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Effect of Polysaccharides (pectins) on Postprandial Glucose

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Abstract— *The cultivar Ghars is the second cultivar of economic importance for Algeria. It's a soft date. So far, the only product derived from this date is "date's syrup". This product is developed by diffusion. The date is a food rich in nutrients. It is known that the consumption of carbohydrate foods causes different elevations of blood sugar. Some studies classify dates as a high glycemic food. The objective of this study is to follow the evolution of the postprandial glycemia of these foods and to characterize them nutritionally. This analysis is carried out according to the method recommended by FAO. Fourteen healthy, non-diabetic volunteers participated in the test. The results show a peak of control hyperglycemia (glucose) is significant (1.82 g / l ± 0.25) compared to dates (1.30 g / l ± 0.20) and their syrup (1.55 g / l ± 0.1), because glucose is a simple carbohydrate, its absorption is fast. These results are explained by the composition of these foods in polysaccharides (date 4.15% ± 0.02) (syrup 3.86% ± 0.38). Since polysaccharides facilitate intestinal transit, slow gastric emptying and slow the absorption of glucose. These results likely suggest that dates of this cultivar could be non-hyperglycemic food.*

Keywords— ***Algeria, Dates, Hyperglycemia, Polysaccharides, Syrup.***

I. INTRODUCTION

Dates constitute the main food for the Saharian population, rich of nutrients (Al-hooti et al, 2002 ; Sidhu et al., 2003). They are available throughout the year. However, many date cultivars remain poorly exploited or even marginalized. And some are endangered others have disappeared. It is therefore, important to take in consideration this palm date's heritage.

In addition, carbohydrate foods can contribute to rise blood glucose levels in a different way depending on the type of carbohydrate in a food (David, 2011). So, we are talking about the food's glycemic power. Indeed, the speed of digestion of carbohydrates in a food depends on its complexity of nutrient interaction in the food bolus (fiber content, fat content, technological treatments, varietal differences in raw materials, etc.) (David, 2011).

Recently, the concepts of glycemic index (GI) and glycemic load (G l) are two tools allowing a qualitative and quantitative estimation of ingested carbohydrates and their impact on their assimilation in the body. Thus, glycemic index measurement was developed as a method of classifying carbohydrates food according to the rise of blood sugar or postprandial blood glucose (glycemic effect) following food intake. Many studies confirm the virtues of food with low glycemic index, for health in general especially during physical activity but also in the case of pathologies such as diabetes and obesity.

The date is a carbohydrate nutrient. It is classified as a hyperglycemic food (GI 95-107) (cultivar not specified). However, the indigenous consumer shows the opposite, in particular for some cultivars (Mimouni et al, 2014). Soft dates of the cultivar "Ghars" are apt to produce a locally popular co-product known as "date's syrup". This co-product is highly recommended by the population of the Saharian region (Mimouni and Siboukeur, 2011). It is exceptionally used to sweet some dishes including couscous. In this context, we proposed to study the glycemic effect of these dates and their product

in order to manage the consumption of this fruit for the different categories: healthy, diabetic, obese.

II. MATERIALS AND METHODS

2.1. Plant material

Dates: Dates, the study material, are harvested at maturity from the cultivars: "Ghars" planted in the south-eastern Algeria, Ouargla (Figure 1A).

Date's syrup: Ghars cultivar dates were used to make the syrup. Our choice is based on their ability to turn into syrup due to their soft consistency which allows them to give good results (Figure 1B).

2.2. Other Material (glucose)

An amount of glucose about 50 g, equivalent to 166.66 ml of 30% glucose solution was used as a reference food (glycemic index = 100 by reference). This solution was provided by the laboratory of Mohamed Boudiaf hospital in Ouargla

Volunteers: According to Fao (1997) recommendations, a minimum of 6 subjects is required for the determination of the GI of a food taking into account the intra-subject variability. In our case, 12 non-diabetic, healthy and non-obese volunteers (BMI <40 kg / m^2) divided into two groups according to the nature of the food tested took part in the tests.

(A) (B)

Fig.1: Plant material. A: Ghars date's cultivar, B: Date's syrup

2.3. Method of analysis

2.3.1. Sample preparation

First, date defecation is performed. It consists of boiling 100 ml of the sample in a boiling water bath for 30 minutes. After cooling, the volume is adjusted to 100 ml and then filtered. Ten milliliters of 10% lead acetate are added to the filtrate. After stirring the solution, it is filtered. The excess lead is removed by adding about 1 g of sodium carbonate to the filtrate. A second filtration is carried out to verify the definitive absence of lead (absence of precipitate) (Girard, 1962).

