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ORIGINAL ARTICLE

Determination of the glycemic index values of the Turkey-specific ice cream

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ABSTRACT

Objective: The glycemic index (GI) is defined as the effect of consumed food on blood glucose relative to the reference food. The aim of this study is to determine the GI value of "Atatürk Orman Çiftliği (AOÇ)" ice cream, which is unique to our country.

Method: This study included 18 adult healthy individuals with normal body mass index (BMI) values (18.5-24.9 kg/m^2) (Female/Male: 10/8). Individuals participating in the study were invited to the our outpatient clinic on different days for two weeks to consume 2 test foods (AOC ice cream) and 2 reference foods (glucose) after 12 hours of fasting. Venous blood samples were taken at 0, 15, 30, 45, 60, 90 and 120 minutes after consumption of reference and test foods and glucose values were recorded. The glycemic index value of the test food was calculated by multiplying by 100 the ratio of the sum of the area under the curve obtained from the test food to the sum of the area under the curve obtained from the reference food.

Results: The median values of the area under the curve of the reference food and the test food were 2360.88 (483.75-4132.5) and 475.95 (44.88-1980), respectively ($p<0.001$). The Glycemic index value of the test foods was 21.46 (4.08-409.3) according to the reference food.

Conclusion: In this study, the glycemic index value of the Turkey-specific "Atatürk Orman Çiftliği" ice cream was found to be 21,46 (4.08-409.3) (Low). These types of foods with a low glycemic index may be preferred to increase the dietary compatibility of the patient with type 2 diabetes, especially at snack meals.

Keywords: carbohydrates, glycemic index, glycemic load, ice-cream.

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INTRODUCTION

Canadian researchers Jenkins and his colleagues first mentioned the term glycemic index (GI) in 1981 [1]. It was originally developed for diabetic patients, but it has also been found to be a viable method for healthy individuals. GI is defined basically as a ranking of foods based on the postprandial blood glucose response compared with a reference food [2,3]. The World Health Organization (WHO) and the United Nations Food and Agriculture Organization (FAO) have reported that carbohydrates should be classified according to their glycemic index [3]. According to this classification, food is divided into three groups as low (GI <55), medium (GI: 55-70) and high (GI> 70) GI foods. Foods with low GI raise blood glucose slowly, while foods with high GI elevate blood glucose rapidly.

Calculation of the glycemic index of foods requires a series of tests. The standards for the calculation of the GI and the details are stated in FAO's "Carbohydrates in Human Nutrition" report. Glycemic load (GL) a different terminology refers to how much the amount of carbohydrates in the portion of the food can affect blood sugar. GL is a measure that combines both the quality and the quantity of consumed carbohydrates [4]. It is calculated by multiplying the amount of carbohydrate in the serving portion of the food with the GI of the food. Foods with a GL ≤10 are classified as low GL, and those with a value ≥20 as high GL.

In recent years it has been shown that feeding with low glycemic index foods provides a delay in the development of type 2 DM, and provides better glycemic regulation and better metabolic control in type 2 DM patients [5,6]. Therefore it is important to calculate the glycemic index values of all foods consumed in daily life and to make an optimal nutrition plan suitable for each individual. Unfortunately, the studies on determining the glycemic index of foods are rather limited in our country. 'Atatürk Forest Farm ice cream' (AOC ice cream) is a nutrient consumed frequently in our country. The aim of this study is to determine the GI value of the country-specific AOC ice cream.

METHOD

Subject Selection: After signing a consent to adhere to the experiment, 18 healthy adult volunteers (8 male and 10 female) without endocrinological or metabolic disease were included in the study. After recording the anthropometric measurements of the participants (body weight, height, body mass index, waist circumference) they were assessed metabolically by an endocrine specialist before the study. Fasting blood glucose, fasting insulin, total cholesterol, triglyceride, HDL cholesterol, LDL cholesterol, VLDL cholesterol, thyroid stimulating hormone, alanine transaminase, aspartate transaminase, total protein, albumin, creatinine levels and total blood counts were measured from blood samples taken after 10-12 hours fasting from individuals.

Blood Sampling and Analysis: In the first phase of the study, the sample of AOC ice cream was sent to The Scientific and Technological Research Council of Turkey Marmara Research Center (TUBITAK Marmara Research Center) to analyze the measures of moisture, fat, protein, nutrient fiber and ash content and the amount of AOC ice cream containing 50 g digestible carbohydrate (Table 1). In the second phase of the study, the individuals consumed the test nutrient (AOC ice cream) for 2 times and the reference nutrient (glucose) for 2 times after 12 hours fasting on different days at one week intervals. The day before the test, they were asked not to make changes in their diet, not to use alcohol, not to consume caffeine-containing beverages, to limit the consumption of carbohydrate foods, to sleep as well as possible and to have normal (similar) physical activity. The prepared foods were measured with a 0.01 gauge scale and the amounts consumed by the individuals were adjusted. They consumed of the food containing 50 g digestible

