Determination of the Glycemic Index of the most popular Iranian rice - Tarom - in two cooking methods: Boiled and Steamed

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A R T I C L E   I N F O

A B S T R A C T

Constant consumption of high-glycemic-index (GI) meals increases the risk of diabetes and cardiovascular diseases. Measurement of this index is possible for each kind of food. Half of the population of the world, including Iranian people, consumes rice as the staple food. This study selected one of the most popular Iranian rice (brand name of Tarom) to measure GI and glycemic load (GL) value with two different cooking methods (boiled and steamed). This interventional study was conducted in 10 healthy male volunteers with similar activity levels. After 10-h fasting, with three days apart (the first day 50 g glucose powder, the second day boiled cooked Tarom rice, and the third day steamed cooked Tarom rice), 100 ml of distilled water was given to them. Blood glucose levels were measured at −5, 0, 30, 60, 90, and 120 min by glucometer. The data was analyzed by the statistical software SPSS using repeated-measures analysis of variance (ANOVA) test and Tukey's test. The GI of boiled Tarom rice was 76.8 (high GI) and that of steamed Tarom rice was 83.9 (high GI). The GL of boiled Tarom rice was 41.95 (high GL) and that of steamed Tarom rice was 43.97 (high GL). Conclusively, Tarom rice has a high GI load whenever cooked by boiled or steamed method and is recommended to be eaten in limited quantities for patients with cardiovascular diseases, diabetes, and people at risk of kidney and thyroid cancers.

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Introduction

The quality of carbohydrates is reflected by glycemic index (GI); GI represents the relative ability of a carbohydrate-containing food to increase the level of blood glucose. Glycemic load (GL) is a measure of quantity of carbohydrate that shows both the GI of dietary carbohydrate as well as the amount of carbohydrate[1]. According to the National Food Consumption Survey, plant foods are a major source of energy intake among Iranians, and more than 60% of their calories are obtained from carbohydrates. In other words, the average dietary intake of carbohydrates (solely from breads and cereals) among Iranians is approximately 450 g per day (rural areas: 413 g/d and urban areas: 518 g/d). In descending order, these are the mean intakes of the following foods in Iran: bread, 320 g/day; white rice, 110 g/day; potatoes, 58 g/day; and spaghetti, 14 g/day. The average intake of refined sugar (in the form of sugar and sugar cubes) has been estimated to be 51 g/day. These data indicate that per-day consumption of refined carbohydrates in Iran is among the highest in the world, while dietary intakes of fiber, fruits, vegetables, legumes, and nuts are lower than the levels recommended by the Food Guide Pyramid[2]. White rice is recognized as the staple food of Iranians in most urban areas. However, in small towns and particularly in rural districts, white bread (namely lavash) is consumed as the main food[2-3]. Among Tehranian adults, the average dietary intake of refined grains has been estimated to be 201 ± 57 g/day, while the average whole-grain consumption is 93 ± 29 g/day[4]. Several studies have investigated high GI and GL as risk factors for diseases, such as diabetes, cardiovascular disease, and obesity[5-7].

Published GI values for rice show they cover a wide range. The GI of white rice is between 54 and 121. This makes it difficult to classify rice as a low- or high-GI food. The Australian white rice GIs ranged from 64 ± 9 to 93 ± 11[8]. Three commonly consumed Indian rice varieties (Sona Masuri, Ponni, and Surti Kolam) were tested to measure their GI. The GI for Sona Masuri was 72 ± 4.5, for Ponni 70.2 ± 3.6, and for Surti Kolam was 77 ± 4[9].

A brief report published in 2008 reported on the GI of the amount of white rice, boiled brown rice (73 ± 4, 68 ± 4)[10]. Glycemic indices of varieties of Sri Lankan rice differ. The GI of red raw rice varied between 56 and 73, and the variety Bg 350 had the lowest GI[11].

White rice is one of the main staple foods and a major source of carbohydrate among Iranian people. There are many types of rice in Iran. If there is a nutritional advantage of one type of rice in comparison to others, then this information would be very helpful for advising on a healthier lifestyle or dietary alteration in the management of extra weight and obesity. This study selected the most popular Iranian rice (brand name of Tarom) to measure GI and GL value and compare GI and GL value in two different cooking methods (boiled and steamed).

Materials and Methods

This interventional study was done in the Department of Nutrition in Mashhad Medical School. The study was approved by the Medical Ethics Committee of the Mashhad University of Medical Sciences and all volunteers gave informed written consent before participating.

Subjects

The Louise study and mean of basmati GI were produced from a sample size of 10[12].

$$n = \frac{\left[Z_{1-\frac{\alpha}{2}} + Z_{1-\beta} \right]^2 \left(S_1^2 + S_2^2 \right)}{\left(X_1 - X_2 \right)^2} = 10$$

Ten healthy volunteers were recruited from the student and personnel population of Mashhad University of Medical Sciences. The participants were Mashhad residents and their ages ranged from 18 to 45 years old, and their body mass index (BMI; in kg/m^2) ranged from 18.5 to 30.

