

STUDY OF THE EFFECT OF DATES ON BLOOD GLUCOSE AND LIPID PROFILE IN HEALTHY HUMAN SUBJECTS

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ABSTRACT

The present study had the objective of evaluating the quality of two dates derived from two varieties of date palms, Ghars and Tamesrit, by the determination of physicochemical and biochemical characteristics and the effect of their consumption on blood glucose and lipid profile. The results obtained showed that both dates have morphological and physicochemical characteristics ranging from acceptable to good characters showing their commercial value. The phytochemical study showed their richness in Alkaloids, Polyphenols, Tannins, Flavonoids and Coumarins with different amounts depending on the variety. Tamesrit and Ghars have proved their richness in phenolic compounds, but the rate of total polyphenols was significantly higher ($p < 0.05$) in the variety Tamesrit compared to Ghars with an antioxidant activity of 900 mg for Tamesrit and 600 mg expressed by EAA / 100 g Ghars extract. Biochemical composition revealed that Ghars and Tamesrit are also rich in fiber and have water content between 21 and 26 %, values classifying them in the semi-soft to soft category, the amount of reducing sugars is important in both cultivars, the glucose content is higher in the variety Ghars whereas sucrose is absent in Tamesrit. The effect of dates on blood glucose showed that only the variety Tamesrit had a significant decrease on blood glucose ($p < 0.01$). Concerning lipid profile, we noted that Ghars variety induced no significant variation of different lipid parameters while the variety Tamesrit reduced the LDLc level (bad cholesterol), thus improving the lipid profile.

Keywords: quality dates, Tamesrit, Ghars, Blood Glucose, lipid profile.

INTRODUCTION

The dates, fruit of the tree *Phoenix dactylifera L.*, considered as a symbol of the Saharan oasis, accounted since the antiquity as an everyday consumed products. They were an essential component of the diet in the majority of arid and semi-arid regions of the world¹. In Algeria, in southern areas, dates are an important part of the diet. Many studies have shown the nutritional richness of dates in simple carbohydrates, vitamins, minerals, amino acids and dietary fiber²⁻⁵, in addition to their nutritional value, their antioxidant content and their therapeutic effect in the treatment of several affections: anemia, cancer, obesity; continues to be demonstrated⁶⁻¹⁰. But there are only few numbers of studies concerning the link

between the consumption of dates and metabolic responses such as glucose and lipid profile in humans¹¹. In this context, this study consisted in the evaluation of the effect of dates consumption on blood glucose and lipid profile in healthy adults.

MATERIAL AND METHODS

Plant material

The choice of dates focused on varieties Tamesrit and Ghars from Ghardaia (Algeria). Ghars is one of the most marketed and consumed varieties in Algeria, fresh and particularly as date paste, whereas consumption of Tamesrit is very important, especially in the producing regions of southern Algeria.

Study population

The population consisted in fifty-two (52) healthy subjects aged between 15 and 66 years and volunteers (sex ratio = 1). They have agreed to consume dates for twenty-one consecutive days and to have blood sampling, in the same time, monitoring the follow-up of the intake of dates. To minimize the bias during the study, subjects were asked not to change their eating habits and physical activity until the study is completed. We excluded from this study, the pregnant women, persons having no teeth, and anyone who does not finish the daily experienced quantity.

Biochemical analysis dates

For each variety of date, total sugars were determined using Dubois method, and Bertrand method¹² was used to determine reducing sugars. Sucrose content is obtained by the following formula:

$$\text{sucrose} = \% \text{ total sugars} - \% \text{ total reducing sugars.}$$

The free glucose was measured by oxidation of the aldehyde function of glucose to gluconate ion, in a basic medium, in the presence of excess iodate ion; and the free fructose by the DNS method. Proteins by kjeldahl method (**AFNOR V03-607**), insoluble fiber by **Weende method (NF V 03-040)**, soluble fiber according to **Multon**¹³, water content by drying at $103 \pm 2^\circ\text{C}$ of the crushed sample (spread out on the surface of a capsule) to constant mass¹². (Humidity, $H\% = m_1 - m_2 / p \times 100$; dry substance $\% = 100 - H\%$).

