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ASSESSMENT OF GLYCEMIC INDEX AND CHEMICAL CHARAC TERIZATION FOR FIVE EGYPTIAN DATE FRUIT VARIETYIES

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ABSTRACT

Date palm (*Phoenix dactylifera*) is one of the oldest trees cultivated by human; Egypt has been ranked as the first country in the production of dates, soft, semi dry and dry date cultivars are cultivated in wide area of Egypt. Therefore, this work was carried out to determine the Glycemic Index (GI) and Glycemic Load (GL) of five Egyptian varieties of date fruit in healthy subjects. Chemical composition analysis was carried out for five types of date fruit (Partamoda, Malakabi, Saadi, Zaghluol and Samani); also, antioxidant power was determined. The study subjects were ten healthy volunteers, each subject was tested on six separate visits with 50 g of glucose and 50 g equivalent of available carbohydrates from the five date varieties. Capillary glucose was measured in the healthy subjects at 0, 30, 60 and 120 min. The GI was determined as ratios of the incremental areas under the response curves for the dates compared to glucose. Collecting data showed that Egyptian varieties of date fruit contain a good nutrients and antioxidant power. Among the five Egyptian varieties of date fruit, the chemical characteristics by moisture content in fruits was the highest in Samani date fruit and lowest in Partamoda dates; also, the five Egyptian varieties of date fruit contain available carbohydrate (7.4% - 69.2%), proteins (1.85 % -7.0%), total dietary fiber, TDF (11.82% - 15.63%) and Energy value (76.2-297.9 Kcal/100g). The antioxidant activity ranged between 52.61 and 79.12% as scavenging activity for free radicals; also, dates rich in phenols. The medium GI was recorded by Malakabi followed by Saadi and Partamoda which had high GL; while, the lowest GI was recorded for soft date fruit (Zaghluol and Samani) which had medium GL. These findings point to the potential benefits of Egyptian date fruit for healthy subjects when used in a stable healthy diet.

Keywords: Egyptian Dates, Chemical Characterization, Antioxidant power, Glycemic Index, Healthy Subjects.

INTRODUCTION

The date (*Phoenix dactylifera* L.) fruit belonging to the family of *Arecaceae* is an important fruit and staple food in most of the Arabian countries. Egypt is world leading dates producer and the first rank with 1590414 tons **(FAOSTAT, 2017)**.

In Egypt, date palms are distributed in Nile valley, oases and desert; include soft dates like (Zaghloul and Samani); semi–dry dates like (Al-Amri and Saadi) and dry dates like (Sakouti, Partamoda and Malakabi) (**Riad, 2012**).

Dates fruit constitute a wide range of nutritional functional components. These nutrients include a good source of easily digestible carbohydrate, dietary fiber, and important traces elements **(Sadiq et al 2013)**. Also, dates are rich source of antioxidants, mainly phenolics, carotenoids and flavonoids which offer protection against oxidative stress **(Al-Farsi et al 2005; Al-Farsi and Lee, 2008; Allaith, 2008 and Rock et al 2009)**.

The type of carbohydrates is best characterized by their glycemic index (GI) **(WHO, 2010)**. GI is a serious tool used in nutrition assessment for diabetic people or in regime programs. Hypoglycemic foods had slow digestion and absorption of their carbohydrates, produce a more gradual altitude in blood sugar and are associated with good health. Hypoglycemic foods have thus been shown to improve the glucose tolerance in both healthy and

diabetic people **(Schulze et al 2004)**. Glycemic index is useful tool to rank the biological response of dietary carbohydrates and can be converted to a functional tool like the glycemic load (GL) for regular dietary advice. The GL is determined by multiplying the glycemic index of a food by the amount of percent carbohydrates contained in a typical serving of that food. Nowadays the consumption patterns interested in hypoglycemic foods to weight control and protect against risk of chronic diseases, like diabetes **(Foster-Powell et al 2002)**. No previous studies were found regarding the GI and GL in local Egyptian palm fruit varieties. Therefore, this study was conducted with the selected five commonly used Egyptian date varieties (Partamoda, Malakabi, Saadi, Zaghloul and Samani) to assess their chemical characteristics, glycemic index and glycemic load values in healthy human subjects.

