Post-prandial blood glucose of four cultivars of date palm (*Phoenix dactylifera*) in healthy subjects

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Abstract

This study was designed to determine the post-prandial blood glucose of four commonly used cultivars of dates ("Ghars"; "Deglet Nour"; "Degla Beida"; "Addela") in healthy subjects and their effects on glycemic index. This research also aims to explore the possibility of consumption of these cultivars of dates by obese and diabetics. These cultivars were chosen on the basis of their consumption enhanced by the local population.

Composition analysis was carried out for four types of dates. The weights of the flesh of the date’s equivalent to 50 g of available carbohydrates (7 to 8 dates) were calculated. The study subjects were twenty eight volunteers (non-diabetic) with a mean age of 22.14 ± 0.134 years. Each volunteer was tested on five separate days with 50 g of glucose (reference food) and 50 g equivalent of available carbohydrates from the 4 cultivars of date. Capillary glucose was measured in volunteers at 0, 15, 30, 45, 60, 90 and 120 min. The post-prandial response was recorded by using MATLAB program. The glycemic index was determined as ratios of the incremental areas under the response curves for the dates compared to glucose. Mean glycemic index of the dates were 43.27±14.05, 52.22±9.82, 53.95±23 and 42.11±14.05 for Ghars, Deglet Nour, Degla Beida and Addela, respectively. There were statistically significant differences in the GI between the four cultivars of dates. The results show low glycemic indices for the four types of dates
included in the study and that their consumption by healthy individuals
does not result in significant postprandial glucose excursions. These
findings point to the potential benefits of dates for diabetic subjects when
used in a healthy balanced diet.

Key words: Dates; Glycemic Index, diabetes, obesity, Algeria

Introduction

Scientific name of date palm tree is *Phoenix dactylifera* L. that it is
belongs to palmaceae. Date palm has been an important crop in arid and
semiarid regions of the world. It has always played an important part in
the social lives of the people of these regions (Besbes et al., 2004; Al-
Farsi et al., 2007; Al-Jasser, 2010). They are also important for the
ecology of the country, being the most adaptive crop and tolerant of
various environmental extremes and stresses such as high temperature,
drought and salinity (Alkhateeb, 2008).

Dates constitute the main part of the diet and are considered one
of the most important economic pillars of the agriculture sector, and
represent a major source of income for the majority of the population in
the rural areas of Arab world. Date fruit is a highly nutritious food. It is a
rich source in carbohydrates (70 – 80 %) comprising mainly of sugars
and dietary fibers, making it one of the most nourishing natural foods
available to the man. They are also a good source of some vitamins (A,
B1, B3, C), protein, carotimodes, anti-oxidants and macro-elements like
phosphorus, iron, potassium and calcium (Ahmed and Ramaswamy,
2006; Biglari et al., 2009; Iqbal et al., 2011).

The importance of the date palm tree was appreciated by several
Algerian researchers. Due to high levels of sugar in the palm, it is one of
the main products of the conversion date liquid sugar or honey dates and
dates concentrate that is used in many industries including
manufacturing, construction industries, cakes and pastries, ice cream,
candy and soda (Roukas and Kotze Kidou, 1997; Al-Farsi, 2003; Sidhu et
al., 2003; Entezari et al., 2004).

Generally dietary fiber having high functional properties acting
as non-caloric bulking agents, increase water holding and retaining
capacities and also enhances oxidation stability. Dietary fibers positively affect structural and physical properties of food, sensory characteristics, texture and shelf-life of product (Elleuch et al., 2008). Soluble dietary fiber is naturally available in fruits such as fruits, vegetable and can have potential application on dietary fiber supplements (Mckee and Latner, 2000). These features are beneficial for groups seeking regular blood glucose. The purpose of this study was to assess the postprandial response (Glycemic Index) of four cultivars of common dates consumed in Algeria in healthy subjects, order to optimize their consumption by other categories seeking regular blood glucose such as diabetics and obese.

**Materials and Methods**

**Test foods**

Ghars, Deglet Nour, Degla Beida and Addela (fig.1), four cultivars of date, very popular in Algeria, were chosen for this study. The same batches of packaged dates (Tamer stage) were purchased from markets of south east Algeria (Ourgla, Ghardaia, El Goléa).

**Reference food**

The 50 g of glucose was used as the reference food (Glycemic Index = 100) against which all test dates were compared.

