Nutrition and Food Sciences Research Vol 2, No 1, Jan-Mar 2015, pages: 19-25

Original Article

Effect of Date and Raisin Snacks on Glucose Response in Type 2 Diabetes

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Received: December 2014 **Accepted:** February 2015

ABSTRACT

Background and Objectives: Snacks are important parts of diabetes patients' diet. The aim of the present study was to evaluate the effects of moderate amounts of dates and raisins, as nutritious snacks, on blood glucose, and to compare these effects with sugar in patients with type 2 diabetes.

Materials and Methods: This crossover clinical trial was performed on 15 patients with type 2 diabetes. In each experimental day, fasting blood glucose (FBG) was initially measured, and a breakfast containing 90 g bread was consumed. Two hours later, blood glucose was measured. Then a snack containing 15 g available carbohydrate from dates, raisins, or sugar was given, and postprandial blood glucose was measured at 30, 60, and 120 min. The procedure was performed on 3 days, each day with one of the aforementioned snacks. Comparisons between the different snacks were done with the Friedman's test.

Results: Consumption of dates, raisins, or sugar did not increase blood glucose (alterations in blood glucose at 30 min compared to the time point before snack consumption were -2.23 ± 32.0, -6.33 ± 24.3, and -2.30 ± 16.9 for dates, raisins, and sugar, respectively), and there was no significant difference between the snacks in blood glucose levels at any time point after their consumption, and also in the area under the curve of blood glucose alterations.

Conclusions: In moderate quantities, the effects of dates, raisins and sugar on the blood glucose of diabetes patients were similar. However, considering their nutrient content, dates and raisins may be more suitable snacks than sugar for patients with type 2 diabetes.

Keywords: Type 2 diabetes, Dates, Raisins, Sugar, Blood glucose

Introduction

Type 2 diabetes is a chronic metabolic disorder characterized by hyperglycemia resulting from derangement in glucose utilization and metabolism (1). According to the statistics, nearly 382 million adults throughout the world and more than 6 million people in Iran were involved in diabetes in 2013 (2). Dietary management is one of the key strategies for the control of diabetes (3). A dietary recommendation for diabetes is to use snacks with low glycemic load and limit consumption of high glycemic index (GI) foods (4).

Dates and raisins are dried or semi-dried fruits containing good amounts of fiber, minerals, and phytochemicals including flavonoids and phenolic acids (5-7). They both have biological properties. For instance, in preclinical studies, dates have demonstrated antioxidant, free radical scavenging, anti-mutagenic, antimicrobial, immune-stimulant, gastro-intestinal protective, nephro-protective, and anti-inflammatory activities (7). Similarly, raisins in human intervention studies have shown antioxidant properties and ability to lower postprandial insulin and glycemic response (5). Raisins also decreased serum triglycerides, total cholesterol, and glycosylated hemoglobin in alloxan-induced diabetic rats (8); they have also shown to decrease hunger and prolong satiety via the increase of leptin and ghrelin, hormones that are involved in appetite control (9). This is particularly important because most of patients with type 2 diabetes are obese, and

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therefore, benefit from healthy low-caloric snacks with prolonged satiation potential.

There is insufficient evidence for the effect of consuming dates and raisins as snacks for patients with type 2 diabetes. Although GI of these foods has been determined, 50 g carbohydrates used in GI tests is more than what is eaten as a snack. The aim of the present study was to determine whether dates and raisins in the amounts that provide 15g carbohydrates impair glycemic control of patients with type 2 diabetes. In the meantime, we compared the glycemic response of dates and raisins with that of sugar.

Materials and Methods

Subjects: This was a non-randomized cross-over clinical trial. The sample size was determined by using the NCSS PASS software (version 11) according to a previous study with a mean of paired differences of 23.6, a standard deviation of differences of 32.5 (10), the power of 80%, and $\alpha < 0.05$. An attrition rate of 20% was used, and so 18 subjects (7 males and 11 females) were initially participated. However, 3 individuals withdrew at the 2nd and 3rd experimental days and so were excluded. Therefore, statistical analyses were performed on the data of 15 subjects (5 males and 10 females) who completed the study. An informed written consent was obtained from the participants. The study was approved by the Ethics Committee of Shiraz University of Medical Sciences (No. CT-P-9362-6712) and registered in Iranian Registry of Clinical Trials (No. IRCT2014112920140N1).

