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Original Article

Glycemic index evaluation of Saudi date varieties: Nutritional and metabolic perspectives

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ABSTRACT

Objectives: Dates constitute an integral part of the traditional Saudi diet and provide a valuable source of nutrition. Precise assessment of the glycemic index (GI) of Saudi date varieties is essential for evidence-based nutrition, yet their postprandial glycemic responses remain understudied. This study aimed to assess the GI and glycemic load (GL) of commonly consumed saudi date varieties to evaluate their postprandial glycemic effects.

Methodology: A randomized crossover study was conducted in 20 apparently healthy adults aged 22–34 years at King Khalid University Hospital, Riyadh, Saudi Arabia. After an overnight fast, test portions providing 50g of available carbohydrates from each date variety were consumed, and glucose was given as the reference food. Capillary blood glucose was measured at fasting and over a 120 minutes postprandial period, and GI values were calculated using the incremental area under the curve.

Results: GI values ranged from 45 ± 4.8 to 61 ± 5.5. Higher values were found for Sufri, Helwah, and Sukkary date varieties, whereas Sag'ai and Shishi varieties produced the lowest.

Conclusion: These findings emphasize variability in glycemic responses across date varieties and provide a rationale for informed dietary choices that promote healthier consumption.

KEYWORDS: Chemical composition, Date palm, Glycemic index, Glycemic load, Saudi Arabia.

doi: https://doi.org/10.12669/pjms.42.11.15355

How to cite this: *Alotaibi SM, Alshatwi AA, Alhowikan AM, Asswini SA, Alhussain MH. Glycemic index evaluation of Saudi date varieties: Nutritional and metabolic perspectives. Pak J Med Sci. 2026;42(11):3008-3014. doi: https://doi.org/10.12669/pjms.42.11.15355*

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* Received for Publication: June 20, 2026
* Revision Received: August 28, 2026
* Revision Accepted: September 08, 2026

INTRODUCTION

Date palm (*Phoenix dactylifera L.*) is an economically important fruit crop with a 6000-year history, integral to food security, heritage, and economic sustainability in arid and semi-arid ecosystems.[1] Dates have received considerable attention due to their high nutritional value, as they are rich in vitamins, minerals, dietary fiber, and bioactive compounds such as flavonoids and polyphenols, providing antioxidant and anti-inflammatory properties.[1,2]

Saudi Arabia is one of the world's major date-producing countries, with numerous varieties grown across different regions of the Kingdom.[3,4] However, the glycemic index (GI) profile of Saudi Arabian date varieties remains understudied, particularly regarding their postprandial effects.

GI measures how carbohydrate-containing foods affect blood glucose levels, whereas glycemic load (GL) considers the quality and quantity of dietary carbohydrates.[5,6] Low GI diets may lower lipid profiles, glycated hemoglobin, and systemic levels of inflammation markers.[5,7] Metabolomic studies showed

that these diets have been associated with higher serine concentrations and lower concentrations of branched-chain amino acids and pro-inflammatory lipids.[8,9] Precise identification of GI and GL values of staple foods such as dates is critical for evidence-guided nutritional practice.

The lack of locally generated GI data poses a barrier to integrating dates into nutritional guidelines, limiting alignment of traditional diets with metabolic health strategies. In Saudi Arabia, data are limited to a few varieties and from one region. A study examined 17 date varieties from Al-Qassim province showed GI values from 42.8 (Shaqra) to 74.6 (Sellaj).[10] Another study examined dates and reported lower GI values at the Tamar (ripe) stage than at earlier stages of maturation.[11] Studies from other date-producing countries have also demonstrated substantial compositional variation among date varieties.[12] Previous studies lack integration of GI measurements with compositional analyses. Environmental and agricultural variation among Saudi regions influences date palm primary and secondary metabolism,[13-15] rendering region-specific glycemic profiling necessary. To the best of our knowledge, no studies have comprehensively characterized the GI, GL, and nutrition of date varieties from the Riyadh region, despite the importance of date production and consumption in the Riyadh region, evidence regarding their effects on glycemic outcomes in individuals with diabetes remains limited. This study aimed to assess glycemic properties and nutritional composition of 13 common date varieties produced in the Riyadh region.