**Volunteers**

28 Study participants (non-diabetic) were recruited with a mean age of 22.14 ± 0.134 years. After providing informed written consent, all
volunteers completed an interviewer-administered questionnaire covering demographic data, tobacco and alcohol use, medications use and current health status. Each volunteer was tested for fasting glucose (0.97 ± 0.05g/l) and complete physical examination, including measurements of height (1.63 ± 0.034 m), Body weight (55.9 ±5.49 Kg) and Body mass index (21.21 ± 0.08 Kg/m²).

Measurement of glycemic response

The glycemic response testing was carried out after an overnight fast, each test being separated from the next (one day). In addition, we used capillary blood for the measurement of glycemic response instead of using venous samples and we also used oral glucose as a reference food. A fasting blood sample was obtained from all subjects for measurements utilizing an Accu-Chek. The dates were weighed using and consumed by all participants with 100 ml of water. Blood glucose was monitored during 2 hrs for the healthy individuals at 0, 15, 30, 45, 60, 90 and 120 min. Areas under the curve (AUC) of blood glucose concentrations resulting from glucose given orally in a dose of 50 g with a corresponding oral carbohydrate load of 50 g were compared (Wolever et al., 1991). The resulting values for all subjects were averaged to calculate the glycemic index for each type of dates. The blood glucose levels used to calculate GIs were measured in our laboratory in the Faculty of Natural Sciences and Life Sciences, University Kasdi Merbah - Ouargla, Algeria between March and June 2010.

Chemical analysis

It was performed intriplicates for each tested parameter. Moisture, total solids, protein (N×6.25), ash, crude fiber, total and reducing sugars contents and sucrose were determined using the standard methods of AOAC (Association of Official Analytical Chemists, 2005).

Statistical analysis

The post-prandial response was recorded by using MATLAB program. The glycemic index was determined as ratios of the incremental areas under the response curves for the dates compared to glucose, as shown in the formula below. Statistical analyses were performed using Excel 2007.

\[
GI = \frac{\text{area under curve for test food}}{\text{area under curve for glucose}} \times 100
\]
Results and discussion

Composition of dates

The composition of the dates studied is shown in Table 1. The moisture content was 11.8 - 35.4% and total solids 71 – 88.18%. The dates contained a high concentration of sugar, which is considered the main component (52.08 – 71.79% total sugars and 52-70.1% reducing sugars). The highest concentration of available carbohydrate was in Ghars dates and lowest in Deglet Nour dates. Sucrose 1.70 - 44.82%, protein 0.81-1.10% and ash 0.57 – 4%. The cultivars used in our present study are rich in certain nutrients and are widely consumed in many countries, particularly those within the North Africa. Composition analysis of the date in our study was in keeping with the results reported by several researchers including (Ahmed and Ramaswamy, 2006 ; Elleuch et al., 2008 ; Biglari et al., 2009 ; Iqbal et al., 2011).

The dietary fiber content varies depending on the type and degree of ripeness (Al-Shahib and Marshall, 2003; Al dhaheri et al., 2004). The percentage of dietary fiber decreases throughout the stages of maturation with the lowest percentage at the tamer stage (Ahmed et al., 1995). Our measurement of the percentage of dietary fibers (3.5 - 5%) was similar to that previously reported (Alkaabi et al., 2011) (2 -3%). Fibers are the solid insoluble part of date flesh. These fibers can be used as dietary fibers due to oil and water uptake, and swelling capacity (Elleuch et al., 2008).

Table 1. Chemical compositions of the flesh of studied dates

<table>
<thead>
<tr>
<th>Analysis (%)</th>
<th>Ghars</th>
<th>Deglet Nour</th>
<th>Degla Beida</th>
</tr>
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<tbody>
<tr>
<td>Adella</td>
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<td></td>
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</table>
Total solids 83.57 86.44 88.18 71
Moisture 16.42 13.61 11.8 35.4
Fiber 4.15 3.90 3.50 5
Protein 1.10 0.99 0.81 1
Total sugars 71.79 52.08 67.33 69
Reducing sugars 70.01 13.90 20.15 52
Sucrose 01.70 36.23 44.82 17
Ash 02.10 0.57 04 0.67

Evolution of post-prandial (peak of hyperglycemia)

The results of evolution in blood glucose are shown in figure 2 (A, B, C, D). The glucose at time 0 has served to verify that the volunteers were well fasting (0.97 ± 0.05 g / l).