The participants were selected by convenience-purposive sampling from the diabetes patients who were under medical care of a diabetes clinic in Shiraz city. Inclusion criteria were as follows: involvement in type 2 diabetes, diagnosed by as FBS ≥ 126 mg/dl (11) and confirmed by a gynecologist, glycated hemoglobin (HbA1c) < 7%, diabetes history of < 10 years, use of metformin as the hypoglycemic agent, and desire for participation. Exclusion criteria were: body mass index (BMI) ≥ 40, pregnancy, alcohol consumption, smoking, severe stress or pain, heart attack in the last 6 months, gastrointestinal disorders and surgeries during the last 6 months, liver or kidney failure, cancer, and taking steroids, antibiotics, levothyroxine and other medications with an effect on glycemic control (12,13).

Procedure: An interview was performed to obtain information on the participants' demographics, diabetes duration, history of diseases, medications, and the dose and the schedule of hypoglycemic agents. Weight was measured in light clothing to the nearest 0.1 kg with a GS 21 Madagascar scale (Beureu, Germany). Height was measured without shoes to the nearest 0.1 cm with a non-stretchable tape fixed on a wall. BMI was calculated by dividing the weight in kilogram by the height squared in meters.

The participants did not change their diet and physical activity during the study. On the experimental days, the participants were on 12-h fasting and the maximum level of exercise they had performed before experiments was 10 min mild walking (14).

The experiments were performed on 3 separate days, each day with one type of snack. At least one week was set between the experiments. The experiments were individualized for each person regarding the times of blood glucose measurements, serving breakfast, and administration of metformin. In each experimental day, fasting blood glucose (FBG) was firstly measured, and then a breakfast containing 90 ± 2 g bread, 50 ± 2 g feta cheese, and 100±5 g cucumber was consumed by the participants. Immediately after breakfast (15), a 500 mg metformin (Glucophage) pill was administered along with a glass of water. This dose of metformin was concordant with the medication regimens of the participants. Two hours after the breakfast, blood glucose was measured again and a snack containing 150 ml tea + dates (or raisins or sugar) in the amount, which contained 15 g of available carbohydrates, was consumed. Glycemic response was measured 30, 60, and 120 min after the consumption of snacks.

Blood glucose measurements: Capillary blood glucose was measured with a glucose meter (Glucocard 01, Arkray, Japan). Each test was performed in duplicate, and the average of the two measurements was used as the actual value. Glucose values obtained through this device were validated against the plasma glucose values obtained by an automatic clinical chemistry analyzer (BT 1500, Biotecnica Instruments, Italy). A strong correlation between the results of the two tests was found (r=0.94, p=0.005). Glucose meters have frequently been used (12,13,16-19) and validated (16,19) by previous investigators.

Snacks: The examinations were performed with 3 kinds of snacks: dates, raisins, and sugar. The dates were Bam Mazafati variety, which contains 62% digestible carbohydrates (20). Raisins were Sultana variety with 67.4% digestible carbohydrates as written on the label. To administer 15 g available carbohydrates, 24.2 ± 0.5 Bam Mazafati dates, 22.25±0.25 raisins, or 15 g sugar was provided. One sort of snack along with a definite amount and concentration of tea was given at a time. A notebook pocket digital scale with the accuracy of 0.1g (P17, China) was used for weighing the snacks. Macronutrient contents of the dates and raisins are presented in Table 1.

Table 1. Macronutrient content of dates and raisins

Macronutrient	Bam Mazafati dates	Sultana raisins	Sugar
Protein (%)	1.6	2.5	0
Fat (%)	0.2	0.4	0
Carbohydrate (%)	72.1	69.4	100
Fiber (%)	10.1	2	0

Statistical analysis: Data were analyzed with the SPSS software (version 19). Normal distribution of the data was examined with Shapiro-Wilk test. Data were presented as means and standard deviations (SD). For each snack, means of blood glucose in different time points were compared using Friedman's test. Similarly, Friedman's test was used for comparisons between alterations in blood glucose level after consuming the snacks. Areas under the curve of blood glucose concentration were calculated as previously described. In Brief, for each subject, the minimum of the 2-h blood glucose concentration between the 3 occasions was set as the baseline, and blood glucose responses after consuming the snacks of the same subject were modified accordingly (21,22). After calculating the areas under the curve for all participants and snacks, the areas under the curve of different snacks were compared using Friedman's test. The comparison was also performed with Repeated Measures, and produced the same results. Statistical significance was set at $p < 0.05$.