The pH was measured using a Karl Kolb pH meter (**NF V 05-108.1970**), the total ash were determined by incineration consisting in stoving the samples at 105°C for 24 hours followed by calcination in a muffle furnace for 5 hours at 500°C ¹⁴.

(Organic matter, $OM = m_1 - m_2 / p \times 100$, Ash $\% = 100 - OM\%$).

Quality assessment of dates

The biochemical quality of dates was evaluated according to the standards set by the Ministry of Agriculture in the ministerial order of November 17th, 1992; for common varieties¹⁵ and quality standards applied internationally reported by Meligi and Sourial¹⁶.

Phytochemical screening

The phytochemical screening and characterization of substances were performed on aqueous extracts and methanol/water extracts (80v/20v)¹⁷.

For the identification of different chemical

groups by color reactions, according to¹⁸; we detected alkaloids by Dragendorff reagent; polyphenols and tannins by the FeCl_3 test; the coumarins by ammoniacal test followed by exposure to UV; the flavonoids by shibata test. The determination of the total polyphenols content was performed by the Folin-Ciocalteu reagent according to Singleton and Rossi method¹⁹ using gallic acid as standard. The resulting color, with maximum of absorption comprised between 725 and 750 nm, is proportional to the quantity of polyphenols present in the plant extracts, the results are expressed as mg GAE / 100 g of dry mass of plant material:

$$C\% = c \times D \times 10 / m \times 100.$$

C: mg Gallic Acid Equivalent for 100 mg of extract; **c:** the read concentration of the sample; **D:** Dilution factor; **m:** mass of the sample.

Evaluation of the antioxidant activity

It is performed using the FRAP method (ferric reducing antioxidant power assay) described by **Oyaizu**²⁰, this method measures the ability of antioxidants presents in the extracts to reduce the Fe^{+++} , of the ferricyanide complex, to Fe^{++} ; this reduction is observed by the formation of a color whose absorbance is determined at 700 nm. The results obtained are expressed in mg of vitamin C per 100 g of the sample.

Experimental protocol

Subjects were divided into two groups, each one receiving the equivalent of 7 dates of one of the two cultivars per person and per day.

Group T: consisted in 26 persons, adult men and women, ingesting Tamesrit variety at a rate of 71 g of pitted dates per day per person.

Group G: consisted in 26 persons, adult men and women, ingesting Ghars variety at a rate of 69 g of pitted dates per day and per person.

This dose is taken on an empty stomach between half past six and half past seven in the morning (depending on the subject); slowly, date after date, without interruption to facilitate digestion. This intake represents a supplementation of normal diet. The participants had to go twice to the study center for regular checkups (one before inclusion and a second at the end of the study) to evaluate certain parameters. This study was performed in agreement with guidelines of the Declaration of Helsinki and Tokyo for humans²¹.

Anthropometric measures

Anthropometric measures were performed in the morning on the whole population (lightly dressed and fasted): weight, measured using a

medically authorized weighing -machine digital scale ($\pm 100\text{g}$), the size, measured using a stadiometer ($\pm 0,5\text{cm}$). BMI (Quetelet index) calculated by the formula:

$$\text{IQ (kg/m}^2\text{)} = \text{weight} / \text{height}^2.$$

Blood sugar measuring

Blood sugar was measured in capillary blood samples with Lifescan One Touch II ® Glucometer, which has been tested for accuracy and precision against a Beckman Synchron CX7 analyzer of a laboratory that uses the glucose oxidase method.

Evaluation of lipid profile

The assays of total cholesterol (TC), HDL-cholesterol, LDL cholesterol and triglycerides (TG) were performed by enzymatic colorimetric methods using kits marketed by Bio Systems, Spain. Reference values adopted are those given by the distributors of these kits.

Statistical Analysis

The mean values of the results obtained from several observations were calculated and shown with standard deviations using Excel software. These data were statistically analyzed using SPSS version 10.1 using the LSD Post-hoc analysis, applicable in data comparisons. The risk probabilities were evaluated at the 0.05 level and the results were considered significant at $p < 0,05$.