METHODOLOGY

This randomized crossover clinical trial was conducted at King Khalid University Hospital in Riyadh, Saudi Arabia, over an 18-month study period. Twenty adults aged 22–43 years were recruited through social media advertising and enrolled in this randomized crossover study. The sample size was selected with reference to previous GI studies evaluating date varieties using crossover designs.[10,11,16] The twenty participants were divided into two groups to allow all 13 date varieties to be assessed across the study population (participant's evaluated six date varieties and the other 10 participant's evaluated seven date varieties).

Ethical approval: Written informed consent was obtained from all participants, and the study was approved by the institutional review board of King Saud University, Saudi Arabia (approval no. E-22-6567). The clinical trial was registered at ClinicalTrials.gov (NCT07286981).

Inclusion criteria:

- Apparently healthy adults without diabetes,
- With normal fasting blood glucose concentrations,
- Who were not pregnant or lactating.

Exclusion criteria:

- Severe obesity with body mass index (BMI) >40 kg/m^2,
- Pre-diabetes,
- Gastrointestinal disease,
- Recent gastroenteritis,
- History of previous gastrointestinal surgery,
- Smoking,
- Chronic or acute diseases.

Screening: Participants attended a screening visit to confirm eligibility. Height was measured using a Seca 703 stadiometer (Seca GmbH & Co. KG, Hamburg, Germany), and body weight was measured using an InBody 720 Body Composition Analyzer (InBody Co., Ltd., Seoul, South Korea). BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Fasting capillary blood glucose was assessed using a validated glucometer following an overnight fast (Accu-Chek Safe-T-ProUno, Roche Diagnostics, Mannheim, Germany).

Experimental protocol: The study protocol followed the recommendations of the Food and Agriculture Organization/World Health Organization (FAO/WHO) and the methodology described by Brouns et al.[16,17] Participants reached the laboratory at 8:00 a.m. for testing, with at least one washout day between visits, having fasted for 10–12 hours, consumed a standardized evening meal before test days, and avoided vigorous physical activity. Test foods included Thirteen date varieties and a glucose reference (50-g glucose dissolved in 250-mL water), which was administered on three separate occasions to assess intra-individual variability. Participants tested the date varieties assigned to their respective groups in separate sessions. Randomization, using a computer-generated sequence, was used for the order of test food, and participants were blinded to the date varieties tested. Each date portion was standardized to provide 50 g of available carbohydrates and was consumed within 10 minutes.

Date samples: The date varieties used in this study were Medjool, Ajwah, Sag'ai, Safawi, Raziz, Shishi, Sukkary, Barni, Sufri, Khalas, Nabtat Ali, Khuduri, and Helwah. The dates were obtained from Al-Dakkah Palm Company Limited, Kingdom of Saudi Arabia.

Chemical composition: The nutritional composition of date samples (Table-I) was analyzed using standard methods at an accredited IDAC Merieux NutriSciences Laboratory, Al-Kharj, Kingdom of Saudi Arabia.[18] Total dietary fiber was measured using the AOAC 991.42 procedure. Sugar composition (glucose, fructose, and sucrose) was determined using high-performance liquid chromatography with a refractive index detector and an amino column. The total carbohydrate content was determined by difference, and energy content was estimated using standard caloric conversion factors. All analyses were conducted in duplicate or triplicate as appropriate.

Table-I: Nutritional composition of the dates used in this study (per 100 g edible portion).

Variety of Dates	*Calories (Kcal/100 g)*	*Carbohydrates (g/100 g)*	*Glucose (g/100 g)*	*Fructose (g/100 g)*	*Sucrose (g/100 g)*	*Total Fiber (g/100 g)*
Medjool	337.26	81.23	25.35	28.40	<LOQ[1]	8.0
Ajwah	320.0	78.0	34.0	27.0	<LOQ	7.5
Safawi	330.0	79.0	34.0	30.0	<LOQ	7.5
Raziz	330.0	79.0	34.0	32.0	<LOQ	8.1
Sag'ai	346.95	83.75	26.28	30.17	<LOQ	8.0
Shishi	330.0	79.0	30.0	26.0	<LOQ	7.7
Sukkary	340.60	81.66	10.66	9.82	35.45	8.0
Helwah	342.0	83.1	26.7	25.4	<LOQ	10.3
Khudri	310.0	76.0	36.0	32.0	<LOQ	8.7
Nabtat Ali	354.0	86.1	11.6	11.3	38.4	11.5
Sufri	330.0	80.0	32.0	28.0	<LOQ	7.5
Barni	339.0	83.1	22.3	23.6	<LOQ	6.71
Khalas	366.10	88.56	26.61	31.56	<LOQ	6.0

[1]LOQ: Limit of Quantitation.

