the meal. Blood glucose curves were constructed from blood glucose values. The GI was calculated by dividing the incremental area under the curve for the tested food (fluffy rice and steamed rice) by that for the standard food (same amount of glucose) and multiplying by 100. In each volunteer, each food was tested thrice so that 3 GIs were obtained and the average was calculated. The GI for tested food was calculated as the mean from the respective average GIs of the 10 volunteers. The GI values of fluffy rice and steam rice were 55.38±17.16 and 66.25±18.49 respectively. Statistically significant difference was not observed. These results indicate that Iranian rice should be classified as medium GI food.

Key words: Rice, glycemic index, glucose, Middle East, human subject.

INTRODUCTION

Numerous studies have been carried out to assess blood glucose response after the intake of different plant sources of carbohydrates (Ito et al., 2005; Venn and Green, 2007; Atkinson et al., 2008). The glycemic index (GI) is an important parameter of food quality which compares the hyperglycemic effect of a tested meal with pure glucose (or of another defined standard food) (Chlup et al., 2004). Several health benefits exist for reducing the rate of carbohydrate absorption by means of a low GI diet. These include reduced insulin demand, improved blood glucose control, weight losing, and reduced blood lipid levels, all factors that may play important roles in the prevention or management of several chronic diseases including diabetes, coronary heart disease (CHD) and possibly certain cancers (Ludwig et al., 1999; Liu et al., 2000; Mosdol et al., 2007; Barclay et al., 2008).

The recent Food and Agriculture Organization of the United Nations (FAO)/World Health Organization (WHO) Consultation on Carbohydrates (FAO/WHO, 1998) recommended that the GI of foods be used in conjunction with information about food composition to guide food choices. Specifically, it was recommended that at least 55% of energy be derived from carbohydrate and that the bulk of carbohydrate rich foods should be those rich in dietary fiber and with a low GI ranking (Chan et al., 2001; Jenkins et al., 2002a; Jenkins et al., 2002b; Jenkins et al., 2002c; Liu and Willett, 2002). Some foods on the world market already show their GI rating on the nutrition information panel. Terms such as complex carbohydrates and sugars, which commonly appear on food labels, are now recognized as having little nutritional or physiological significance. The WHO and FAO recommend these

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Abbreviations: GI, Glycemic index; **CHD**, coronary heart disease; **FAO**, Food and Agriculture Organization of the United Nations; **IAUC**, incremental area under the curve; **WHO**, World Health Organization.

terms be replaced with the total carbohydrate contents of the food and its GI value. In Iran, however, we were not able to find any food product containing the nutritional label with GI value (Chlup et al., 2004). For many foods in the Middle East, the glycemic index has not been defined yet. Therefore, any effort to enable the determination and practical use of GI may support establishing optimum dietary recommendations and good eating habits. In this study, the GI of Iranian rice was determined, and effects of cooking methods on GI value were evaluated.

MATERIALS AND METHODS

Tested foods

Two different foods with a known content of nutrients were tested: (1) Pure glucose (Merck, Germany), one serving contained 50 g glucose that was dissolved in 300 ml tap water before drinking, (2) white rice (Golestan company, Iran); composition: carbohydrates, 80.15%; protein, 6.0%; fat, 1.4%; energy, 365 kcal/100 g; one serving contained 62.38 g equal to 50.0 g of carbohydrates (50 g carbohydrate portion is a typical serving in Iran). The rice was prepared by two cooking methods (A and B) on the basis of Iranian food habits: (A) Fluffy rice: we soaked the rice in water for 35 min, and then put it in boiling water for 10 min; after which it was drained of water. The rice was placed in a pan, simmered on low heat for 20 – 30 min. (B) Steam rice: we boiled the rice for 5-8 min, and then simmered on low heat for 30 min until all water was absorbed or evaporated.

Determination of the glycemic index

To determine the GI, measured portions of tested food containing 50 g of carbohydrates were eaten by each of the 10 healthy volunteers in the presence of investigators after an overnight fast. Finger prick blood samples were investigated at 30 min intervals over the next two hours after the meal (times: 30, 60, 90,120 min; the beginning of the food intake was time 0). We measured blood glucose concentrations in each volunteer by means of a glucometer (On. Call Now, ACON Laboratories, Inc. USA) in our laboratory.