2.3.2. Syrup preparation

The extraction technique involves the preparation of the sample and the extraction of soluble solids by a physical process. To have a good quality product, you have to start from a good quality of raw material. This is why we started with the dates sorting**.** The extraction method adopted is inspired by the extraction of sugar from beet and whose principle is based on the passage in solution through a permeable cellulose membrane (according to the laws of diffusion by passive transport) of juice's soluble materials (Alberts et al., 2002). For the present study, sugars are extracted by diffusion using water heated to 30 ° C as a solvent. This temperature has the advantage of limiting the transfer of impurities into the date juice. The diffusion phenomenon is based on the movement of molecules from high concentration (sugars and soluble substances stored in cell tissue) towards the low concentration (water). Then the filtrate is subjected to a concentration at 60 ° C (Figure 2). The purpose of this operation is to avoid syrup's microbial deterioration and thus to obtain a saturated syrup with a degree of Brix 75 ° Bx. This temperature was used to avoid the destabilization of sugars (caramelization, formation of furfural derivatives, etc.) (Mimouni and Siboukeur, 2015 (a); Mimouni et al., 2015 (c)).

2.3.3. Biochemical analysis

Total sugars are determined according to the Dubois method (Dubois et al., 1956). The principle is to measure the neutral carbohydrates with the phenol-sulfuric reagent of 1 ml of sample in the presence of 1 ml of phenol (5%) and 5 ml of concentrated sulfuric acid, then to measure their absorbance at 485 nm. The reduction in the sugar content is determined by the Bertrand method (Audigie et al., 1995). In an alkaline and hot medium, reducing carbohydrates have reducing properties vis-à-vis the copper ion (Cu_2^+). This method is based on the reduction of cupro-alkaline liquor. The sucrose content is

determined by the following formula: Sucrose% = (total sugars% - reducing sugars %) x 0.95. The determination of glucose is carried out by an enzymatic - colorimetric method. Glucose is oxidized by dissolved oxygen to gluconic acid. The reaction is catalyzed by glucose oxidase). The optical density (OD) of the mixture is read after 10 minutes of incubation at 505 nm (Aoac, 2005). The fructose dosage is determined by a chemical method. Ketohexoses are much less resistant to the action of hot hydrochloric acid than aldohexoses. They give rise to hydroxy-methyl-furfural, which reacts with resorcinol to form a colored complex, in red the optical density is read at 420 nm (Aoac, 2005). The polysaccharides (pectins) are determined in the form of calcium pectate, after extraction with hot water, then by saponifying with NaOH, and precipitation with $CaCl_2$ in acetic medium (Aoac, 2005). The pectin content is expressed as a percentage of dry matter.

2.3.4. Postprandial response Monitoring

This step involves volunteers whose thier blood sugar is tested after ingesting the reference food (glucose) for 120 minutes (1st visit) and the test food (dates and syrup) (2nd and 3rd visit) (Figure 2).

Conduct of testing

The tests take place in the same laboratory of the Biological Sciences Department at the University of Ouargla. Before tests, recommendations are made to the volunteers. They should have a light dinner of low GI foods the night before and the timing should ensures that they have fasted for 10 hours before the first tests. Testing begins at around 8 a.m., with a basal blood test using a lancing device. During the first visit, 50 g of glucose are served and consumed by each volunteer. During the second and third visit, a quantity of dates (70g) or syrup (62g) able to provide respectively around 50g of carbohydrates is served and consumed under same conditions. The blood glucose reading is taken every 15 min. then every 30 min. The count begins when the subject is feeding (t0). In that respect, blood samples are taken at t0, at t0 + 15, at t0 + 30, at t0 + 45, at t0 + 60, at t0 + 90 and at t0 + 120 min (David, 2011). The evolution of postprandial glucose is carried out according to the Matlab program (trapezoids), using an application called “IG Dates” (Figure 2) (Fao, 1997).