RESULTS AND DISCUSSION

Evaluation of the quality of dates

The results of morphological and physicochemical characterization of the dates, Ghars and Tamesrit, are given in Table 1.

According to the quality criteria reported by **Meligi and Sourial**¹⁶ and **Mohammed et al.**²² on the Iraqi and Egyptian cultivars, both varieties have acceptable to good quality criteria, suggesting that these two dates are of good quality and deserve to be exploited. Their culture should be extended to other regions; especially Tamesrit that has better characteristics and whose culture is very limited currently, compared to Ghars²³.

In this study the analysis of results obtained, shows that the two varieties have a fair to good character with a $\text{pH} > 5,8$, moisture content between 10-30%, total sugar levels acceptable, a large size for Tamesrit and average size for Ghars and acceptable weight.

The water content of the date's pulp varies sensibly, that obtained for the variety Ghars 26.35%, is in accordance with that recommended for the marketing of varieties of

common dates which is 26% According to EEC UN DF-08 standards; but it is lower than that reported by **Munier**²⁴ (30%). According to Hussein and Hussein²⁵, the water content of mature dates depend on the frequency and volume of irrigation at BSER stage (maturation stage), the relative humidity at the harvesting and during storage; the water content of Tamesrit variety (21%) is similar to that found by **Acourene et al.**¹⁵ for the same variety.

Phytochemical screening

The results of the phytochemical characterization are presented in Table 2.

These tests revealed in the two varieties of dates the presence of alkaloids, polyphenols, tannins, flavonoids and Coumarins. Tamesrit and Ghars have proved to be rich in phenolic compounds, but the rate of total polyphenols was significantly higher ($p < 0,05$) in Tamesrit variety compared to Ghars (**Fig.1**). **Al-Farsi et al.**²⁶ noted that the difference in the phenolic content of dates is due to several factors, such as: variety, growing conditions, maturity season, geographical origin, soil fertility, storage conditions and time of exposure to the sun. Tamesrit and Ghars have antioxidant activity; a high linear correlation was found between the antioxidant activity and polyphenol content for both varieties ($r = 0,98$). But the variety Tamesrit, has a significantly higher capacity ($p = 0,007$) to reduce the iron compared to Ghars, that is 900 mg EAA / 100 g extract Vs 600 mg EAA/100 g.

This activity has been explained by the presence of p-coumaric acids, flavonoids and phenols in the dates⁷. It is also important to note that some sugars in dates have antioxidant properties^{27,28}.

Biochemical characterization of dates

The results of the biochemical analysis are shown in Table 3.

Tamesrit and Ghars varieties are rich in total sugars; they contain respectively 58,7% and 57,5% (FM) that is, 75.1% Vs 76.1% (DM); these rates are in agreement with literature data²⁴, the main ones are reducing sugars (glucose and fructose) with the glucose content higher in the variety Ghars.

The water content is 26% for Ghars and 21% for Tamesrit; these values allow classifying the two varieties as semi-soft to soft date. The values of ash rate obtained in the two varieties of dates, Tamesrit and Ghars are respectively 2% and 1.7% (DM), they are close to those found by **Acourene et al.**¹⁵, who reported values ranging from 1.8 to 2,9% (DM). **Al-Hooti et al.**²⁹ have also reported rates varying from 1.6 to 2% for the Emirati varieties

Protein content for the two varieties Ghars and Tamesrit are respectively 1.88 and 2.59 %, these results are in accordance with those reported by **Sawaya et al**,³⁰.

The total fiber content varies from 5.55 to 13% respectively for Ghars and Tamesrit; our results are comparable with those found in thirteen varieties of dates whose values range between 6.5 and 11%².

The content of soluble dietary fiber showed that Tamesrit variety is the richest ($p = 0.001$) that is 4% against 2% for Ghars, these values are close to those reported by **Al-Fayadh and showiman**³¹, that is 0.5 to 3, 9%.

Effects of dates on biological parameters

Results of the impact of the consumption of Tamesrit or Ghars dates, by healthy subjects, for three weeks, on some biological parameters (BMI, blood glucose, plasma triglycerides, cholesterol, and LDLChol HDLChol) are presented in Table 4.