Results

General characteristics of the study subjects and the amount of food items consumed at breakfast are presented in Tables 2 and 3, respectively. The consumption of bread, feta cheese and cucumber did not differ between the 3 experimental days. The study was started with 18 subjects, but 1 person discontinued her participation at the 2nd experimental day due to back pain, and 2 other individuals withdrew due to personal difficulties at the 3rd experimental day. Therefore, overall, 15 subjects completed the study. The flowchart of participants is presented in Figure 1.

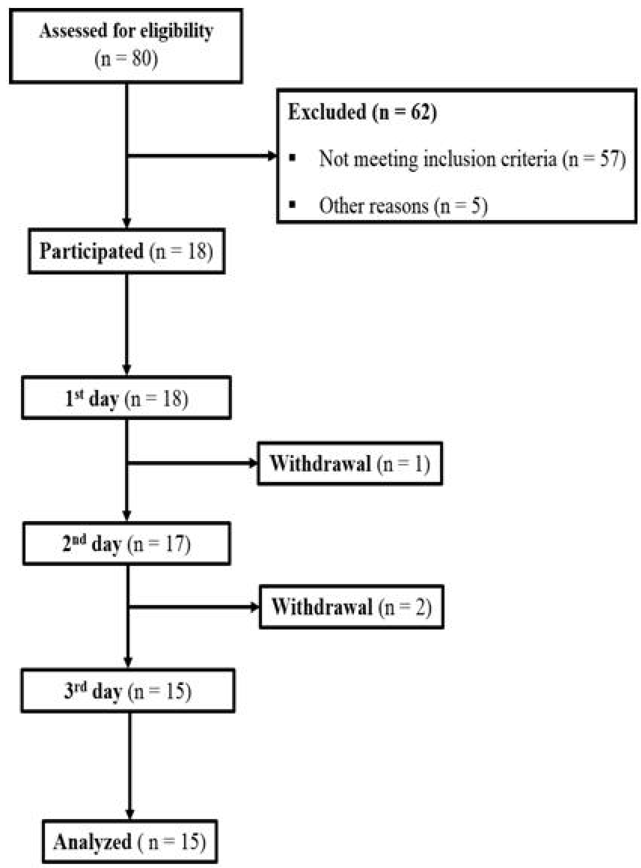

Figure 1. Flowchart of the subjects

Table 2. Demographic, physical activity, and medical characteristics of the study subjects[1]

Characteristics	Mean ± SD or n (%)
Age (y)	58.5 ± 8.4
Gender	
Male	5 (33.3)
Female	10 (66.7)
Education level	
< Diploma	10 (66.7)
≥ Diploma	5 (33.3)
Weight (kg)	71.4 ± 12
Height (cm)	160.8 ± 7.4
BMI (kg/m^2)	27.5 ± 3.3
Waist circumference (cm)	97.6 ± 10.5
Waist-hip ratio	0.96 ± 0.1
Diabetes duration (y)	2.4 ± 1.7
Metformin (mg/day)	750 ± 325
HA1c (%)	6.0 ± 0.7
Physical activity	
< 30 min/day	4 (26.7)
30 min/day	6 (40)
> 30 min/day	5 (33.3)

[1] N=15

Table 3. Consumed amount of each breakfast item on different occasions

Food item	Dates occasion	Raisins occasion	Sugar occasion	p-value[1]
Bread	88.7 ± 4.4	89.6 ± 1.2	89.8 ± 0.6	0.8
Feta cheese	40.1 ± 9.7	42.6 ± 10.6	38.4 ± 11	0.2
Cucumber	92.5 ± 16.9	88.7 ± 20.2	92.9 ± 17.8	0.5

[1] Friedman's test was used for comparisons. N=15 in each occasion

Fasting blood glucose and levels of blood glucose 2 h after breakfast (immediately before consuming the snacks), and 30, 60, and 120 min after consuming the snacks are presented in Table 4. There was no significant difference in blood glucose levels between different snacks at any time points. Similarly, areas under the curve of blood glucose did not differ between the snacks.