MATERIALS AND METHODS

Materials

Five Egyptian dates variety (*Phoenix dactylifera* L) were collected at edible maturation stage in August and September 2018; tow dry date varieties grown in Aswan city like Partamoda and Malakabi, one of semi dry Saadi grown in Kharga Oasis, tow fresh dates like Zaghluol grown in Giza were obtained from Agricultural Research Center, Giza and Samani grown in Rasheed region. While, ethanol, methanol, aluminum chloride and sodium carbonate were obtained from El-Gomhoreya Co., Cairo, Egypt. Also, 2,2-diphenyl-2-picrylhydrazyl radical (DPPH) and Folin-Ciocalteus phenol reagent were purchased from Sigma–Aldrich Inc. (St Louis, MO, USA).

Method of analysis

Chemical characterization of different Egyptian date varieties

The five Egyptian date varieties were analyzed for their moisture content, ash, crude fiber, protein, fat, carbohydrate by difference and total dietary fiber (TDF), according to the methods described in **AOAC, (2012)**. Available carbohydrates were calculating according to the following equation: Available carbohydrate = 100 - (Protein + fat + moisture + ash + total dietary fiber). The energy value was calculated based on their content of crude protein, fat and available carbohydrate using the following equation: Energy value (kcal/100 gm) = (Crude protein × 4) + (available carbohydrate × 4) + (Crude fat × 9) according to **AOAC, (2012)**.

Determination of Antioxidant power

The total phenolics content of the methanolic extract of five date fruit varieties was determined colorimetrically, using the Folin-Ciocalteu method. The results were expressed as milligrams of gallic acid equivalent per ml extract (mg GAE/ml) by reference to the gallic acid calibration curve as described by **Singleton et al (1999)**. Also, total flavonoids content was determined and expressed as milligram quercetin equivalent as described by **Mohdaly et al (2012)**. While, the ability of the extracts to scavenge DPPH free radicals was determined by the method described by **Brand-Williams, et al (1995)**. The percentage of scavenging effect was calculated from the decreased in absorbance against control according to the following equation:

$$\text{Scavenging activity \%} = [(Abs_{control} - Abs_{sample})/Abs_{control}] \times 100$$

Study design and subjects

The study was announced to a group of healthy Subjects to participate in the study. Forty eight individuals responded to the study advertisement. After providing informed consent, all volunteers completed an interviewer administered questionnaire covering demographic data and tobacco use, medical history and current health status for them. Each subject underwent to an anthropometric measures. Inclusion criteria required that those in the healthy group were indeed healthy. Exclusion criteria included for diabetic disease volunteers, smokers and declined participation and unable to start immediately. Ten healthy subjects (5 males and 5 females) were enrolled for the study as shown in **Fig. (1)**.

Fifty grams of glucose was dissolved in water and given to them for drinking. The blood glucose levels at fasting state and there after followed by administration of glucose, at 30, 60, 90 and 120 minutes were determined and recorded using the glucometer (Fine test, Auto-coding premium). Instead of glucose, the previously fixed portion of selected variety containing 50 grams of carbohydrate was fed. The blood glucose levels were also determined as given above and recorded for six visits as shown in **Fig. (1)**.

