Determination of the Glycemic and Insulinemic Indexes of Raisins in Three Populations

Yeonsoo Kim[1], Steven R. Hertzler[1], Heidi K Byrne[2], Craig O. Mattern[2]

[1] The Ohio State University, Columbus, OH, [2] State University of New York at Brockport, Brockport, NY

Abstract

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There are only limited published data on the glycemic index (GI) and insulin index of raisins. Further, the GI and insulin index of raisins have not been determined in endurance athletes or in persons with prediabetes. The objective of this study was to determine both the GI and the insulin index of raisins, and to evaluate if these indexes are similar when measured in different populations. The study groups consisted of 10 healthy sedentary subjects (S, 25.7±1.3 y, BMI=23.3±1.7 kg/m^2), 11 endurance athletes (A, 23.1±1.0 y, BMI=24.1±0.3 kg/m^2), and 10 prediabetic individuals (P, 50±2.6 y, BMI=32.6±1.9 kg/m^2). Subjects consumed 50 g of available carbohydrates from raisins and from a glucose solution (reference food) on two separate occasions. Serum glucose and insulin concentrations were measured from capillary finger-stick blood samples at baseline and at 15, 30, 45, 60, 90, and 120 min (& 150 and 180 min for P) postprandially. The GI of raisins was low (GI≤55) in the S (49.4±7.4) and P (49.6±4.8) groups and was moderate (GI 55-69) in the A group (62.3±10.5), but there were no differences among the groups (P=0.437). The insulin index values of raisins were 47.3±9.4, 51.9±6.5, and 54.4±8.9 for the S, A, and P groups, respectively. On average, the A group secreted 2-2.5-fold less insulin per gram of carbohydrate compared with the S and P groups, respectively (P<0.05). In summary, raisins are a low to moderate GI food and their insulin index is proportionate to their GI, regardless of the population studied. Athletes were able to normalize postprandial glycemia with lower insulin secretion.

Introduction

The GI concept has been applied in sports nutrition, weight loss, and in the dietary management of diabetes. In addition, there is considerable scientific agreement that high fasting and/or postprandial insulin levels increase cholesterol synthesis and impair fat mobilization from adipose tissue. Thus, it is increasingly recognized that the knowledge of the GI of a food is not complete without the knowledge of the insulin response as well. Foods with low postprandial blood glucose or insulin responses would be helpful to athletes and to those people with diabetes or impaired glucose tolerance. There are only limited published data regarding the GI of raisins and none for their insulin index. In addition, it is not known if the GI of raisins obtained in healthy subjects would apply to athletes or people with pre-diabetes. Therefore, the objective of this study was to determine the glycemic and insulinemic indexes of raisins in 3 groups: 1) a healthy, young adult, non-athletic group; 2) a group of young adult competitive aerobic athletes; and 3) a group of people with impaired fasting glucose, or pre-diabetes.

Methods

The study consisted of 10 healthy sedentary persons (S), 11 endurance athletes (A), and 11 pre-diabetic individuals (P). Informed consent was obtained from subjects prior to the screening test.

Methods, continued

The eligibility criteria for study participation were as follows;

- Fasting blood glucose of S and A groups < 100 mg/dL
- Fasting blood glucose of P group 100-125 mg/dL
- BMI of S and A group 18.5-24.9 kg/m^2
- S and P group had not exercised > 3 h/week for the past 6 months
- A group had aerobically trained ≥ 8h/week for the past 6 months
- Age of S and A groups 18-35 years
- Age of P group 18-65 years

Feeding protocol

The study was a two-treatment, randomized, crossover study with a minimum 3 days apart between treatment visits. Each subject participated in two separate 2-hour meal tolerance tests consisting of a glucose solution and raisins. Subjects were asked to fast overnight for at least 10 hours. Subjects reported to the laboratory in the morning on test days, and baseline blood sample was collected via capillary finger-stick. Subjects then consumed a glucose solution or raisins containing 50 g of available carbohydrate in random order. Further blood samples were then collected at 15, 30, 45, 60, 90, and 120 minutes (and 150 and 180 minutes for the P group) after intake of the study product.

Blood sample analysis

Blood samples were collected via capillary finger-stick at baseline (0), 15, 30, 45, 60, 90, and 120 minutes (and 150 and 180 minutes for the P group) after administration of test meal. Whole blood samples were centrifuged for 10 minutes to get serum. Serum glucose concentrations was measured using the YSI 2700 Select Biochemistry Analyzer via the glucose oxidase method. Serum insulin was analyzed by Enzyme-Linked Immunosorbent Assay (ELISA) using an insulin DSL-10-1600 ELISA kit (DSL, Inc., Webster, Texas).