They were measured at the beginning and the end of consumption, that is, three weeks later.

The mean BMI of the whole population studied before and after consumption of 71 g/day Tamesrit and 69 g/day Ghars, for three weeks; was not accompanied by any weight change at the end of the study (Table 4).

A significant decrease in blood glucose in the group T was also observed with a difference of 12% ($p=0.01$). Among the studied population, nine subjects whose blood sugar was at the beginning of the study, slightly elevated (≥ 1.15 g/l), was significantly decreased, with an average of 1.16 ± 0.20 before consumption Vs 1.02 ± 0.12 after consumption ($p = 0.004$). No significant change was observed in the group G.

The blood sugar decrease in group T could be related to its high fiber content. It has been shown through *in vitro* studies and in humans that the fibers in the digestive system act as the main factor slowing the absorption of glucose, moderating the rise in blood glucose^{32,33}; they are much more effective at lowering blood glucose when hydrated³⁴. Similarly fructose of Tamesrit could also be the cause of its hypoglycemic effect; in fact, the fructose with a low glycemic index, when at high concentration in food may result in the reduction of postprandial blood glucose³⁵.

Concerning the lipid profile, the two groups did not show significant changes in blood levels of total cholesterol at the beginning and the end of dates consumption; whereas we noticed a

significant decrease in the LDLChol of the group T with a difference of 12% ($p = 0.009$).

This decrease is even more important as the rate of LDLChol was initially high (> 1.5 g/l) with an average value of 1.73 ± 0.25 g/l before consumption of Tamesrit and went to 1.33 ± 0.007 g/l after consumption that is, a decrease of 23% ($p = 0.001$) in nine subjects.

A non-significant decrease was observed in the rate of HDLChol as well as a tendency in the decrease of the ratio LDLChol / HDLChol for both groups. The absence of significant change in triglyceride levels in both groups was observed.

Based on these results, we note that the variety Ghars induces no significant variation in lipid parameters; conversely, the variety Tamesrit reduced the rate of LDLChol (bad cholesterol), thus enhancing the lipid profile. This effect could be related to the intake of soluble fiber, confirmed by several epidemiological studies, showing that the soluble fiber, independently of the fat intake, are dietary component, important in preventing cardiovascular disease^{36,37}.

CONCLUSION

Two varieties of dates Ghars and Tamesrit were studied for their morphological, physicochemical, biochemical and biological characteristics to assess their commercial nutritional and functional qualities. It has been shown that the two varieties have acceptable to good character¹⁶.

They are also a source of carbohydrates, dietary fiber, polyphenols, having antioxidant activity that would protect against free radicals and cancer⁷.

Regarding their effect on lipid profile and blood glucose rate, only the variety Tamesrit contributed to the improvement of circulating lipids and blood glucose.

This positive result on blood glucose should be assessed with consumption of Tamesrit or variety whose chemical composition is similar and see if it can improve the lipid profile or blood glucose levels in patients with type 2 diabetes or with a disorder of lipid profile.

This study has allowed us to correct the misconception of our imagination, we believe that all varieties of dates were as a generic product, whereas, each variety has characteristics which make it suitable for a particular purpose or a particular target.

Table 1: Morphological and physicochemical characteristics of dates (Ghars and Tamesrit)