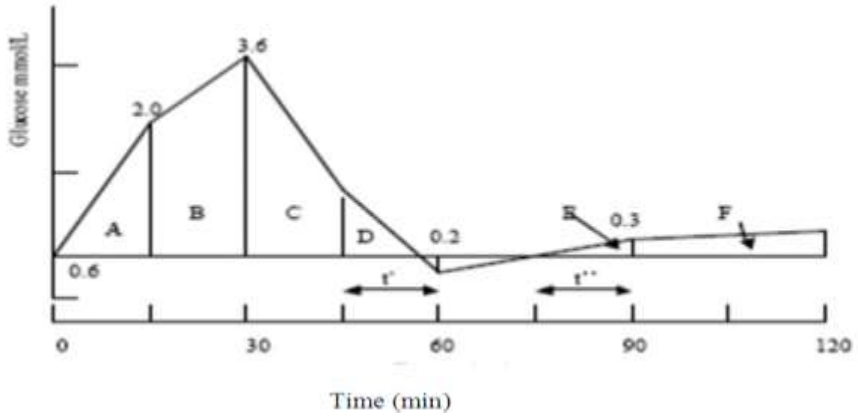

Fig.2: Illustration of the glycemic response evolution (according to Fao / Who, 1997)

III. RESULTS AND DISCUSSION

3.1. Biochemical characterization of dates and their syrup

The biochemical composition of dates and their syrup is illustrated in Table 1. These results show that the dates of cultivar Ghars contain a significant amount of total sugars (72% ± 0.02), a content of reducing sugars (70.98 % ± 0.02), sucrose (1.02% ± 0.2), glucose (32% ± 0.01), fructose (38.98% ± 0.04) and pectins (4.15% ± 0, 02). Many authors, having worked on several date cultivars, affirm that date sugars will vary according to cultivar, pollen, maturity and climate (Munier, 1973; Ahmed and Ramaswamy, 2006; Elleuch et al, 2008; Kulkarni et al, 2008; Biglari et al, 2009; Iqbal et al, 2011). The sugars nature will also vary depending on the consistency of the date (Mimouni and Siboukeur, 2011; Mimouni et al, 2014). Soft cultivars are very rich in reducing sugars, unlike sucrose (Elleuch et al, 2008; Siboukeur, 1997). Several authors report that dates contain significant amounts of total sugars. Namely: (Aleid, 2006) (81%); (Mimouni, 2009) (67.33 - 71.79%); (Al-gboori and Krepl, 2010) (86.10 - 87.91%). The values recorded in this study are within the range cited by these authors; results reported in a lot of works depend in part on the analytical method used. Glucose and fructose result from the reversal of sucrose by invertase during date’s maturity. In comparison with the total sugar content, it is

observed that reducing sugars predominate in the cultivar studied. Dosing sugar of the cultivar Ghars at the same tmar stage by an auto-analyzer (SKALAR) show that the content of reducing sugars is equal to 62.41% (Siboukeur, 1997). Values recorded by Al-gboori and Krepl. (2010) are 73.40 - 82.70%, which indicate that their study material is composed of soft cultivars. Soft dates contain a low level of sucrose. This may be due to the high water content that provides a favorable environment for invertase activity. In addition, the polysaccharide content recorded in this study is within the range reported by the authors (5 to 8%) (Gamal et al, 2009).

Regarding, the date syrup developed by the adopted method has a clear appearance (Figure 1), which allowed us to avoid resorting to clarification processes. The date-derived product is characterized by a predominance of carbohydrates (Bahramian et al, 2011; Ganbi, 2012; Queshi et al, 2012; Siboukeur et al, 2013). Date syrup contains total sugars (83.5% ± 0.28), reducing sugars (78.12% ± 0.12), sucrose (0.5% ± 0.02), glucose (27%) ± 3.23) and fructose (35% ± 0.001). Many authors claim that date extracts have appreciable contents of three major sugars, namely glucose, fructose and sucrose (Bahramian et al, 2011; Ganbi, 2012; Siboukeur et al, 2013). The total sugar content is comparable to that reported by some authors in Saudi Arabia (Gamal et al, 2009) (74%) and (Ammar, 2012) (73%). The content of reducing sugar is very high compared to the sucrose one. These results are similar to those found by some authors for syrup from the soft date cultivar (Khalas) (Aleid, 2006). The author reports that reducing sugars predominate (81% against 1% for sucrose). The pectin contents seem high, they are from 1.46% to 1.8% (Aleid, 2006; Alanazi, 2010). Values recorded in the present study could be explained by the fact that the extraction methods caried out without recourse to pectinases (Gamal et al, 2009).