Blood glucose measurement: Capillary blood sampling performed via finger-prick methodology at baseline (fasting) and at 15, 30, 45, 60, 90, and 120 minutes after consumption of the test foods. Glucose concentrations were measured using a validated glucometer (Accu-Chek Safe-T-ProUno, Roche Diagnostics, Mannheim, Germany), and participants remained seated throughout the test period.

Data analysis: Incremental areas under the blood glucose response curves (iAUC) were calculated using the trapezoidal rule, excluding areas below baseline.[19] GI values were calculated by expressing the iAUC of each test food as a percentage of the mean iAUC of the glucose reference consumed by the same participant. GL was calculated using GI values and the available carbohydrate content per serving. Because each experimental portion was standardized to provide 50-g of available carbohydrate, the GL of each experimental portion was calculated as GI × 0.5. Each test portion was standardized to provide 50 g of available carbohydrate; therefore, the GL values reported in Table-III represent the glycemic load of the experimental portions containing 50-g of available carbohydrate. The weight of dates required to provide 50 g of available carbohydrate varied among varieties and is reported in Table-III. The formula used to determine the glycemic load is as follows:

$$GL = \frac{(GI \times \text{Available CHO in a serving size (g)})}{100}$$

- Data are reported as means±standard error of the mean (SEM), following the descriptive statistics approach outlined.

RESULTS

Twenty healthy adults (15 males and five females) participated in the study; Characteristics of participants are summarized in Table-II. Blood glucose responses to different date varieties are shown in Fig.1. Most date varieties produced a peak in postprandial blood glucose at 45 minutes, followed by a decline. Helwah, Sufri, Sukkary, and Safawi produced peak glucose concentrations at 30 min, followed by a decline.

The GI and GL values for the 13 date varieties are presented in Table-III. GI values were categorized as low (≤55), medium (56–69), or high (≥70). The GI values ranged from 45 ± 4.8 for Shishi to 61 ± 5.5 for

Table-II: Characteristics of the study participants (n=20).

Characteristics	*Mean± SEM*
Age (years)	28.7±1.1
Height (cm)	170±2.5
Weight (Kg)	70.4±3.13
BMI (kg/m^2)	24.2±0.7
Fasting blood glucose (mg/dL)	97.5±1.9

Table-III: Glycemic index and glycemic load of each variety of dates

Variety of Dates	*N*	*Glycemic Index±SEM*	*Glycemic Load±SEM*	*Weight consumed* (g)*
Medjool	10	57 ± 5.2	28	68.27
Ajwah	10	51 ± 6.1	25	70.92
Safawi	10	56 ± 7.1	28	69.93
Raziz	10	55 ± 4.6	27	70.52
Sag'ai	10	48± 3.3	24	66.00
Shishi	10	45 ± 4.8	22	70.12
Sukkary	10	57 ± 8.3	28	67.87
Helwah	10	59 ± 6.7	29	68.68
Khudri	10	50 ± 4.8	25	74.29
Nabtat Ali	10	54 ± 5	27	67.02
Sufri	10	61 ± 5.5	30	68.96
Barni	10	54 ± 5.4	27	65.45
Khalas	10	50 ± 6.9	25	60.56

*Weight of each date variety required to provide 50 g of available carbohydrate.