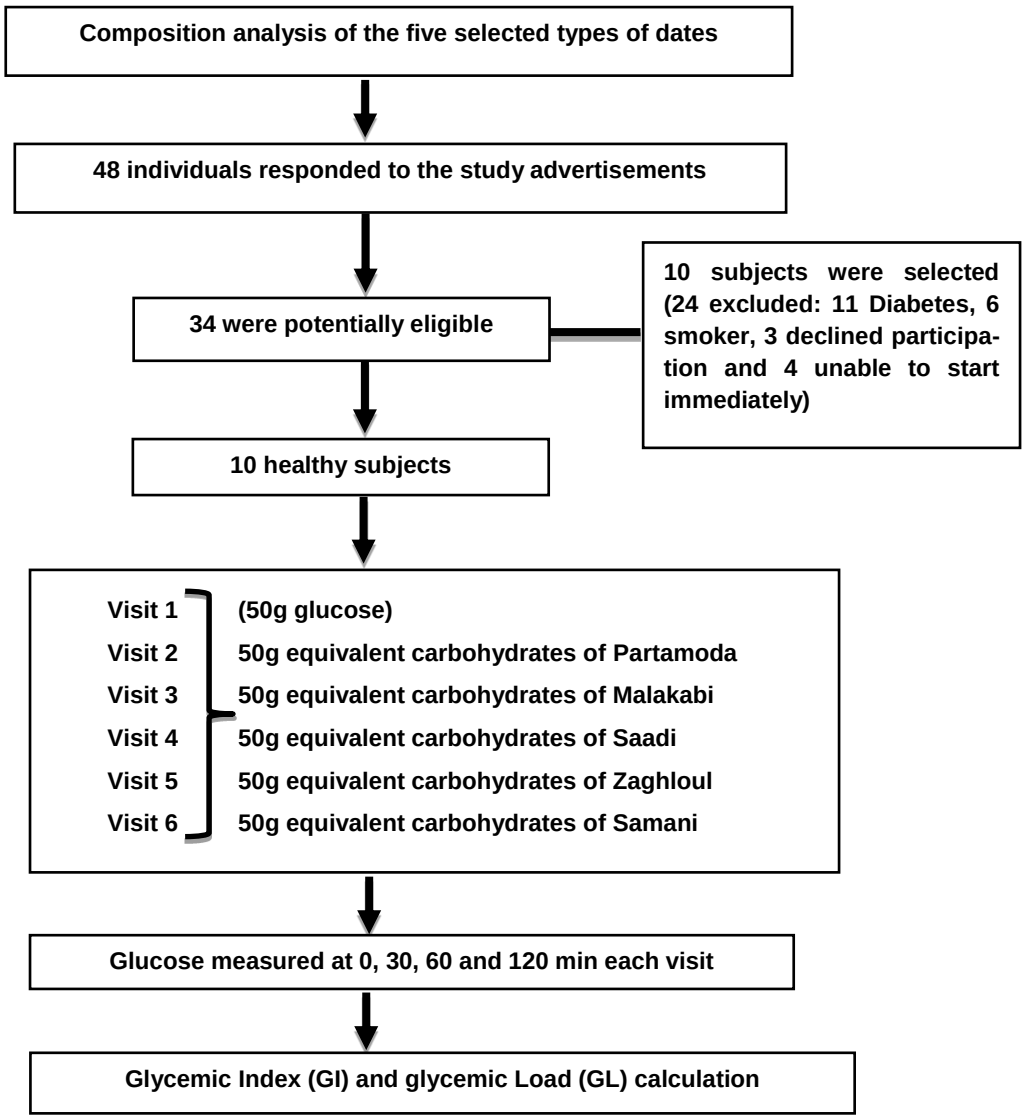

Fig. 1. Schematic design for healthy study subject

Anthropometric measurements

Anthropometric measurements included body weight and height; waist circumferences; and calculated waist-to-height ratio. Body mass index (BMI) and ideal body weight percentage (IBW %) were also calculated. All measurements were performed according to the techniques described by **WHO (2008); Lee et al (2008); Whitney et al (2010),** respectively.

Glycemic Index and Glycemic Loud calculation

According to the methodolgy of calculating the area under the curve recommended by **FAO/WHO, (1998)** the incremental areas under the curve (IAUC) of blood glucose concentrations resulting from glucose given orally in a dose of 50 g as the reference food (GI = 100) against which all tested Egyptian dates variety were compared. The Glycemic Index (GI) is computed using the standard formula: GI= (IAUC test Food/IAUC

standard reference Food)x 100**.** Also, the Glycemic index values were used to calculate the Glycemic load (GL) using the formula: GL = (GI x available carbohydrate content per serve size)/100.

Statistical analysis

All data were expressed as the mean±SE and they were analyzed statistically using the one-way analysis of variance ANOVA followed by Duncan's test. In all cases *p<0.05* was used as the criterion of statistical significance by SAS program **(SAS, 1996)** according to the procedure reported by **Steel et al (1997)**.

RESULTS AND DISCUSSION

Chemical characterization of Egyptian date fruit varieties

Data given in **Table (1)** indicated that the Samani soft dates had the highest moisture, ash, fat and crude fiber contents compared with the other Egyptian date varieties. Also, the other soft date variety (Zaghloul) recorded the highest protein and total dietary fiber. While, the dry and semi dry dates (Partamoda, Malakabi and Saadi), respectively, showed high content of energy value, available and digestible carbohydrate. This observation is agreed with those reported by **(Osman, 2008 and Sakr et al 2010).**

Table 1. Chemical characterization of Egyptian date fruit varieties (g/100g)