The averages of the respective B-glucose concentrations after the meal were used to draw a B-glucose response curve for the two-hour period. The incremental area under the curve (IAUC) was calculated for each meal in every volunteer separately (as the sum of the surface of triangles and trapezoids between the B-glucose curve and horizontal baseline going parallel to x-axis from the beginning of B-glucose curve at time 0 to the point of 120 min) to reflect the total rise in B-glucose concentration after eating the tested food. The IAUCS for the standard reference food (that is, 50 g of pure glucose) was obtained similarly to the mean from the first three independent IAUCS1, IAUCS2 and IAUCS3 in the same volunteer. In the IAUC/IAUCS calculations, all B-glucose values in the course of the test lower than the first value (at time 0) were equalized to the respective first value.

In each volunteer, the GI (%) was calculated by dividing the IAUC for the tested food by the IAUCS for the standard food and multiplying by 100. The following formula was used:

$$GI = \frac{IAUC}{1/3\ (IAUCS1 + IAUCS2 + IAUCS3)} \times 100$$

In each volunteer, each food item was tested 3 times so that 3 GI was obtained and (after the exclusion of disturbed tests) the mean was calculated. The GI for each tested food was calculated as the mean from the respective mean GI of the 10 volunteers.

Healthy volunteers

The study protocol was confirmed by Ethical Committee of Kashan University of Medical Sciences. The participants in this study were healthy persons recruited from the nursing and health students. The consent form was taken from the volunteers. Thorough clinical and laboratory investigations were performed to establish that the volunteers were healthy (Table 1).

Statistical analysis

Analysis of data was performed using SPSS statistical software package. Results are expressed as means with their standard errors. Statistical analysis between glycemic indices were made by Paired t-test. $P < 0.05$ was considered statistically significant.

RESULTS

Biochemical factors measured in blood samples of subjects and healthy subjects were entered in this study (Table 1). Our results showed that the GI of fluffy rice and Steam rice were 55.38% and 66.25% respectively (Figure1). These values indicate that Iranian rice should be classified as medium GI food, although the GI of steam rice is very close to foods with low GI. Table 2 shows GI of fluffy rice and steam rice in men and women groups. When comparing the glycemic index of fluffy and steam rice, statistically significant difference was not observed. Mean B glucose curve for glucose, fluffy rice and steam rice in male and female are shown in Figures 1, 2, 3 (respectively).

DISCUSSION

To our knowledge, this study is the first report on Iranian rice GI. The GI has proven to be a more useful nutritional concept than the chemical classification of carbohydrate that permits new insights into the relationship between the physiological effects of carbohydrate rich foods and health. Several prospective observational studies have shown that the chronic consumption of a diet with a high glycemic index is independently associated with an increased risk of developing type 2 diabetes, cardiovascular disease and certain cancers (Venn and Green, 2007).

International Tables of Glycemic Index were published by the American Journal of Clinical Nutrition in 1995 and 2002. Tables of the GI values contain about 750 different foods. According to the GI, foods may be divided into three groups: foods with low GI (GI = 55% or less), foods with medium GI (GI = 56–69%) and foods with high GI (GI = 70% or more) (Chlup et al., 2004; Venn and Green, 2007; Atkinson et al., 2008) [1, 2, 4]. Rice is the most

Table 1. Characteristics of healthy volunteers.