Calculation of GI and insulin index of raisins

The positive incremental Area Under the Curve (IAUC) for blood glucose were calculated geometrically.

$$\text{GI of raisins} = \frac{\text{serum glucose IAUC of raisins}}{\text{serum glucose IAUC of glucose}} \times 100$$

$$\text{Insulin Index of raisins} = \frac{\text{serum insulin IAUC of raisins}}{\text{serum insulin IAUC of glucose}} \times 100$$

Statistical analysis

Descriptive statistics and normality tests were obtained for all variables using the NCSS 2000 software package (NCSS Computing, Kayesville, UT). Repeated measures ANOVA was used to determine global significant differences. In the event of a significant ANOVA result (P < 0.05), Tukey-Kramer post-hoc tests was used for pairwise comparisons.

Results

Table 1. Subject characteristics.

	S	A	P
N (M/F)	10 (2/8)	11 (5/6)	10 (3/7)
Age (years)	25.7 ± 1.3	23.1 ± 1.0	50.0 ± 2.6
Height (cm)	166.4 ± 2.5	175.8 ± 2.4	167 ± 2.6
Weight (kg)	64.8 ± 4.5	74.8 ± 2.9	94.5 ± 6.6
BMI (kg/m^2)	23.3 ± 1.7	24.1 ± 0.3	32.6 ± 1.9
Fasting blood glucose (mg/dl)	87.2 ± 1.7	87.6 ± 2.3	110.5 ± 2.6

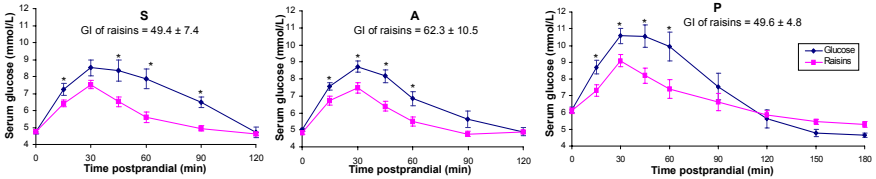

Figure 1. Serum glucose responses to raisins and glucose in the sedentary, athlete, and pre-diabetes groups. Data points are the mean ± SEM.
* Significant differences between glucose and raisins (P < 0.05).

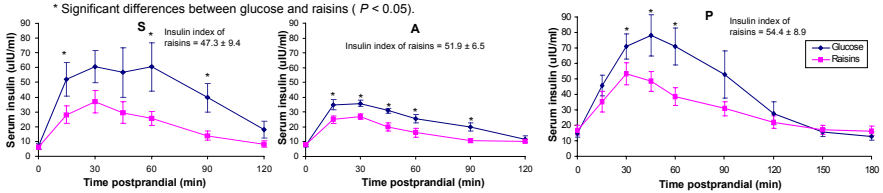

Figure 2. Serum insulin responses to raisins and glucose in the sedentary, athlete, and pre-diabetes groups. Data points are the mean ± SEM.
* Significant differences between glucose and raisins (P < 0.05).

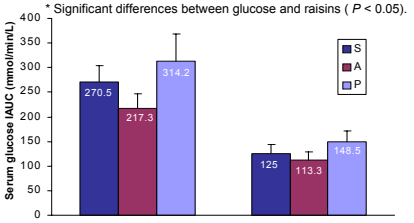

Figure 3. Serum glucose IAUC values for glucose and raisins in the sedentary, athlete, and pre-diabetes groups. Data points are the mean + SEM. There was no significant difference between subject groups within the same test meal.

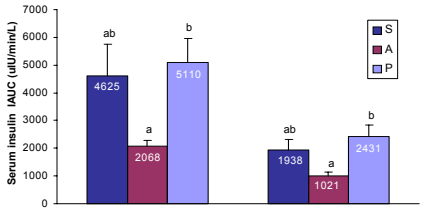

Figure 4. Serum insulin IAUC values for glucose and raisins in the sedentary, athlete, and pre-diabetes groups. Data points are the mean + SEM. Superscripts with different letters are significantly different between groups within the same test meal (P < 0.05)

Conclusions

Raisins are a low to moderate GI food and their insulin index is proportionate to their GI, regardless of the population studied. Athletes were able to normalize postprandial glycemia with lower insulin secretion.

Acknowledgements

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