Composition	Egyptian Dates				
	Partamoda	Malakabi	Saadi	Zaghloul	Samani
Moisture	12.29^{c} ±0.91	12.91^{c} ±0.13	13.15^{c} ±0.49	64.53^{b}± 0.03	67.91^{a} ±0.02
Ash	1.96^{b} ±0.18	1.96^{b} ±0.17	2.06^{b} ±0.1	2.35^{ab}±0.1	2.76^{a} ±0.11
Fat	1.02^{e} ±0.03	1.65^{c} ±0.00	1.21^{d} ±0.04	3.07^{b}±0.02	3.78^{a} ±0.01
Protein	2.61^{c} ±0.01	1.85^{e} ±0.01	4.44^{b} ±0.13	7.00^{a} ±0.03	2.31^{d} ±0.02
Crude Fiber	2.95^{c} ±0.02	2.75^{e} ±0.01	2.84^{d} ±0.01	4.03^{b} ±0.01	4.25^{a} ±0.01
TDF	12.91^{d} ± 0.01	13.12^{c} ±0.03	11.82^{e}± 0.01	15.63^{a}± 0.02	15.02^{b} ± 0.01
Carbohydrate by difference	79.18^{a} ±0.94	78.89^{a} ±0.07	76.31^{b} ±0.5	19.03^{c} ±0.1	18.98^{c}±0.08
Available carbohydrate	69.2^{a}± 0.95	68.5^{ab}± 0.07	67.3^{b} ± 0.48	7.4^{c}± 0.09	8.2^{c} ± 0.1
Energy value (Kcal/100g)	296.5^{a}± 3.78	296.3^{a}± 0.24	297.9^{a} ± 1.60	85.3^{b}± 0.34	76.2^{c}± 0.33

Data are mean ± SE, *n=3*, Different uppercase letters in the same raw represent statistically significant differences at probability level of 5%.

Antioxidant power of Egyptian date fruit varieties

The data presented in **Table (2)** showed that Malakabi had significant increase in the content of total phenolic followed respectively by Zaghloul > Samani > Partamoda > Saadi. Also, significant increase in the content of total flavonoids in the Malakabi followed by Partamoda. Whereas, the results showed a significant increment in antioxidant activity in Zaghloul (79.12%) followed by Malakabi (78.63%) and Samani (75.48%) comparing with Partamoda and Saadi. These results are in harmonization with those obtained by **(AlTamim, 2014).**

Table 2. Antioxidant power of Egyptian date fruit varieties

Egyptian Dates	Antioxidant status		
	Total phenols mg GAE/100g of extract	Total flavonoids mg QE/100g of extract	Scavenging activity %
Partamoda	3.01^{cd} ±0.07	0.94^{b}±0.03	55.33^{b}±5.78
Malakabi	5.43^{a} ± 0.33	1.91^{a}± 0.02	78.63^{a}± 0.88
Saadi	2.27^{d} ± 0.02	0.84^{c}±0.02	52.61^{b}± 2.45
Zaghloul	4.68^{ab} ±0.9	0.58^{d}± 0.04	79.12^{a}± 0.42
Samani	3.88^{bc} ± 0.43	0.07^{e}± 0.01	75.48^{a}± 2.36

Data are mean ± SE, *n=3*, Different uppercase letters in the same column represent statistically significant differences at probability level of 5%.

Anthropometric characteristics for healthy study subjects

Data observed in **Table (3)** indicated that the anthropometric measurements showed a significant increase in weight and height in males compared to females, however, insignificant difference was noticed in the body mass index and waist circumference. While, the results of the ideal body weight (IBW%) and Waist-to-Height Ratio (WHtR) had significant increase in females compared to males. These results are in parallel with those of **Alkaabi et al (2011)** designed study to determination the glycemic index of Emirates date varieties in healthy and diabetic subjects.

Table 3. The anthropometric characteristics for healthy subjects

Variable	Subjects	
	Male	Female
Weight, kg	82.6^{a} ±4.2	69.6^{b}±3.8
Height, cm	182.4^{a}±2.5	165.6^{b}±2.4
BMI, kg/m^2	24.75^{a}±0.7	25.33^{a}±1.1
IBW, %	90.94^{b}±2.3	117.85^{a}± 4.9
Waist circumference, cm	80.2^{a} ±2.4	85.6^{a}±4.14
Waist-to-Height Ratio (WHtR), cm	0.44^{b}±0.02	0.52^{a}±0.03

Data are mean ± SE, n= 5, Different uppercase letters in the same raw represent statistically significant differences at probability level of 5%.