Subjects were excluded if they reported a history of hyper blood pressure, suffered from diabetes, were taking medication for any chronic disease conditions, or were pregnant, breastfeeding, or smoking.

Subjects attended each testing session after a 10 h overnight fast, having been instructed not to consume unusually large meals, drink alcohol, smoke or exercise vigorously on the previous day, and to avoid cycling or walking to the laboratory. They had to eat lunch and they were not to fast for more than 18 h.

Test and Standard Meal

On the first three visits, subjects were given the standard reference food of glucose (dextrose monohydrate). Fifty grams of glucose powder was dissolved in 250 ml of distilled water. Two cooking methods of Tarom rice were used as a test meal. The subjects took a 50 g-available carbohydrate portion for a test meal along with 100 ml of distilled water. Cooking was prepared according to a nutritionist's instructions.

Boiled cooked method: this is the method where the rice is boiled in water. This is a common method for cooking rice in Europe and the USA.

Steamed cooked method: in this method, the rice is boiled first, then rice is taken from the boiled water into the filter, after that rice is put in the pot on a low temperature for around an hour. During this time rice is completely cooked with steam. This method is the most common way of cooking rice in most parts of the Iran.

On the second visit, subjects took boiled cooked Tarom rice and on the last visit, steamed cooked Tarom rice was consumed.

The compositions of the steamed and boiled cooked Tarom rice were determined in Test laboratory (Table 3).

Protocol

The FAO/WHO standard method for measuring the GI was used in this study[13].

Subjects arrived in the lab after fasting overnight for at least 10 h. Blood glucose levels were measured in capillary whole blood obtained by index finger prick (Accu-Chek Active glucometer, Roche, Mannheim, Germany) in the fasted state (−5) and at 0, 15, 30 45, 60, 90 and 120 min after commencement of consumption of the test and standard meals.

For most GI data, the area under the curve (AUC) is calculated as the incremental area under the blood glucose response curve (IAUC), ignoring the area beneath the fasting concentration. This can be calculated geometrically by applying the trapezium rule. When the blood glucose value falls below the baseline, only the area above the fasting level is included. Therefore, the positive increment of the AUC for post-prandial plasma glucose was calculated for each test of each subject.

To determine the GI of the boiled and steamed cooked Tarom rice, the AUC was calculated for both the reference meal and the test meal. As glucose was the standard test and its GI by definition is 100, the ratio of the calculated AUC of the test meal to glucose is the GI of the test meal.

Data analysis and statistical methods

The results were analyzed using the SPSS for Windows version 20 software package. The values were presented as mean ± standard deviation (SD) and the significance level was set at $P<0.05$. Repeated measure analysis of variance (ANOVA) test and Tukey test were used to determine whether significant differences existed between the GI values of boiled cooked and steamed cooked Tarom rice.

Results

The mean of blood glucose and the blood glucose response curve following glucose consumption and the boiled and steamed cooked rice test are presented in Table 1. There is a significant difference between the blood glucose mean of standard group and steamed cooked, boiled cooked group ($P = 0.049$, 0.044), although there is no significant difference between the blood glucose mean between steamed cooked group and boiled cooked group ($P = 0.955$).

The GI of each cooking type of rice was calculated by dividing the blood glucose response curve for each cooking type by the test meal (glucose solution), multiplied by 100 to obtain a percentage score. The GL was calculated by multiplying the GI and amount of available carbohydrate of the test meal and dividing by100.

The GI and GL of two cooking methods of Tarom rice is illustrated in Table 2.

Table 1. Frequency of the mean of blood glucose of boiled cooked, steamed cooked and standard

Groups	The mean of blood glucose						The blood glucose response curve
	-5min	0	30min	60min	90min	120min	
Boiled cooked	3.2±89	7.6±90.10	9.1±107.90	9.7±105.80	11.1±98.9	5.4±89.9	586.6
Steamed cooked	7.8±91.2	5.8±94.10	12.4±116.6	12.9±125.7	5.7±106.8	3.6±107.2	641.6
Standard (Glucose)	13.5±101.9	24.2±124.4	32.1±171.5	40.3±150.9	17.7±116.6	19.8±98.7	764
ANOVA Test		F=4.184	P=0.032				
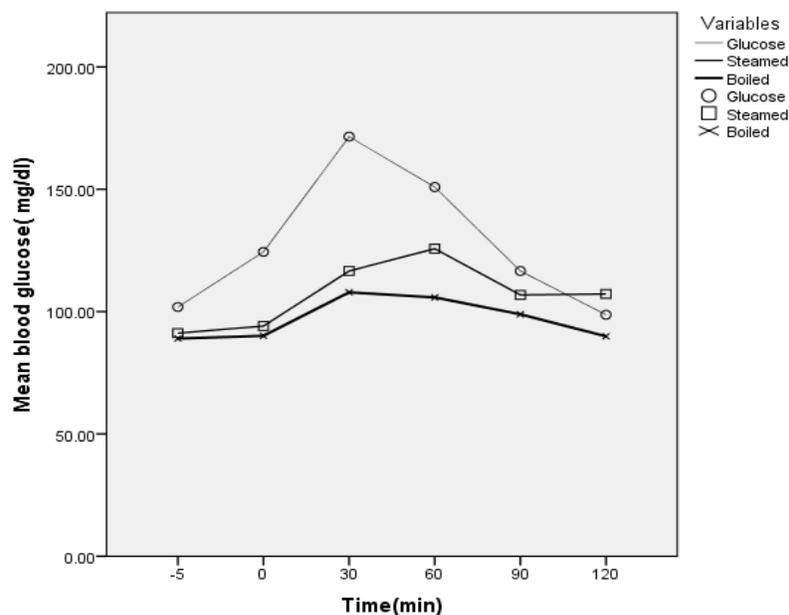
Figure 1. The mean blood glucose of standard, boiled and steamed cooked in different times