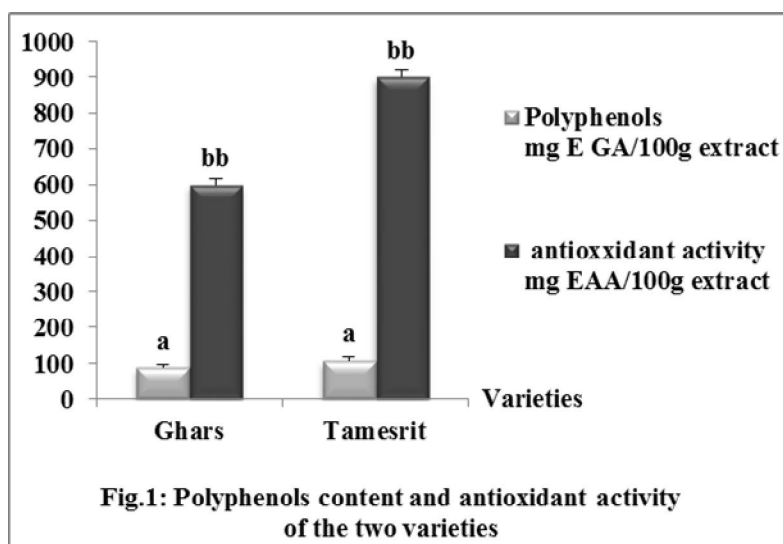
Varieties characteristics	Ghars	Tamesrit	Characters [16]
pH	6,40	6,00	<5.4 : bad characters 5.4 - 5.8 : acceptable >5.8 : good character
Humidity	26,35	21,50	<10 % : bad characters 10 - 24 % : good character 25 - 30 % : Acceptable >30 bad characters
Total sugars	55,00	58,00	60 - 70 % : Acceptable > 70% : good character
Fruit length	4,1	5,2	<3.5 cm : bad characters >3.5 , 4 ≥ cm : Acceptable ≥4 cm : good character
Fruit weight (g) (average of 7 fruit)	7,5g	12,5 g	< 6 g : : bad characters 6 - 8 g : Acceptable 8 g : good character
Fruit diameter	2,5	2,9	<1.5 cm : bad characters 1.5 - 1.8 cm : Acceptable >1.8 cm : : good character
Pictures of fruits			  <p>Ghars Tamesrit Cores</p>

Table 2: Chemical groups present, antioxidant activity of dates

Varieties Chemical groups	Ghars	Tamesrit
alkaloids	++	++
coumarins	++	++
polyphenols	++	+++
tannins	+++	++
flavonoids	+++	+++

Strongly Positive Reaction: +++; moderately positive reaction ++.



Polyphenols: a: Ghars Vs Tamesrit significant difference ($p \leq 0.05$),
Antioxidant activity: bb: Ghars Vs Tamesrit highly significant difference ($p \leq 0.01$).

Table 3: Biochemical composition (%) of the two varieties, Ghars and Tamesrit

Varieties Parameters	Ghars	Tamesrit
glucose	34,60 ± 0,21	30,00 ± 0,9
fructose	20,00 ^a ± 0,34	28,00 ^b ± 0,6
Reducing sugars	55,00	58,6
Sucrose	2,20 ± 0,03	0
insoluble fibers	3,55 ^a ± 0,45	8,80 ^b ± 0,01
soluble fibers	2,00 ± 0,01	4,22 ± 0,01
proteins	2,59 ± 0,05	1,88 ± 0,12
Ashes	1,7 ± 0,001	2,00 ± 0,01
water content	26,35 ± 2,1	21,50 ± 0,98

The means followed by the letters a and b in the same row are significantly different ($p \leq 0.05$).

Table 4: BMI (body mass index), blood glucose and lipid profile before and after consumption of dates

Parameters		Varieties	Ghars	Tamesrit
BMI (kg/m ²) ± SD	Before		25,07 ± 3,31	26,78 ± 3,00
	After		25,01 ± 0,18	26,82 ± 2,8
Gly (g/l) ± SD	Before		0,90 ± 0,13	1,06 ± 0,23
	After		0,92 ± 0,12	0,93 ± 0,30*
TG (g/l) ± SD	Before		1,19 ± 0,27	1,19 ± 0,22
	After		1,21 ± 0,19	1,15 ± 0,31
Chol. T. (g/l) ± SD	Before		1,80 ± 0,11	1,88 ± 0,21
	After		1,90 ± 0,32	1,77 ± 0,20
LDL Chol (g/l) ± SD	Before		1,07 ± 0,16	1,26 ± 0,21
	After		1,11 ± 0,30	1,11 ± 0,19**
HDLChol (g/l) ± SD	Before		0,50 ± 0,08	0,47 ± 0,11
	After		0,47 ± 0,08	0,47 ± 0,08

* indicates a statistically significant change and ** significant.

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