Glycemic Index and Glycemic Loud for different Egyptian dates variety

The results in **Table (4) and Fig. (2)** revealed that the blood glucose response after consuming different Egyptian date varieties was significantly lower when compared with glucose. The soft dates variety (Zaghloul and Samani) had the lowest glycemic index (less than 55%), while, other date observed medium GI value ranged from 65.92 to 69.04% for Partamoda, Saadi and Malakabi, respectively, according to classification of foods based on their respective GI values in the healthy study subjects. Also, the glycemic load (GL) values which reviled to the serving sizes of different dates. The soft date varieties can be considered as medium GL food while the other dates dry and semi dry (Partamoda, Malakabi and Saadi) according to classification of foods based on their GL values. Therefore, based on the nature and amount of carbohydrates, these Egyptian date varieties would be more advantageous especially the soft varieties (Zaghloul and Samani) for diabetic and healthy people **(USDA, USDHHS, 2000)**.

Table 4. Glycemic index (GI) and glycemic loud (GL) of Egyptian date varieties in healthy subjects

Variety	GI (%)	GL (%)
Partamoda	65.92^{a} ± 1.62	32.96^{a} ± 0.81
Malakabi	69.04^{a} ± 1.72	34.52^{a} ± 0.86
Saadi	67.42^{a} ± 2.25	33.71^{a} ± 1.13
Zaghloul	30.36^{b} ± 0.72	15.18^{b} ± 0.36
Samani	34.69^{b} ± 1.24	17.35^{b} ± 0.62

Data are mean ± SE, *n=10*, Different uppercase letters in the same column represent statistically significant differences at probability level of 5%.