Sufri. Eight varieties (Ajwah, Raziz, Sag'ai, Shishi, Khudri, Nabtat Ali, Barni, and Khalas) were classified as low-GI foods, whereas five varieties (Medjool, Safawi, Sukkary, Helwah, and Sufri) were classified as medium-GI foods. None of the tested varieties had a high GI. The highest GI was observed for Sufri, followed by Helwah, Sukkary, and Medjool, whereas Shishi and Sag'ai showed the lowest GI values. The differences in GI may reflect differences in sugar composition, fiber characteristics, fruit matrix structure, and other physicochemical properties; however, these factors were not formally evaluated as predictors in the present study. The GL values ranged from 22.5 for Shishi to 30.5 for Sufri. Sufri dates showed the highest

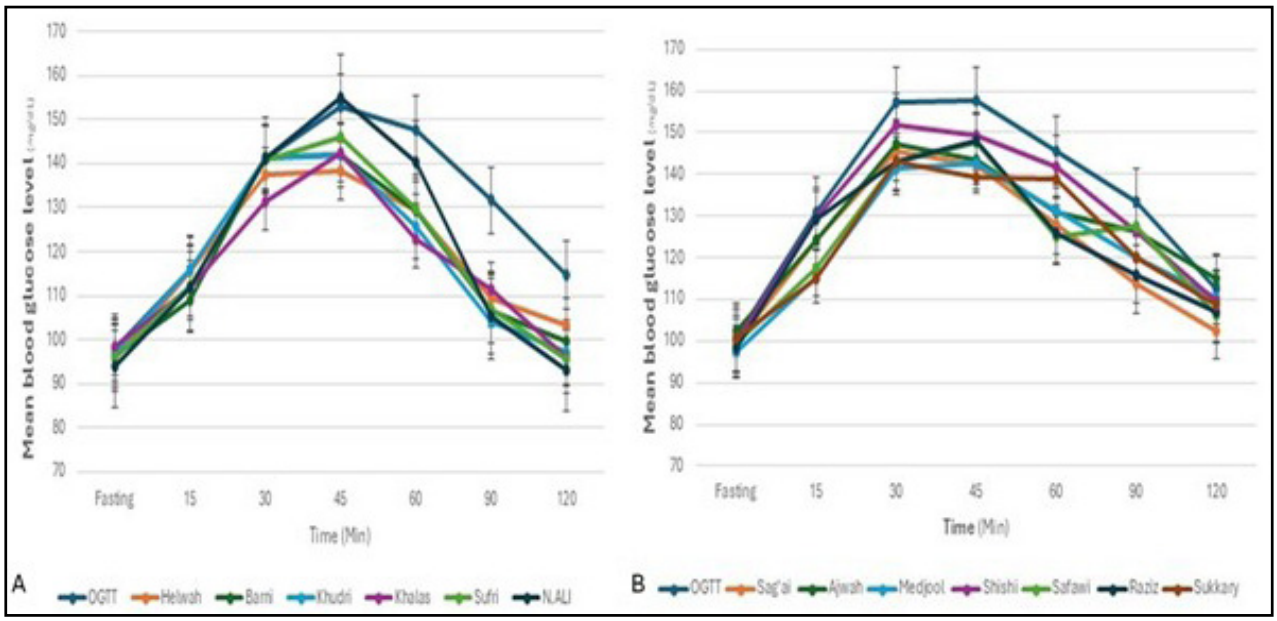

Fig.1: Mean blood glucose responses (0–120 min) to different date varieties and reference glucose solution; oral glucose tolerance test (OGTT).

GL, and Shishi dates had the lowest. Notably, total fiber content alone did not consistently predict GI across all varieties: Nabtat Ali dates contained the highest total dietary fiber among all varieties tested (Table I) yet were nonetheless associated with a comparatively medium GI, while Shishi and Sufri showed similar fiber content and glucose-to-fructose ratios despite representing the lowest and highest GI values, respectively. Sukkary dates were further distinguished by a markedly different sugar profile, in which sucrose rather than free glucose and fructose predominated, a compositional feature that may influence the rate of carbohydrate digestion and absorption. These observations suggest that the glycemic response to dates likely reflects a complex interplay of sugar type, fiber content and fruit matrix structure rather than any single compositional variable in isolation.

