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ORIGINAL ARTICLE

Glycemic response of honey and dates consumption

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ABSTRACT

Background and objective: The current study aims to evaluate the glycemic index of local honey and date intake in healthy adults.
Methods: The study was conducted on 24 healthy volunteers. They were given 50 g of carbohydrates from Haji Omeran local honey, Khudri (or Khadrawi) local date and reference food (white bread). The average body mass index and age of volunteers are almost similar. The blood samples were collected from finger capillaries to assess the glucose levels by using glucometer at selected time points (0, 15, 30, 60, 90, and 120 minutes). The data was recorded and statistically analyzed by one-way ANOVA and Duncan comparison.
Results: The study results showed that the glycemic index of the honey and date is classified as a medium glycemic index, referring to their high carbohydrates content. The results also indicated that honey and dates have significantly different effects ($P<0.05$) on the blood glucose responses compared to reference food (white bread) in healthy subjects. The mean blood glucose levels after honey ingestion were higher than that when the date was ingested and lower than that of the reference food. In addition, the blood glucose responses for different foods in the study for females and males are not significantly different ($P>0.05$).
Conclusions: In conclusion, eating behavior regarding honey and date consumption, particularly portion size and ingestion timing, is essential to manage blood glucose levels. Thus, glycemic index values should be considered in promoting a healthy lifestyle from chronic related metabolic disorders especially, diabetes mellitus, cardiovascular disease, and obesity.

Keywords blood glucose response, date, diabetes, glucose, glycemic index, honey, reference food

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INTRODUCTION

Honey and date are rich in simple carbohydrates, mainly glucose and fructose. They are also consumed widely in middle eastern countries. In addition, they are defined as staple food products at breakfast, and that is frequently administered in the form of snakes and for breaking the fast in the holy month of Ramadan.[1,2]

Honey is a natural sugary product produced by honey bees (*Apis mellifera*).[3] Natural honey is a sticky and viscous solution with an estimated percentage content of 80–85 carbohydrates that is mainly fructose (36-50) and glucose (28-36), and the remaining are 15–17 water, 0.1–0.4 protein, and 0.2 ash.[4] Besides, date palm (*Phoenix dactylifera* L.) is one of the oldest fruit source known in the dry and semidry areas.[5] The date fruit has more than 80% sugars, and the remaining 20% is fiber, lipid, protein, and ash.[6] Although the chemical composition of a date varies according to the stage of ripening, growing condition, and others, generally; dates rich in sugar (~71.2–81.4% of dry weight). The main sugars are fructose and glucose.[7]

Dietary carbohydrates became a target for scientific research due to their effect in elevating blood glucose level (BGL) and insulin secretion, in particular foods that contain a high amount of sugar, such as honey and dates with an average glycemic index (GI) values of 61 ± 3 and 42 ± 4, respectively.[8–10] With the presence of such an effect, the GI has become a current topic for assessing the impact of different carbohydrates-containing foods on BGL and their impact on health.[11] So it is important to investigate the food GI and examine its influence on both healthy and sick individuals. The findings will accordingly be useful in introducing many dietary therapies and strategies in many chronic illnesses.[12]

The GI was first proposed in 1981 to categorize food items by the glycemic response. The food GI depends on the quickness of digestion and absorption of its carbohydrates, which is determined mainly by its chemical and physical properties. A particular food item's GI is determined by measuring the blood glucose (BG) response following food consumption (containing carbohydrate) relative to a carbohydrate-containing reference food, typically glucose or white bread named standard food.[12,13] GI ranks carbohydrate-containing foods based on how quickly they elevate blood sugar concentration. By comparing the area under the BG response curve of the test food with that of the reference food, which provides a relative value of 100. In this context, foods are given a numeric value, and then generally classified as having a low ($\leq$55), moderate (56-69), or high ($\geq$70) GI.[14] In 1995, after the first publication of 62 foods' GIs, an expansion list of about 550-600 common western foods was included in the international table of GI.[15] Since the concept of diet GI introduced, there has been considerable research interest in GI contribution to the states of health, both in terms of management and prevention of certain metabolic disorders. In 2002, 2008, and 2021 the original table updated to more than 3450 items of food and reached 4000 items in total due to GI's important insight.[8] Diseases in which GI has been shown to play a critical role include type 2 diabetes (T2D) and prediabetes states of impaired glucose test (IGT), cardiovascular disease (CVD), obesity, and certain cancers.[8,16–18]