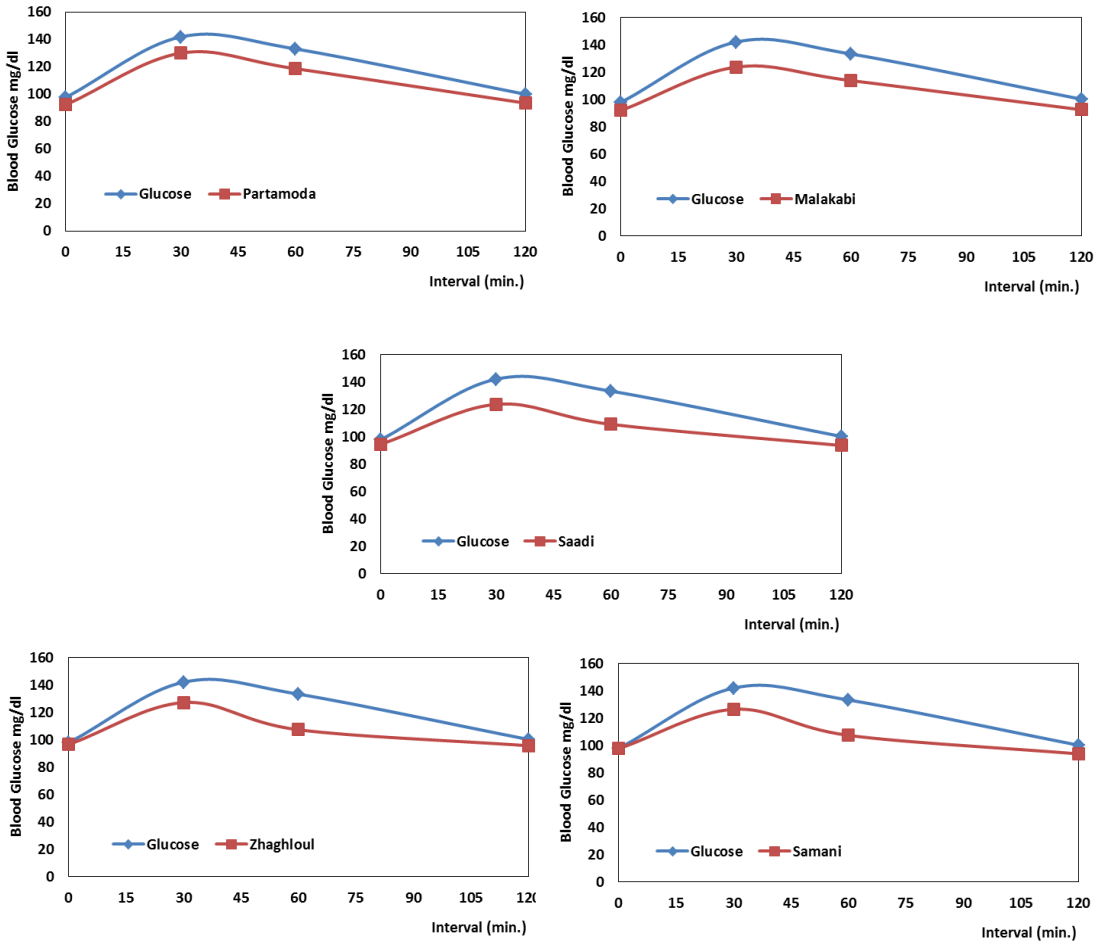

Fig. 2. Mean capillary glucose concentrations following ingestion of Egyptian date fruit varieties in healthy subjects (*n-10*).

CONCLUSION

Based on the aforementioned data, we could conclude that the composition of five Egyptian common types of date fruit varieties (Partamoda, Malakabi, Saadi, Zaghloul and Samani) had strong nutritional interest as indicated by high antioxidant power. Also, by calculated their glycemic indices, the soft varieties of dates (Zaghloul and Samani) would have low Glycemic Index in healthy subjects.

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تقييم مؤشر نسبة السكر في الدم والتركيب الكيميائي لخمسة أنواع من ثمار التمر المصرية [121]

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الموجـــــــز

يعد نخيل التمر (*Phoenix dactylifera*) من أقدم الأشجار التي يزرعها الإنسان؛ تحتل مصر المرتبة الأولى في إنتاج التمر، حيث يتم زراعة أصناف التمر الطرية وشبه الجافة والجافة في مساحة واسعة من مصر. لذلك، تم تنفيذ هذا العمل لتحديد مؤشر نسبة السكر في الدم (GI) وحمل نسبة الجلوكوز في الدم (GL) لخمسة أصناف مصرية من ثمار التمر لأشخاص أصحاء. أجري تقدير التركيب الكيميائي لخمسة أنواع من التمور(Malakabi ،Partamoda ، Saadi ،Zaghluol و Samani)، أيضا، تم تحديد التأثير المضاد للاكسدة لمستخلصاتها. كان عدد الأشخاص الأصحاء المتطوعين عشرة، وتم اختبار كل شخص في ست زيارات منفصلة مع 50 جرام من الجلوكوز و 50 جرام مما يعادل الكربوهيدرات المتاحة من الخمسة أنواع من التمور. تم قياس الجلوكوز في الأشخاص الأصحاء بعد 0 و 30 و 60 و 120 دقيقة. تم تحديد مؤشر نسبة السكر في الدم كنسب للمناطق المتزايدة تحت منحنيات الاستجابة للتمور مقارنة بالجلوكوز. أظهرت النتائج أن الأصناف المصرية من ثمار التمر تحتوي على مغذيات جيدة، بالاضافة الي ان لها تأثير قوي كمضاد للاكسدة. من بين خمسة أصناف مصرية من ثمار التمور، وبالنسبة للتركيب الكيماوي كان محتوى الرطوبة في الثمار هي الأعلى في ثمار التمر السماني وأقلها في التمر Partamoda؛ أيضا، تحتوي على كربوهيدرات متاحة (7.4٪ – 69.2٪)، وبروتينات (1.85٪ – 7.0٪) ، والألياف الغذائية الكلية TDF،(11.82٪ – 15.63 ٪) وكمية الطاقة (76.2 – 297.9 كيلو كالوري / 100 جم). تراوح نشاط مضادات الأكسدة بين 52.61 و 79.12 ٪ كنشاط لإزالة الشقوق الحرة. أيضا، التمور غنية جدا في الفينولات. تم تسجيل GI المتوسطة بواسطة صنف Malakabi يليها الصعيدي و Partamoda التي لديها GL عالية. بينما ، تم تسجيل أدنى مؤشر نسبة السكر في الدم لصنفي الزغلول والسماني الذي كان لهما حمل نسبة السكر في الدم متوسطة GL. تشير النتائج إلى الفوائد المحتملة للتمور للأشخاص الأصحاء عند استخدامها في نظام غذائي صحي متوازن.

الكلمات الدالة: التمور المصرية، التركيب الكيميائي، التأثير المضاد للأكسدة، مؤشر نسبة السكر في الدم، الأشخاص الأصحاء

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