Carbohydrate and total dietary fiber contents varied from 76.0 to 88.56 g/100 g and from 6.0 to 11.5 g/100 g, respectively. The date varieties with higher caloric content included Khalas, Nabtat Ali, and Sag'ai, whereas the date variety with the lowest available carbohydrates was Khudri. Higher dietary fiber content and differences in glucose-to-fructose ratios may influence glycemic responses; however, these relationships were not formally tested in the present study.

DISCUSSION

The composition and quality of dates are influenced by the cultivation environment and climate.[13,14,20] given the nutritional importance of dates in Saudi Arabia, this study determined the GI and GL values of popular dates verities in Saudi Arabia.

According to the GI classification used in this study, eight date varieties—Ajwah, Raziz, Sag'ai, Shishi, Khudri, Nabtat Ali, Barni, and Khalas—were classified as low-GI foods (≤55), whereas five varieties—Sufri, Helwah, Sukkary, Medjool, and Safawi—were classified as medium-GI foods (56–69). None of the tested varieties had a high GI (≥70).

The GI values observed in the present study were broadly within the range reported in previous studies of Saudi date varieties, although direct comparisons should be interpreted cautiously because of differences in varieties , participants, ripening stages, and methodological procedures. In one study, five varieties of ripe (Tamer stage) dates were assessed in among 13 healthy participants (40.2±6.7 years) and 10 participants with Type-2 diabetes (40.8±5.7 years) for GI and GL. The findings revealed GI values ranging from 46 to 55 in healthy individuals and from 43 to 53 in those with diabetes.[11] Minor variations between studies may be attributed to differences in date variety, growing conditions, and ripeness (Tamer stage).

Another study evaluated 17 date varieties at the Tamer stage among 19 healthy participants and reported a wide range of GI values.[10] Sellaj and Maktoomi exhibited the highest GI values (74.6±10.1 and 71.0±11.1, respectively), while Shaqra, Sukkary, and Sag'ai showed the lowest (42.8±5.5, 43.4±4.7, and 44.6±6.0, respectively). The same study reported GL values ranging from 8.5 to 24, with Sellaj showing the highest GL (24), whereas Ajwah and Shaqra exhibited the lowest (8.5 and 9.2, respectively).[10]

An important methodological feature of the present study was that the amount of each cultivar required to provide 50-g of available carbohydrate varied substantially, ranging from 60.56 to 74.29 g, reflecting differences in carbohydrate density among the varieties. Because the experimental portions were standardized to provide an equivalent amount of available carbohydrate, the observed differences in GI represent differences in postprandial glycemic response to a standardized available-carbohydrate challenge rather than differences in the amount of carbohydrate administered.

Although there was considerable variability in carbohydrate, sugar, and fiber composition among the 13 date varieties, this variability did not translate into a straightforward, uniform relationship with the observed glycemic responses. For instance, Shishi and Sufri dates showed nearly identical fiber content (7.7 vs. 7.5 g/100-g) and glucose-to-fructose ratios (~1.15), yet exhibited the lowest and highest GI values in the study, respectively, suggesting that factors beyond gross fiber content such as fruit matrix structure, degree of ripening, or non-carbohydrate bioactive compounds—may also influence glycemic response.[21]

Notably, Nabtat Ali dates contained the highest total dietary fiber of all varieties tested (10.3 g/100-g) but were nonetheless associated with a comparatively higher GI, further indicating that total fiber alone is an incomplete predictor of glycemic impact. In contrast, Sukkary dates were distinguished by a markedly different sugar profile, with sucrose (35.45g /100g) rather than free glucose and fructose as the predominant sugar a compositional feature that may potentially contribute the rate of carbohydrate digestion and absorption, since sucrose requires enzymatic hydrolysis by intestinal sucrase prior to monosaccharide absorption.

Collectively, these findings suggest that the glycemic response to dates is likely governed by a complex interplay of sugar type and proportion, fiber content, and fruit microstructure, rather than by any single compositional variable in isolation. Future studies incorporating formal correlation or regression analyses across a larger panel of varieties, alongside standardized measures of fruit matrix properties, would help clarify the relative contribution of each factor.