Table 1: Biochemical composition of dates and its syrup Content

Characteristics	Average (n = 12)
Fasting glycemia (g / l) (before t_0)	0.95±0.05
Age (years)	22.14 ± 0.134
Weight (Kg)	55.9 ±5.49
Size (m)	1.63±0/034
BMI (Kg / m^2)	21.21±0.08

3.2. Postprandial glycemia

The postprandial evolution response is based on hyperglycemia caused by the reference food (glucose) and the food to be tested (dates or syrup) and glycemia monitoring for 120 min. as recommended by Fao / Who. The subjects selected for these tests must be in good health and not diabetic. They were selected on the basis of fasting glycemia and certain biological indices. From Table 2, the fasting glucose level is 0.97 (g / l) ± 0.05. The average age of this human cohort is equal to 22.14 years ± 0.13, the average weight is equal to 55.9 kg ± 5.49, the height is equal to 1.63 m ± 0.034 and the index body mass (BMI) is approximately 21.21 kg / m^2 ± 0.08. The results show that all the volunteers are in good health, non-diabetic and non-obese. The normal value of blood sugar varies between 0.70 g / l and 1.10 g / l. Diabetes occurs when blood sugar is above 1.26 g / l on an empty stomach. You are also diabetic if, at any time of the day, your blood sugar is greater than or equal to 2 g / l at least twice (Snow and O'dea, 1981; Grimaldi and Heurtier, 1999).

Table 2: Biological Indices of Volunteers

Analysis (%)	**Ghars Cultivar**	**Date Syrup**
Total sugar	72± 0.02	83,5±0.28
Reducing sugars	70.98± 0.02	78,12 ±0.12
Sucrose	1.02±0.2	0,5± 0.02
Glucose	32 ±0.01	40.86 ± 3.23
Fructose	38.98±0.04	39.10 ± 0.001
Pectins	4.15±0.02	3.38±0.38

BMI: Body Mass Index

Carbohydrate foods are responsible of glycemia rising and insulin secretion. Results of blood glucose evolution are illustrated in Fig. 2. The curves are plotted using a computer tool "IG DATE". Values used to draw the curves represent average results obtained with the 12 volunteers. The variation caused by the ingestion of glucose shows a significant difference compared to the foods tested (F = 3.69, p = 0.015), this could be justified by the difference in biochemical composition of both foods tested (glucose and dates / syrup).

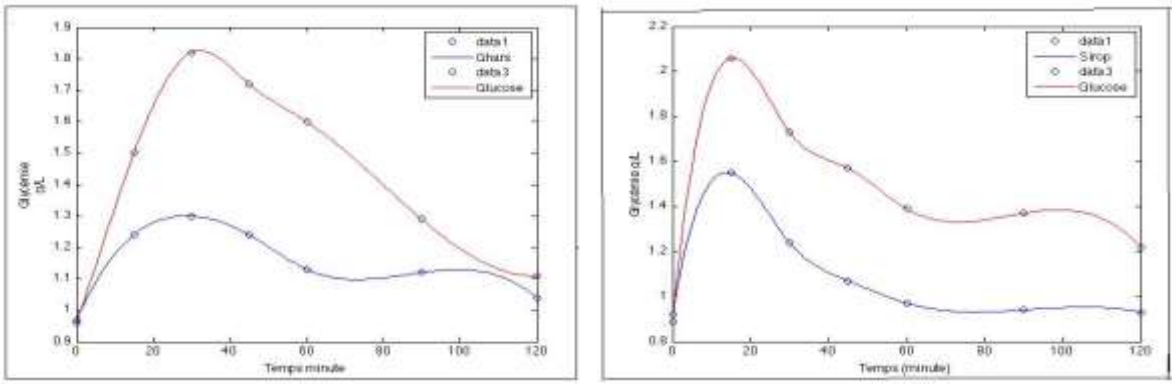

Fig. 2 Evolution of glycemia (g / l) after ingestion of the reference food (glucose) and the test food (A, Dates / B, Syrup)

3.3. Spike of hyperglycemia and postprandial

Figure 2 shows glycemia average values obtained after ingestion of each food tested, for the reference food (glucose) and the test food (dates). The hyperglycemic spike is at t_0 + 30 min. These results are comparable to those mentioned by (Hlebowicz et al, 2009), these show that the average hyperglycemia peak for ten healthy subjects after eating a meal containing whole rye bread and white bread was at after 30 min, and the research of Gunnerud et al. (2012) have shown peaks in hyperglycemia for foods prepared from (humans and cattles) milk at 30 min.