The spike and abnormally high BG dysregulate the insulin-producing beta cells in the pancreas and prolong blood saturation with glucose, eventually leading to increased beta-cell failure and further elevated BG to be a characteristic disease like diabetes if not controlled. Therefore, it is substantial to target the prevention of any extreme rises in BG concentration to reduce the risk of beta-cell failure and prevent the development of diabetes mellitus (DM).[19] Considering high fructose diet consumption may also increase insulin resistance and lipogenesis in the liver due to metabolic affinity to be stored as glycogen and

indirectly lead to fat metabolic disorders.[20,21] Thus, a healthy food choice guide advocates the integration of low GI foods with a complex non-starchy polysaccharide diet, as may represent a potential strategy to decrease the risk of developing DM.[17,22] This study aimed at investigating the local honey and dates GI according to the glycemic response in the healthy volunteers (human trial). Also, to find out the effect of gender on glycemic response. In addition, to take a side and restate the nutritional awareness on the impact of local honey and date on BGL.

MATERIALS AND METHODS

Participants

The research was conducted at the Food Sciences and Quality Control Department, College of Agricultural Engineering Sciences, University of Sulaimani. The study relies on the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) 1998 GI testing protocol.[23,24] The study was approved by the Ethical Committee of the College of Agricultural Engineering Sciences, University of Sulaimani as well as it followed the principles of the Declaration of Helsinki. All volunteers were updated about the study aims, and confirmation was collected accordingly.

Glycemic index testing

A twenty-four healthy human volunteer (females 12, males 12), free from any chronic illnesses and not using any medicines, enrolled for this study. The average body mass index (BMI) and age of volunteers were 20.6±2.7 kg/m2 and 22.4 ± 1.5 years, respectively. The GI testing started at 8:30 am. Portions of tested foods (Haji Omran local raw unfiltered honey, local Khudri or Khodri or Khadrawi date at tamer stage), and standard food (white bread) comprising of 50 g available carbohydrates were given to the subjects in random order and on separate occasions (days) after an overnight fast of ≥10 hours. A standard drink of pure water (150 ml) was also provided with each test food.[23,25]

Each volunteer had to have from 6-8 experimental sets and was requested to ingest each test food within 3-4 minutes. The average values are used to calculate the GI of the test foods.[26] BGL was determined using a professionally calibrated glucometer (Accu-Chek Aviva plus, Roche, USA) following standard procedures. Each participant's blood sample was collected through a capillary finger prick using a lancet at fasting, 0, 15, 30, 45, 60, 90, and 120 minutes. The logical time setting was based on the FAO method to determine GI of food and American Diabetic Association (ADA) criteria. After eating food, insulin will start to function immediately, and within 2 hours, postprandial BGL returns to the pre-meal level in healthy people.[23,27] Each blood sample was placed on a test strip which was inserted into a calibrated glucometer, and the BGL was measured.[22,23,27]

The area under the glycemic response curve for each food is provided in a percent of the mean response to the standard reference food taken by the same subject and ignoring the area below the fasting concentration. The incremental area under the curve (IAUC) and GI calculation were performed according to the methods described by another research.[23] The GI values calculated as:

$$GI = \left(\frac{IAUC\ test\ food}{IAUC\ standard\ reference\ food} \right) \times 100$$

Statistical analysis

The IAUC and GI data were subjected to statistical analysis using GraphPad Prism v9.1.1. The data also analyzed by one-way analysis of variance (ANOVA), and the means were compared by the (Duncan) test as described by Statistics Analysis Program (XLSTAT, 2016) with significant differences were defined at $P<0.05$. Results were expressed for baseline characteristics of the study subjects as mean±standard error of the mean (SEM) for BG responses.

RESULTS AND DISCUSSION

The study was performed to evaluate and compare the glycemic response of honey, date, and references food in healthy volunteers. In different time intervals (0, 15, 30, 60, 90, and 120 minutes), the BGL data after ingesting tested foods from the 24 healthy individuals demonstrate in Table 1 and Figure 1.

According to ADA criteria, all the participants were at healthy state; the mean of fasting BG was within the normal range around 93.7 mg/dL, and there were no differences in the impaired fasting BG value. In addition, the oral glucose tolerance test (OGTT) was at normal range values and did not increase to higher levels of more than 150 or 200 mg/dL.[28]

The results generally show an initial increase in BGL after 15 minutes of ingesting the tested foods. Then the level reached the peak at 30 minutes for the date, the BGL was at 125.62 mg/dL, and 123.91 mg/dL for honey. Followed by a gradual decline to 93.04 mg/dL and 93.16 mg/dL for date and honey, respectively, at postprandial 120 minutes because the participants were healthy, and the BGL returned to the pre-meal level.