In addition to their natural sugars, dates contain beneficial nutrients, such as dietary fiber, which may confer health benefits and help mitigate potential adverse effects associated with high-sugar foods. These fibers, especially non-digestible oligosaccharides

classified as prebiotics, are essential in the support of gut health and improvement of immune responses.[22] In this regard, the date dietary fiber content varied from 6 to 11.5-g/100-g. Nabtat Ali, Medjool, Raziz, Sag'ai, Sukkary, and Helwah dates had the highest (≥8 g) compared to other dates. Kamal-Eldin et al. (2020) analyzed the fiber content of 10 wide varieties of Emirati dates and reported that the dietary fiber ranged from 5.2 to 7.4-g/100-g.[22]

The potential health relevance of GI and GL has been examined extensively in broader nutritional literature. A meta-analysis of prospective cohort studies found a positive correlation between GI and the risk of coronary heart disease, Type-2 diabetes, and certain types of cancer.[23] Randomized controlled trials have shown that diets with a low GI and low GL values have anti-inflammatory effects regarding reduced C-reactive protein concentration, which is linked to a lowered risk of various cardiometabolic diseases, that is, coronary heart disease, Type-2 diabetes mellitus, or insulin resistance syndrome.[7,24] Consumption of diets with high GI values may induce low-grade systemic inflammation and thereby increase the levels of biomarkers of systemic inflammation.[15,25] Previous dietary intervention studies have reported associations between GI or GL and changes in metabolites related to inflammation and energy metabolism.[8,9] The GLYNDIET trial, a 6-month randomized controlled study involving 102 overweight/obese adults, found that a low-GI diet led to higher serine levels and lower concentrations of branched-chain amino acids (leucine, valine) and specific lipids (including sphingomyelins, lysophosphatidylcholines, and phosphatidylcholines) compared to a high-GI diet.[8] Additionally, a crossover feeding trial compared high-GL and low-GL diets over four weeks and found higher kynurenic acid levels during the low-GL phase, aligning with our findings on GL and this metabolite.[26] A follow-up study by the same group identified 18 metabolites related to inflammation and energy metabolism that differed significantly between low-GL and high-GL diets, further supporting the role of GI/GL in metabolic regulation.[9] These observations align with a broader meta-analysis of date-fruit intervention trials, which found consistent reductions in fasting and postprandial glucose but a neutral effect on HbA1c, suggesting that short-term glycemic improvements do not necessarily translate into measurable changes in glycated hemoglobin over time.[15] These findings from previous dietary intervention studies provide broader evidence that GI and GL may be relevant to metabolic health. However, whether the differences in GI and GL observed among the date varieties examined in the present study translate into meaningful long-term metabolic effects remains to be established.

Limitations: This study has several limitations. The sample was mainly male (15 males vs. five females), likely reflecting the demographics of respondents to the social media induction strategy rather than deliberate selection bias; this may limit generalizability, as sex affects glycemic response. Additionally, only healthy adults without diabetes, prediabetes, or other metabolic disorders were included, so the findings cannot be directly generalized to this population, who often exhibit altered glycemic and insulinemic responses to carbohydrate intake. The proposed link between GI values and fiber/sugar structure was not statistically tested in the present study and should be regarded as a reasonable explanation rather than a confirmed finding.

CONCLUSION

The GI, GL, and nutritional values of the 13 date varieties were determined. Knowing date varieties that elicit lower glycemic responses could help reduce the total GI of many individuals' diets in Saudi Arabia. This result may encourage the prevention and treatment of chronic diseases, such as diabetes and obesity, by managing dietary GI. However, further studies should compare the metabolic profiles and properties of dates across different ripening stages, and those of other date products.

***Acknowledgement*:** This study does not involve any personal, financial, or other conflicts of interest.

Conflicts of interest: None.

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Authors' Contribution:

SMA: Contributed to the conceptualization of the study, collected the data, performed the analysis, and drafted the manuscript. Responsible for the accuracy and integrity of the work.
MHA: Conceptualization of the study, designed the study protocol, analysis and interpretation, administered the project, and critically revised the manuscript.
AMA: Contributed to the conceptualization of the study and critically revised the manuscript,
AAA: Conceptualization of the study supervised the study, and critically revised the manuscript.
SAA: Contributed to the investigation and data collection
All authors have read and approved the final manuscript and agree to be accountable for integrity of the study.