The curves of blood glucose are depicted in Figure 2. Alterations in blood glucose at 30, 60, and 120 min after consuming the snacks relative to the time point before consumption of snacks are illustrated in Table 5.

Table 4. Blood glucose levels at different time points on each experimental day

Time point	Dates	Raisins	Sugar	p-value[2]
Fasting	125.0 ± 18.9	120.0 ± 16.7	123.1 ± 18.2	0.2
2 h after breakfast	161.2 ± 46.9	159.6 ± 40.9	164.3 ± 47.2	0.5
30 min after snack	159.0 ± 36.5	153.3 ± 38.7	162.0 ± 39.4	0.4
60 min after snack	134.0 ± 38.8	134.8 ± 34.6	132.8 ± 39.0	0.9
120 min after snack	103.8 ± 20.9	108.3 ± 22.7	103.1 ± 16.4	0.4
Area under the curve (mg.min/dl)[1]	14724 ± 3485	14896 ± 3837	14416 ± 3451	0.6

[1]The area under the curve was calculated from 2 h after breakfast to 120 min after snack. More information is provided in Materials and Methods. The number of subjects was 15 for each treatment.
[2] Friedman's test was used for comparisons.

Table 5. Alterations in blood glucose level after consuming the snacks at different time points

Time point	Dates	Raisins	Sugar	p-value[1]
30 min	-2.23 ± 32.0	-6.33 ± 24.3	-2.30 ± 16.9	0.8
60 min	-27.2 ± 23.0	-24.8 ± 27.3	-31.5 ± 19.8	0.6
120 min	-57.5 ± 34.8	-51.3 ± 32.9	-61.2 ± 40.6	0.5

[1] Friedman's test was used for comparisons. N=15 for each treatment

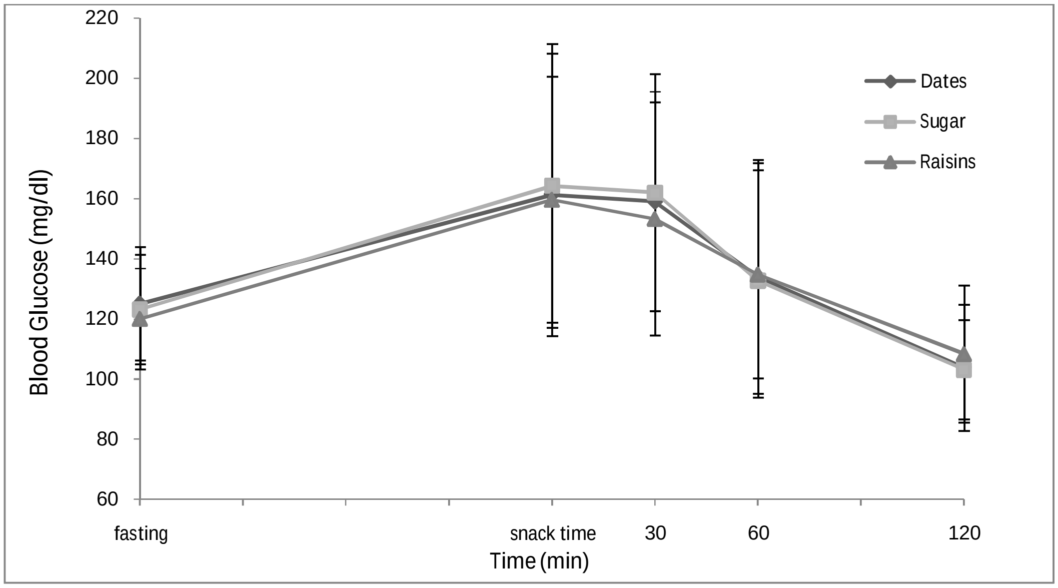

Figure 2. Blood glucose levels in each experimental day. Each data point represents the mean and the standard deviation of all subjects. There was no significant difference between the snacks at any time point. N=15 for each treatment.