Table 2. GI and GL of two cooking methods of Tarom rice

Cooking methods	Glycemic Index(glucose=100)	Glycemic Load
Boiled cooked	76.8	41.95
Steamed cooked	83.9	43.97

Table 3. The composition of the boiled and steamed cooked Tarom rice

Cooking method	Carbohydrate %	Fiber %	Water %	Protein %	Fat %
Boiled cooked	54.62	1.30	41.85	1.85	0.38
Steamed cooked	52.41	0.38	44.60	2.09	0.062

Discussion

The current study shows that the GI and GL of Tarom rice that is cooked by two methods (boiled and steamed) are high. The steamed cooked Tarom rice has a higher GI value than other cooking methods. This study demonstrated the effect of the cooking method on GI value. Also, this difference might be due to its fiber content, which can lower the GI (Table 3). The Sri Lankan study demonstrated this relationship[14], although this relationship is incompatible with the results of a Malaysian study[15]. In agreement with this finding, the Australian study shows the rice with higher amylose content (Doongara, 28% amylose) had lower GI than the normal amylose rice (Calrose, Pelde, 20% amylose)[8]. Another study investigated that high amylose rice, such as basmati, has widely been found to have low GI values. Also, the Sri Lankan study result showed this relationship between fiber content and GI amount. In this study, different amounts of complex carbohydrate are probably another reason for the difference in GI value. In the steamed cooked method, a more complex carbohydrate lyses into a simple carbohydrate (Table 3). Also, steamed cooked rice digests faster than boiled cooked rice in the GI tract. Another factor that may affect the GI value is the amount of fat. Fat can lower the GI value. The boiled cooked rice has a higher amount of fat than the steamed cooked rice (Table 3). Besides cooking methods, food processing methods such as "easy-cook" affect the GI. The easy-cooked basmati had a significantly higher GI value than the standard basmati rice. GIs of basmati rice, basmati easy-cook rice and American easy-cook rice were determined as 42.8, 68.4, 49.4, respectively[12]. This rice (Tarom rice) has a high GI value, and therefore it is recommended for diabetic people to consume less of it, and some study results support this recommendation[16-20]. Some studies have suggested that the dietary carbohydrate, GI, and GL might affect cardio vascular disease (CVD) through an effect on body mass index (BMI)[21-23]. Foods with higher GI, such as white rice, can cause a quick postprandial increase in insulin secretion and blood glucose level, and have an increased risk of CVD in western[17] and Asian populations[18]. A recent study done in Isfahan demonstrated that high carbohydrate intake of specially refined sources with high GI and GL, is associated with increased risk of stroke[24]. There is an association between the high maternal dietary glycemic index (DGI) and the risk of birth defects[25]. A meta-analysis investigated that both GL and GI were directly related to risk of endometrial and breast cancer[6]. A few studies showed that the DGI and GL were directly associated with the risk of prostate[26], upper aero digestive tract[27], and stomach cancer[28]. A case-control study on renal cell carcinoma (RCC) conducted from 1992 to 2004 in four Italian areas, pointed to direct relationships between dietary levels of GI and GL and RCC risk [29]. In conclusion, this study has provided GI values for Tarom rice that is cooked by two methods (steamed and boiled) and has showed a relationship between GI value and cooking methods. It has also highlighted some of the other factors affecting the GI of a food. This information is useful for researchers interested in calculating the GI in dietary surveys to study diet-disease relationships, and in the planning of dietary intervention studies. This is in order to have a clear idea of the GI of the intervention diets and to ensure that the diets for comparison truly differ in GI. It also provides valuable data for practitioners who have responsibility for advising individuals on their diet.

Conclusion

Tarom rice has a high GI load whenever cooked by boiled or steamed method and is recommended to be eaten in limited quantities for patients with cardiovascular diseases, diabetes, and people at risk of kidney and thyroid cancers.

Acknowledgment

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