Table 1. Analysis results showing the contents of the test food

Energy	178 kcal/100 g
Moisture	64.43 g/100 g
Ash	1.51 g/100 g
Protein	6.95 g/100 g
Carbohydrate	18.66 g/100 g
Fibre	<0.65 g/100 g
Fat	8.54 g/100 g
Calcium	216mg/100 g

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carbohydrates within 10 minutes (venous blood samples were taken from individuals before consuming the reference and test food). During the measurements, individuals are required to be stable in terms of physical activity. Venous blood samples were taken at 15, 30, 45, 60, 90, and 120 th minutes from all participants after consumption of reference and test foods, and glucose values were recorded. Blood glucose values were marked on the graphic of averages of the two measured values thus blood glucose curves of the reference food and the test food were obtained. Then, by plotting a horizontal line from the blood glucose value at the 0 th minute (starting point), only the area above the line (the remaining area under the curve) is accounted for. The glycemic index value of the test food was calculated by proportioning the area under the curve obtained from the test food to the area under the curve obtained from the reference food and multiplying by 100. This study was approved by Ethics Committee of Ankara University School of Medicine (date: 27.06.2016, number: 12-553-16). Informed consent was obtained from all individual participants included in the study.

Statistical Analysis: Continuous data were expressed as means ± standart deviations or medians and range. The percentage values were given in discrete data. The Mann-Whitney U test was used to compare two groups of continuous variables. The Wilcoxon Test was used to compare the individual area under the curve (AUC) values of glucose and AUC values of AOC ice cream.

RESULTS

Eighteen healthy subjects were included in the study (Female/ Male: 10/8). The mean age, height, weight, BMI and waist circumference values of the individuals were respectively 29.94 ± 8.15, 167 ± 0.11 cm, 63.35 ± 13.04 kg, 22.55 ± 2.18 kg/m^2, 76.17 ± 9.29 cm. No pathological value was found in the biochemical parameters of the individuals (Table 2). The median values of the area under the curve produced by the reference food and test food consumed by the individuals are 2360.88 (483.75-4132.5) and 475.95 (44.88-1980), respectively (p <0.001) (Table 3). The GI value of the test food was 21.46 (4.08-409.3) according to the reference food. Also, the glycemic load was calculated as 4 for the test food AOC ice cream (GL greater than 20 is considered high, a GL of 11–19 is considered medium, and a GL of 10 or less is considered low). There was no difference between gender in terms of GI value of the ice cream (p=0.173) (Table 4).

Table 2. Baseline characteristics of individuals

	Male (n=8)	Female (n=10)	p value
Age (years)	28 (21-43)	27 (22-43)	0.829
Height (cm)	176 (168-196)	160 (147-167)	<0.001
Weight (kg)	77 (59-94)	53.45 (49-62)	<0.001
Body Mass Index(kg/m^2)	24.6 (20.6-24.8)	21.5 (19.09-24.48)	0.006
Waist circumference (cm)	85.5 (78-90)	67.5 (62-78)	<0.001
Fasting Blood Glucose (mg/dl)	91 (86-100)	86 (83-100)	0.101
Insulin (µIU/ml)	6.7 (4.2-10.1)	6.25 (4-13.2)	0.829
Total Cholesterol (mg/dl)	175 (136-198)	170.5 (143-196)	0.829
LDL (mg/dl)	111 (82-129)	92 (82-129)	0.274
HDL (mg/dl)	43.5 (32-58)	60.5 (47-76)	0.001
Triglyceride (mg/dl)	97.5 (47-150)	76.5(57-136)	0.203
TSH (mIU/ml)	2.06 (0.55-3.46)	2.14(0.77-3.74)	0.762

Table 3. Area under the curve (AUC) of test food and reference food

	Median (min-max)	p
AUC of Glucose	2360.88 (483.75-4132.5)	<0.001
AUC of Ice cream	475.95 (44.88-1980)	
GI of test food	21.46±(4.08-409.3)	

Table 4. Glycemic index values of ice cream in different genders

	Male	Female	
	Median (min-max)	Median (min-max)	p
GI	27.9±(12.4-409.3)	19.9(4.08-88.1)	0.173

DISCUSSION

According to the classification of the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO), foods are divided into three groups according to their GI values (>70 high, 55-70 moderate, <55 low). In this study, the glycemic index value of the Turkey-specific 'Ataturk Forest Farm ice cream' (AOC ice cream) was found to be 21,4 (4.08-409.3). This value is much lower than the average value determined for ice cream in the international glycemic index table (51±3) [7].

Generally, at least 10 healthy volunteers are required for glycemic index determination studies [8]. In order to increase the statistical significance, we included 18 individuals in this study. Although it is known that gender is not an important factor in the glycemic index calculations we took care to ensure that the number of male and female participants in this study was balanced as much as possible [9].

Thomas and colleagues found that the standard deviations were significantly higher in the glycemic index determination methods with shorter tests and less frequent blood sampling [10]. Therefore we used the glycemic index calculation method proposed by the Food and Agriculture Organization for non-diabetic individuals. Thus seven blood samples were collected over 2 hours to calculate incremental AUC.