Discussion

In the present study, the consumption of a snack containing 15 g available carbohydrates from dates, raisins, or sugar 2 h after the breakfast did not increase blood glucose levels in patients with type 2 diabetes, and consumption of either snacks did not have a different effect on blood glucose level during 2 h after the consumption.

In agreement with this study, Razaghi et al. (23) reported that alteration of blood glucose 2 h after consumption of 10 g dates was similar to that after consumption of 5 g sugar cubes in patients with type 1 diabetes (23). Also the GI of 5 varieties of dates was almost equal to half of that of glucose in healthy subjects and patients with type 2 diabetes (12). Given that GI of sugar is approximately half of that of glucose (24), the results of the present study are in the same line with the results of Alkaabi et al. (12) because we found that area under the curve of blood glucose after consuming dates was similar to that of sugar. Similarly, Lock et al found that dates have a GI similar to foods with moderate GI like sugar (25). Tables of GI confirm these findings (26).

Studies on raisins also demonstrated a moderate GI for raisins in both healthy subjects and patients with type 2 diabetes (25, 27). Wilson and coworkers compared glycemic responses after consumption of 100 kcal of banana, white bread, raisins, or Thomson seedless grapes, and found that the glycemic responses of banana, white bread, and raisins were almost similar but that of seedless grapes was statistically higher (13). Nevertheless, in their study, the consumption of 30.3 g raisins increased blood glucose level statistically at 30 min whereas, in our investigation, consuming 22.3 g raisins did not cause a significant difference in blood glucose level at the same time point. Benefits of raisins against diabetes and insulin resistance, dyslipidemia, obesity, and high blood pressure have also been pointed out in previous investigations (28).

In spite of good fiber and fructose content of raisins and dates, we did not find a low glycemic response by dates and raisins probably because of their high carbohydrate content, especially glucose. Raisins have 66-77% carbohydrates, with 32-37% glucose as the main carbohydrate followed by 26-31% fructose (6). Likewise, dates have almost the same amounts of carbohydrates, ranging from 53% to 89%, mainly as glucose and fructose (7). Although various studies have shown more or less similar results regarding moderate glycemic response after consumption of dates and raisins, the variety of fruits and the degree of ripeness can also affect the intensity of their glycemic response (12). Contents of carbohydrates, the proportion of fructose to glucose

(29), fiber (30), moisture (31), and even phenolic compounds (5) may be important factors in determining glycemic response probably through affecting stomach emptying, the rate of intestinal absorption, and insulin response.

In the current study, the snacks were consumed with tea; however, it is unlikely that consumption of tea have affected the glycemic responses. In previous studies, consumption of tea or coffee did not affect GI of foods though it reduced within-individual variability in blood glucose and thus lowered standard deviation (32).

The results of this study showed that consumption of 24.2 g Bam Mazafati dates (approximately 2 dates) or 22.3 g Sultana raisins (equal to 2 tablespoons) at the snack time did not cause significant alterations in blood glucose level. However, as sugar caused the same effect on blood glucose, these snacks may not be considered very healthy for patients with type 2 diabetes, though due to their good content of minerals, vitamins, fiber, and antioxidants (6,7), they are more suitable snacks compared to sugar. Moreover, sugar is usually consumed in higher quantities when it is consumed in the form of cakes, cookies, and other sweets, and therefore, it should not be recommended for patients with type 2 diabetes. It is noteworthy that the amount of consumed carbohydrates is as important as their type, and moderation in the consumption of carbohydrates from any sources is an important principle of a healthy diet, especially for patients with diabetes (33).

Acknowledgements

We are thankful to the patients who kindly participated in this study. We also thank the Research Deputy of Shiraz University of Medical Sciences for financially supporting this work (grant number 92-01-84-6712). Thanks are also to Mr. Arash Homayouni for his collaboration in the project and to the Research Consultation Center and Clinical Research Development Center of Namazee Hospital for assistance in the statistical analysis.

Financial disclosure

The authors declared no financial interest.

Funding/Support

Shiraz University of Medical Sciences

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