ASSESSMENT OF GLYCEMIC INDEX AND CHEMICAL CHARACTERIZATION FOR FIVE EGYPTIAN DATE FRUIT VARIETIES

Lamia A. Mahmoud*, Mahmoud R.M. and Ashoush I.S.
Food Sci. Dept., Fac. of Agric., Ain Shams Univ., P.O. Box 68, Hadayek Shoubra11241, Cairo, Egypt

*Corresponding author: lamiaabdelmohsen3@yahoo.com
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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, Zaghloul 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).

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).

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 Zaghloul grown in Giza and Samani grown in Rasheed region. While, ethanol, methanol, aluminum chloride and sodium carbonate were obtained from El-Gomhoorya Co., Cairo, Egypt. Also, 2,2-diphenyl-2-picrylhydrazyl radical (DPPH) and Folin-Ciocalteu 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 methanol 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:

\[
\text{Scavenging activity \%} = \frac{[\text{Abs}_{\text{control}} - \text{Abs}_{\text{Sample}}]}{\text{Abs}_{\text{control}}} \times 100
\]

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).
Assessment of glycemic index and chemical characterization for five Egyptian date fruit varieties

Composition analysis of the five selected types of dates

48 individuals responded to the study advertisements

34 were potentially eligible

10 subjects were selected (24 excluded: 11 Diabetes, 6 smoker, 3 declined participation and 4 unable to start immediately)

10 healthy subjects

Visit 1 (50g glucose)
Visit 2 50g equivalent carbohydrates of Partamoda
Visit 3 50g equivalent carbohydrates of Malakabi
Visit 4 50g equivalent carbohydrates of Saadi
Visit 5 50g equivalent carbohydrates of Zaghloul
Visit 6 50g equivalent carbohydrates of Samani

Glucose measured at 0, 30, 60 and 120 min each visit

Glycemic Index (GI) and glycemic Load (GL) calculation

**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 methodology 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)

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

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

<table>
<thead>
<tr>
<th>Egyptian Dates</th>
<th>Antioxidant status</th>
<th>Total phenols mg GAE/100g of extract</th>
<th>Total flavonoids mg QE/100g of extract</th>
<th>Scavenging activity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partamoda</td>
<td>3.01 ±0.07</td>
<td>0.94 ±0.03</td>
<td>55.33 ±5.78</td>
<td></td>
</tr>
<tr>
<td>Malakabi</td>
<td>5.43 ±0.33</td>
<td>1.91 ±0.02</td>
<td>78.63 ±0.88</td>
<td></td>
</tr>
<tr>
<td>Saadi</td>
<td>2.27 ±0.02</td>
<td>0.84 ±0.02</td>
<td>52.61 ±2.45</td>
<td></td>
</tr>
<tr>
<td>Zaghloul</td>
<td>4.68 ±0.90</td>
<td>0.56 ±0.04</td>
<td>79.12 ±0.42</td>
<td></td>
</tr>
<tr>
<td>Samani</td>
<td>3.88 ±0.43</td>
<td>0.07 ±0.01</td>
<td>75.48 ±2.36</td>
<td></td>
</tr>
</tbody>
</table>

Data are mean ± SE, n=3. Different uppercase letters in the same column represent statistically significant differences at probability level of 5%.
Assessment of glycemic index and chemical characterization for five Egyptian date fruit varieties

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 (WHR) 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, kg</td>
<td>69.6±3.8</td>
<td>82.6±4.2</td>
</tr>
<tr>
<td>Height, cm</td>
<td>165.6±2.4</td>
<td>182.6±4.2</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>24.7±1.1</td>
<td>25.3±1.1</td>
</tr>
<tr>
<td>IBW, %</td>
<td>90.9±2.3</td>
<td>117.8±4.9</td>
</tr>
<tr>
<td>Waist circumference, cm</td>
<td>80.2±2.4</td>
<td>85.6±4.14</td>
</tr>
<tr>
<td>Waist-to-Height Ratio (WHR), cm</td>
<td>0.44±0.02</td>
<td>0.52±0.03</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Variety</th>
<th>GI (%)</th>
<th>GL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partamoda</td>
<td>65.92±1.62</td>
<td>32.96±0.81</td>
</tr>
<tr>
<td>Malakabi</td>
<td>69.04±1.72</td>
<td>34.52±0.86</td>
</tr>
<tr>
<td>Saadi</td>
<td>67.42±2.25</td>
<td>33.71±1.13</td>
</tr>
<tr>
<td>Zaghloul</td>
<td>30.36±0.72</td>
<td>15.18±0.36</td>
</tr>
<tr>
<td>Samani</td>
<td>34.69±1.24</td>
<td>17.35±0.62</td>
</tr>
</tbody>
</table>

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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Assessment of glycemic index and chemical characterization for five Egyptian date palm varieties


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تقييم مؤشر نسبة السكر في الدم والتركيب الكيميائي لخمسة أنواع من ثمار التمور المصرية

لبياء عبد المحسن محمود - رمضان محمد محمود - إيهاب صلاح عشوش

قسم علوم الأغذية - كلية الزراعة - جامعة عين شمس - ساب - 68 - حي سيرات - القاهرة - مصر

*Corresponding author: lamiaabdelmohsen3@yahoo.com

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الموجز

بعد نخيل التمر (Phoenix dactylifera) يعد أقدم الأشجار التي يزرعها الإنسان؛ تحل مصر المرتبة الأولى في إنتاج التمر، حيث يتم زراعة أصناف التمر في جميع أنحاء البلاد، وتمثل زراعته مصدراً مهماً من الدخل. تم تطبيق هذا العمل لتحدد مؤشر نسبة السكر في الدم (GI) وحمل نسبة الجموكوز (GL) لخمسة أنواع من ثمار التمور، بالإضافة إلى تقييم تركيبها الكيميائي ونشاط مضادات الأكسدة. تم تذكر أن التمور تحتوي على مركبات تساهم في حماية الجسم من الأمراض المزمنة. يتميز التمر المصري بالتنوع الشامل في أنواعه، حيث تحتوي المиндلات الثمانية أنواع من التمور على ترتيبات متنوعة من محتوى السكر، والكتل الكربوهيدراتية، والمواد الأخرى.

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