Carbohydrates are the main energy source for humans and carbohydrate metabolism plays a significant role in several diseases. High glycemic index meals cause rapidly rising blood glucose and insulin levels. Many studies have shown that low glycemic index diets improve insulin resistance, beta cell damage, endothelial damage and dyslipidemia [11-13]. As a result of a meta-analysis, diabetic individuals who consume lower GI foods were reported to have better blood glucose control and a significant decrease in HbA1c levels [4]. The results of epidemiologic studies indicate the relationship between high GI or GL diets and increased myocardial infarction [14,15]. In another study it was reported that a high GI diet increased the risk of metabolic syndrome by 41% compared to a low GI diet [16]. It has been also shown in previous studies that low glycemic index foods increase insulin sensitivity in patients with type 2 diabetes and reduce daily insulin requirements in patients with type 1 diabetes, and reduces serum triacylglycerol levels [4,12,17]. Unfortunately, in our country studies on determining glycemic index are very limited. There are a few studies of glycemic index determination made with different types of bread and honey consumed in our country [18]. It is the first study to determine the glycemic index for Turkey-specific ice cream.

There are several factors that may affect the GI of a food, including the presence of other macronutrients, protein, fat and moisture contents, carbohydrate structures, differences in processing, preparation and cooking methods and acidity. It is argued that both the amount and source of carbohydrates are important determinants of postprandial glucose and insulin response in studies [19]. Therefore the same food may have a different glycemic index value even with the same amount of carbohydrates. The presence of large amounts of protein and fat may reduce the glycemic response by increasing insulin secretion and slowing gastric emptying. Compared to ice cream produced in Switzerland the fat and protein content was significantly higher in Turkey-specific ice cream (carbohydrate, protein, fat and calorie content of Switzerland specific ice cream per 100 grams are 13.2 gr, 1.8 gr, 7.4 gr, 128 kcal, respectively). We think that the protein and fat content of the test food (AOC ice cream) has an important role in obtaining this result. Furthermore, cooling process may have played a role in these results. Although the effect of cooling on the glycemic index is not clear, it can be speculated that it may decrease the glycemic index values by increasing the resistant starch ratio [20,21].

There are a limited number of studies in the literature aiming to determine the glycemic index of ice cream. Although the average glycemic index of ice cream is accepted as 51±3 in the international glycemic index table, the glycemic index values range from 36 to 68 depending on the fat content of the ice cream. In a study of Buker at all, the glycemic load of a cholesterol-free tofu-based frozen dessert (TFD) and ice cream was compared. They found that sucrose and lactose-rich ice cream caused less glycemic load than TFD-containing glucose-rich carbohydrates [22]. In another study conducted by Ganon et al, when 50 gr glucose was ingested as milk, ice cream or only glucose; glycemic response and glycemic load were found to be highest in the glucose alone group. Following the ingestion of 50 gr carbohydrate as ice cream, they found that the

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plasma glucose response was higher than for milk ingestion [23]. In our study, similar results were obtained with the test food that has lactose-rich content.

It is generally accepted that the glycemic index is a property of foods and that it is not affected by the characteristics of individuals such as age, sex, body mass index and ethnicity [24]. In contrast to this view, it has been shown in some studies that demographic variations of individuals can change the mean glycemic index values of foods. For example, Venn et al. showed that ethnicity has a significant effect on the mean glycemic index values in a study of 73 healthy Whites and 27 healthy Asians individuals [25]. We think that ethnic differences in the study population may play a role in the low glycemic index value of the product used in our study.

Showing glycemic index values on food labels is a current issue all over the World, especially in countries such as Australia and Canada. The Canadian Ministry of Health has published a report on the idea that GI values should be included in nutritional labeling and that this information will help consumers make healthier choices. In order to discuss these issues in our country, it is necessary to determine the glycemic index of frequently used food [26]. In the future, more prospective studies are required to assess the relationship between a lower glycemic index diet and the development of chronic diseases including diabetes, cardiovascular diseases and cancer. Also, glycemic index studies with different products in diabetic or prediabetic patients are needed.

In conclusion, the present study has provided reliable values of GI and GL for food commonly consumed in Turkey. The GI value of AOC ice cream was 21.46 (4.08-409.3). In addition, the glycemic load (GL) of 100 gr AOC ice cream was calculated as 4 (low). As it is thought that about half of the daily needed energy is derived from carbohydrates the consumption of carbohydrates with a healthy and low glycemic index is an important issue. AOC ice cream is consumed frequently in our country. These types of foods with a low glycemic index may be preferred to increase the dietary compatibility of the patient, especially at snack meals.

Author contribution

Study conception and design: NY, DÇ, NB, SG, MFE, VTG, ÖD, MŞ, and RE; data collection: NY, ÇK, and ŞC; analysis and interpretation of results: NY, MŞ, and ÇK; draft manuscript preparation: NY, ÇK, and ABB. All authors reviewed the results and approved the final version of the manuscript.

Ethical approval

The study was approved by the Ethics Committee of Ankara University School of Medicine (Protocol no. 12-553-16/27.06.2016).

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Conflict of interest

The authors declare that there is no conflict of interest.

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