In our study, the peak of hyperglycemia obtained with reference food (glucose 50g) for the mean curve of twenty eight volunteers was large compared to recorded for peaks of food tested (dates). Our results are also comparable to those recorded by Hlebowicz et al. (2007), they showed that postprandial peak in healthy after eating reference food is large compared to rye grain.

The peak of hyperglycemia obtained with pure glucose at 30 min reached 1.82 g / l, because pure glucose is a simple sugar, easy to absorb and this absorption is followed by a significant hyperglycemia early but short-lived. However, the peaks of cvs Ghars, Degla Beida and Addela at 30 min reach 1.30, 1.37 and 1.21 g / l respectively. These peaks appear to be less important compared to glucose. A smaller peak hyperglycemia and late was recorded for Deglet Nour (1.34 at time 45 min). This variation between varieties can be explained by the composition of the date and metabolic heterogeneity of volunteers. Our results are comparable to those found by Alkaabi and al. (2011). They have shown peaks for five cvs at 30 min which are in the range of 1.35 to 1.40g/l. These results can be explained by the richness of dates in fiber.
According NORMAND et al. (2001), the presence of fiber, fat and proteins will limit the peak postprandial hyperglycemia.

Note that according Hlebowicz et al. (2009), the consumption of dietary fiber has been shown a significant reduction in risk of developing diabetes. According to their study, they did not show any increase in the level of glucose in the blood after eating a meal of whole rye grains (bread) compared to reference food. The authors found hyperglycemia peaks at time 40 min reaching 0.48 g/l. For comparison, JENKINS et al. (2010) confirm the results found by previous authors. They showed that the reduction in post-prandial glucose was remarkable after incorporation of viscous polysaccharides (NVP) or commercial fibers in food. The authors report that the addition of 5 g of NVP in breakfast, starch, rice, roast turkey and yogurt allowed having hyperglycemia peaks the order of 0.53, 0.38, 0.51 and 0.61 g/l respectively against 0.84, 0.76, 0.82. and 0.74 g/l respectively for the same food without NVP.

The composition of a food affects blood glucose response through the concept of glycemic load, more food is rich in macronutrients other than carbohydrates, glycemic response will be the less and will influence on blood glucose (NORMAND et al., 2001).

![Graph A](image1.png)

![Graph B](image2.png)
According to the graphics of peaks postprandial hyperglycemia mentioned above, we have calculated the GI values. The results of measured mean GIs for four cvs were 43.27±14.05, 52.22±9.82, 53.95±23 and 42.11±14.05 for Ghars, Deglet Nour, Degla Beida and Addela, respectively. The GI is a newly introduced concept. It is being successfully used in the classification of a large number of sweet foods on the basis of blood glucose response relative to that of the reference food: glucose; the glucose’s GI being equal by convention in 100. Thus, foods are classified according to their "GI" as "Foods at high GI" (>higher 70), or "Foods at Moderate GI" (56-69) or "Foods at Low GI" (≤56). The recommended foods to the obese people and the diabetic are those with a low GI. The results obtained show that the all of the dates cultivars studied, present a low GI. The study suggests that the studied dates are part of the 'Foods at Low GI '. These results are supported by Alkaabi et al. (2011), cited the GI in range 46.3 – 55.

The consumption of four cvs did not result in significant postprandial glucose excursions. From international tables, the mean GI ±
SEM for dates is $42 \pm 4$ (Atkinson et al., 2008). In summary, the reported GI for dates classifies them as low to medium food. The low GI of dates can be attributed to their high fructose and dietary fiber content. A diet low in GI may decrease the risk of coronary disease, such as diabetes (Liu and Willett, 2002).

Our results suggesting that such patients can consume dates in similar quantities to those used in this study without the risk of inducing undesirable postprandial excursions in blood glucose. The equivalent of 7-8 dates was used in each of our studies.

**Conclusion**

We have determined the composition of four common cultivars of dates (Ghars, Deglet Nour, Degla Beida and Adella) and calculated their glycemic index through hyperglycemic curves. Our results support the study hypothesis that the tested cultivars of dates would have low GI and does not result in significant postprandial glucose excursions. Future prospective studies are needed to evaluate the effects of long-term consumption of these dates on prevention of diabetes and other chronic diseases and on the control of hyperglycemia in subjects with diabetes.

**References**