On the other hand, the IAUC generally for reference food (3005.07 mg/dl/min) was higher than the tested foods (honey 1809.33 mg/dl/min & date 1878.79 mg/dl/min) as shown in Table 1.

The differences in IAUC refer to the variation in the GI of honey 60.21 and the date GI 62.52. Therefore, based on the IAUC calculation, the GI for both tested food samples was at the medium class of the GI classification range.[14]

The results indicated that honey and date have significantly different ($P<0.05$) effects on the BG responses compared to the reference food, as shown in Table 1 with further detail.

Table 1 The mean and SEM of blood glucose response and the value of GI of reference food, honey, and date that was analyzed by ANOVA test and Duncan comparison.

Carbohydrate	Categories	Blood glucose response mg/dL (mean ± SEM)						$IAUC_{(mg/dl/min)}$	GI
		Time (minutes)							
		0	15	30	60	90	120		
50 grams	Local honey (Haji Omeran)	93.79 ± 0.73^{a}	112.33 ± 0.96^{c}	123.91 ± 0.84^{d}	113.08 ± 0.83^{c}	102.91 ± 0.81	93.16 ± 0.81^{a}	1809.33	60.21
50 grams	Local date (Khudri or Khadrawi)	93.08 ± 0.72^{a}	105.70 ± 1.16^{b}	125.62 ± 0.77^{d}	115.79 ± 0.62^{c}	105.79 ± 0.70^{b}	93.04 ± 0.62^{a}	1878.79	62.52
50 grams	Reference food (white bread)	92.857 ± 0.72^{a}	113.42 ± 0.70^{b}	137.21 ± 0.73^{d}	126.85 ± 0.83^{c}	114.28 ± 0.75^{b}	95.21 ± 0.65^{a}	3005.07	100^{25}

Different letters (a, b, c, d) in the same rows means significantly different at $P<0.05$.

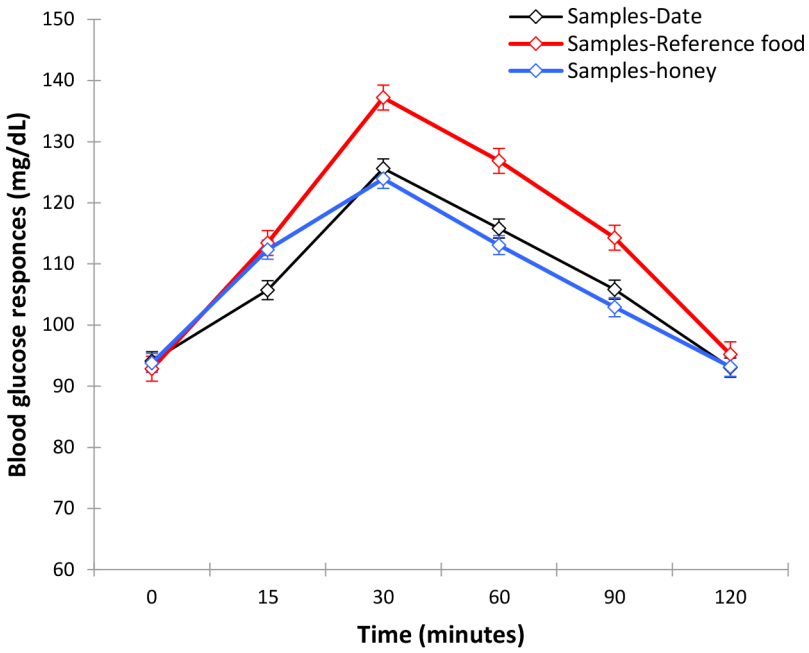

Figure 1 **Mean of blood glucose responses of volunteers after ingesting the tested foods (honey, date, and reference food).**

Furthermore, the obtained GI value of honey (60.21) is almost similar to Australian honey GI that was 59±5.[29] Likewise, as stated in another research that Khudri date contains 74.56% carbohydrates with 61.7 GI,[30,31] that is comparable with the obtained result (62.52 GI) in this study. Despite these confirmations, different kinds of honey have a wide scale of GI due to bees making it from various sources of flora that affect sugar content and types of honey.[32] Also, date has a different variety and stage of maturity, contributing to alteration in GI value.[33]

The carbohydrate content is the primary influence factor to consider when testing for GI value. It is essential to realize that most of the carbohydrates in Khudri date and local honey are monosaccharides. The estimated amount of fructose is around 37.12% and glucose 33.33% in date,[30,31] and the honey contains approximately 63.83% of reducing sugar mainly (fructose and glucose) and sucrose (4.09%).[34] Therefore, high consumption of available and ready-GI-monosaccharide sugar might be a critical factor in carbohydrate food choice because it passes through the digestion and absorption processes rapidly and cause the rise of BGL. High blood glucose that activates insulin secretion may stimulate lipogeneses metabolism in the liver in the long term. Such a metabolic orientation has required attention due to the high fructose content that may results in insulin resistance and metabolic disorders such as diabetes.[17,32,35]