Parameter	Mean±SE	Reference Value
Number of Subjects	10	
Men/Women	5/5	
Age(years)	20.14±0.02	
BMI(kg/m^2)	21.35±0.63	<25
Blood pressure systolic(mmHg)	112.16±1.84	<130
Blood pressure diastolic(mmHg)	74.36±1.51	<85
HbA1c(%)	6.48±0.08	6.3-7.3
T3(ng/ml)	1.07±0.1	0.5-2.1
T4(ng/ml)	8.26±0.32	4.2-12
TSH(µIU/ml)	2.91±0.25	0.4-5.2
Cortisol(µg/dl)	9.07±0.75	5-25
Insulin(µIU/ml)	6.96±0.89	0.7-20
Cholesterol(mg/dl)	133.21±6.33	150-200
LDL-Cholesterol(mg/dl)	75.92±4.75	<130
HDL-Cholesterol(mg/dl)	41.71±1.52	40-70
VLDL-Cholesterol(mg/dl)	18.35±1.38	10-40
Triacylglycerols(mg/dl)	91.5±6.81	50-150
C-reactive protein(mg/dl)	0.3±0.03	<1
Total protein(g/dl)	6.85±0.12	6.3-8.6
Albumin(g/dl)	3.95±0.4	3.5-5.2
Glucose(mg/dl)	85±2.45	70-110
Na(mmol/l)	139.02±0.48	135-145
K(mmol/l)	4.01±0.07	3.6-5.2
Cl (mmol/l)	100.53±0.88	90-110
Ca(mg/dl)	9.66±0.07	8.4-11
P(mg/dl)	3.71±0.07	2.5-5
Mg(mg/dl)	2.03±0.04	1.9-2.5
Urea(mg/dl)	30.73±1.31	17-45
Creatinin(mg/dl)	0.87±0.06	0.4-1.2
Uric acid(mg/dl)	4.14±0.29	2.5-6.5
Bilirubin total(mg/dl)	0.49±0.05	0.1-1.2
Bilirubin direct(mg/dl)	0.14±0.01	0.1-0.4
ALT(IU/l)	16.2±1.45	5-40
AST(IU/l)	14±1.14	5-40
GGT(IU/l)	28.14±1.32	7-50
ALP(IU/l)	171.78±6.1	64-306

important cereal crop and the staple food of over half the world population. As the primary dietary source of carbohydrate in this population, rice plays an important role in meeting energy requirements and nutrient intake (Chan et al., 2001; Patindol et al., 2010). In this study, we specifically investigated the postprandial glycemic response to commonly consumed rice in the Iranian diet prepared by two cooking methods. Our results showed that the GI of fluffy rice and steam rice were 55.38 and 66.25% respectively. These values indicate that Iranian rice should be classified as medium GI food, although the GI value of steam rice is very close to that of foods with low GI values. In 12 studies on white rice mean of GI was calculated as 64%; in Pakistanian rice, 69%; in Indian rice (boiled in salted water), 72% and Canadian rice (boiled 5 min), 41% (Gatti et al., 1987; Rahman et al., 1992; Kanan et al., 1998). The various GI levels may result from differences in the methods of cooking and processing and in the molecular and physical characteristics of the starch in the final products (Rashmi and Urooj, 2003; Venn and Green, 2007).

GI values may also be influenced by testing methods. Different testing methods including the use of various types of blood samples (capillary or venous), different experimental time periods, and different portions of foods (50 g of total rather than of available carbohydrate) may

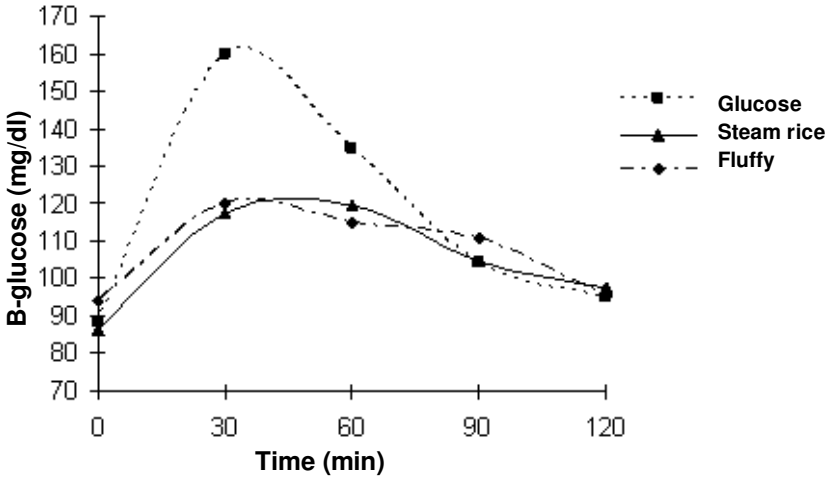

Figure 1. Mean B-glucose curve for glucose, fluffy rice and steam rice. Each meal contained 50 g of carbohydrate; in all 10 volunteers a total of 90 tests performed (in every volunteer 3 tests with glucose, 3 test with fluffy rice, 3 tests with stem rice).

Table 2. Glycemic index of fluffy rice and steam rice in 10 volunteers (5 men and 5 women); mean ± SD [%].