According to ADA, the increase in blood sugar level may not be harmful at the present test time.[36] However, depending on GI values, date and honey with medium GI value may have a negative health consequences in the future, especially for people with a family his-

tory with diabetes and other health problems. By inducing hyperglycemia and hyperinsulinemia, many studies revealed that a high GI diet may increase the risk of chronic diseases, including obesity, T2D, and CVD.[37] On the contrary, a low GI diet exhibit a reduced rate of absorption of carbohydrate, giving better control over serum glucose and decreasing insulin demand that helps prevent and manage various associated disorders.[38] Adopting strategical dietary plan is undoubtedly support in GI control; for instance, dietary fiber content and with less sensitive affect the amount of protein content in food may affect the value of GI via the various mechanism of action (gastric emptying, starch enzymatic digestion reduction, and decreasing the mucosa absorption rate).[17,39] However, date and honey are low in fiber and protein, especially honey.[4,7]

Furthermore, the gender effect and association to BG response for the tested foods in the study shows that females and males responses were not significantly (P>0.05) different if compared time by time as shown in Figure 2. The outcome is also supported by the result data mentioned in the other research.[40]

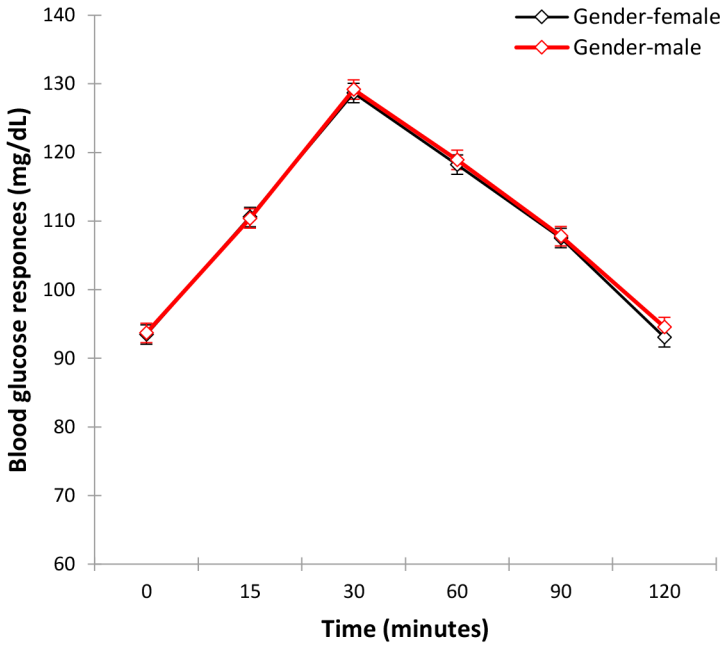

Figure 2 Comparison of mean blood glucose responses for different test foods that females and males ingested by Duncan comparison test at the level of *P*<0.05.

CONCLUSIONS

Depending on the research result, honey and date increase BG due to the high carbohydrate content that mainly consists of glucose and fructose with medium GI. Therefore, paying attention to eating behavior and food choice, including frequent ingestion, dietary

intake combination, portion size, timing, especially on an empty stomach, are critical nutritional management. Ultimately, preventing the rapid increase of BGL in the long-term might be recommended to mitigate the risk factor of developing health problems such as diabetes, CVD, and obesity.

ABBREVIATIONS

ADA, American Diabetic Association; ANOVA, analysis of variance; BG, blood glucose; BGL, blood glucose level; BMI, body mass index; CVD, cardiovascular disease; FAO, Food and Agriculture Organization; GI, glycemic index; IAUC, incremental area under the curve; IGT, impaired glucose test; OGTT, oral glucose tolerance test; SD, standard deviation; SEM, standard error of the mean; T2D, type 2 diabetes; WHO, World Health Organization.

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DECLARATIONS

Authors' contributions

All authors have equally contributed to this work, reviewed and approved the final version of the manuscript before publishing.

Conflict of interest

The authors declare no conflict of interest.

Ethical approvals

The current study and its protocol were approved by the Ethical Committee of the College of Agricultural Engineering Sciences, University of Sulaimani, as well as it followed the principles of the Declaration of Helsinki. All volunteers were updated about the study aims, and confirmation was collected accordingly.

Data availability

The data that support the findings of this study is available from the corresponding author, upon reasonable request.

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