Group	GI for fluffy rice	GI steam rice
Men	52.11±7.43	57.91±21.96
Women	58.64±24.56	74.58±11.40
Total	55.38±17.16	66.25±18.49

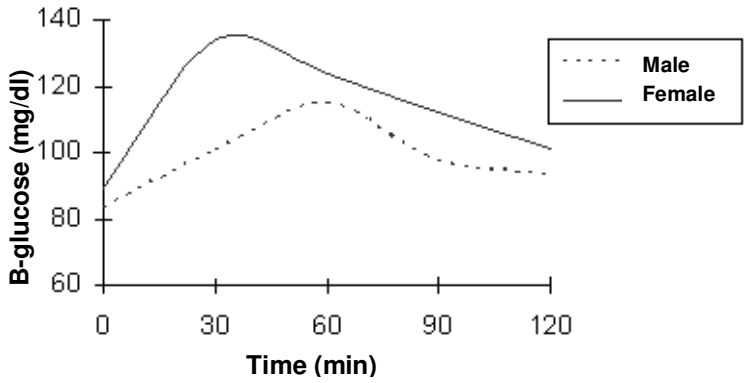

Figure 2. Mean B-glucose curve for steam rice in male and female.

influence the GI value. Recently, 7 experienced GI testing laboratories around the world participated in a study to determine the degree of variations in GI values when the same centrally distributed foods were tested according to the laboratories' normal in-house testing procedures (Wolever et al., 2003). The 5 laboratories that used finger-prick (capillary blood samples) for measuring postprandial glycemia, obtained similar GI values for the same foods and less intersubject variations. Although capillary and venous blood glucose values have been shown to be highly correlated, it appears that capillary blood samples may be preferable to the venous sample for reliable GI testing. After the consumption of food, capillary glucose concentrations change to a greater

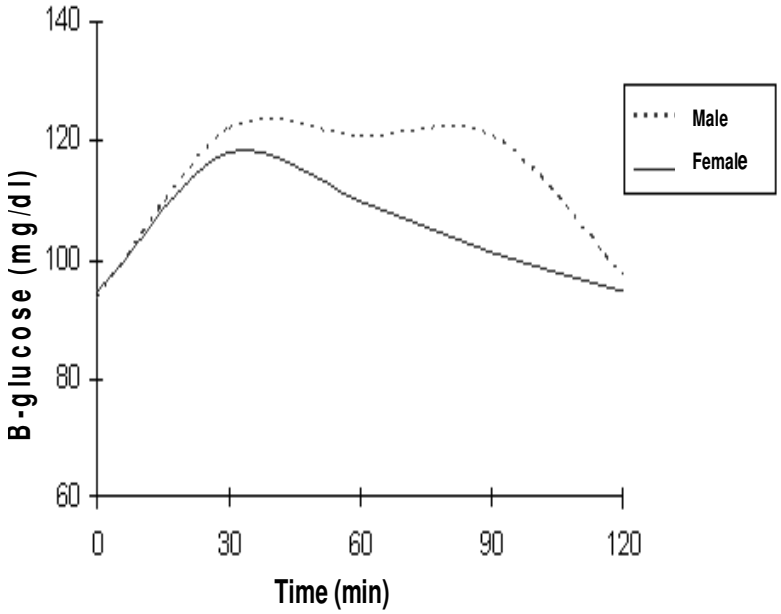

Figure 3. Mean B glucose curve for fluffy rice in male and female.

degree in contrast to vein. Therefore, capillary blood may be a more relevant indicator of the physiologic consequences of high-GI foods (Wolever et al., 2003).

Although it is clear that GI values are generally reproducible from place to place, there are some instances of wide variation for the same food. Rice shows a large range of GI values, but this variation is due to inherent botanical differences in rice from country to country rather than on methodological differences. Differences in the amylose content could explain much of the variation in the GI values of rice (and other foods) because amylose is digested more slowly than amylopectin starch (Miller et al., 1992). Furthermore, the greater the degree of gelatinization of the starch the more granules increase the GI (Ross et al., 1987). We think that one of the factors that lead to the higher GI of steam rice may be due to high degree of gelatinization.

GI values for rice cannot be reliably predicted on the basis of the size of the grain (short or long grain) or the type of cooking method. Rice is obviously one type of food that needs to be tested separately and locally [2].

Conclusion

Our results indicate that the Iranian white rice has medium GI, hence it is suggested that diabetic patients and obese subjects use Iranian rice in their diets.

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