The hyper-glycemic peak with date syrup, is the same like the control food (glucose) is reached at T_0 + 15 min. Usually, this peak coincides with insulin secretion (Fao, 1997; David, 2011; Alkaabi, 2011). Not all foods containing carbohydrates induce the same glycemic and insulin response in the body. A food with an early peak hyperglycemia is a major problem for diabetics because insulin secretion occurs after the peak of hyperglycemia and will not allow coincidence between the postprandial response and insulin secretion (Garcin, 2001**).** For the tests carried out, the peaks are obtained relatively later at T0 + 30 (glycemia equal to 1.82 g / l ± 0.25 and 1.30 g / l ± 0.20) for glucose and dates, respectively. Interesting results, the insulin secretion coincides with the postprandial response. This positive aspect in the case of dates is due to the beneficial action of the polysaccharides (fibers) contained in dates. However, the value recorded in the case of syrup is quite interesting because it is lower than that of glucose (1.55 g/l against 2.3 g /l). The peak hyperglycemia reached with pure glucose at t_0 + 30 min. and at t_0 + 15 min is important. Pure glucose is a simple sugar; its absorption is easy, accompanied by an intense and short hyperglycemic peak. On the other hand, the hyperglycemic peaks of dates are less important. In general, this peak is much lower than that of the reference food. The results recorded in this study are consistent with those found by Gunnerud et al. (2011). These authors report that maximum hyperglycemia values for five varieties of dates are between 1.35 and 1.39 g / l. These results could also be explained by the date's composition of polysaccharides (4.15%). Indeed, the presence of fibers, lipids and proteins limits the peak of postprandial hyperglycemia, which is mentioned in many researches (Normand et al, 2001; Mimouni, et al, 2015 (b)).

Mimouni et al. (2015)(b) agree on the effect of dietary fiber intake on reducing the risk of developing diabetes According to their study, no increase in the level of glycemia, after the ingestion of a meal based on whole rye grains (rich in fiber) compared to white bread which reveals a peak reached at 40 minutes after the ingestion with a value of 0.48 g / l. Postprandial reduction in glycemia is achieved after the incorporation of viscous polysaccharides in cereal and protein foods (Hlebowicz et al, 2009; Mimouni, et al, 2015(a)).

The low peak of hyperglycemia recorded with date syrup may be due to the presence of soluble fiber and mineral elements, as well as the hypoglycemic effect of fructose (GI = 20) (39.10% ± 0.001). Our results are consistent with those mentioned by David (2011). The author shows that the consumption of fruit fructose (FructiLight) leads to a very weak postprandial glycemic response, an hyperglycemic peak about 0.12 g / l against glucose (3.07 g / l).

For a diabetic, the difference observed between postprandial glucose and fasting glucose called "postprandial delta" is a good marker of blood sugar. A normal postprandial delta should not exceed "0.5". In the case of this work, the postprandial delta calculated for Ghars dates and syrup is 0.07 and 0.10, respectively.

Postprandial glycemia (glycemia at T_0 + 120 min) is equal to 0.9 g/l. This value is low compared to that recorded with glucose (1.11 g / l), date (1.34 g / l) and syrup (1.37 g / l). This shows that the volunteers are

healthy. Noting that desired postprandial glucose should not exceed the value of 1.4 g / l (Hlebowicz et al, 2009; Rosen et al, 2009).

Nutrition researchers, including David, (2011) have shown that consumption of different carbohydrate foods leads to different elevations in blood sugar for an equivalent carbohydrate intake. Thus, the speed of digestion of carbohydrates in a food depends on its complexity (fiber and fat content, technological treatments, varietal differences in raw materials, etc.). In this search, the syrup shows a slight increase compared to the dates. This could be explained by the physical state of the syrup (liquid), but dates are eaten in a solid state. According to the same authors , the heat treatment and the physical state of a food have a direct influence on the speed of the digestion's and absorption's physiological process , and therefore on the glycemic index. Thus, a food in liquid form, more quickly digested and absorbed, has a higher glycemic index than the same solid food (grapes: GI = 45 and grape juice: GI = 55) (David, 2011).

IV. CONCLUSION

According to this study, the Ghars date cultivar studied allows to obtain an easily product that could be produced by the adopted method in this study at the household level. Its composition is interesting both nutritionally and dietetically. It is rich in soluble nutrients. It could also be provided to children, athletes, pregnant women, nursing mothers and convalescents. Dates and their syrup have lower glucose evolution kinetics. This justifies the effect of polysaccharides which slow down the absorption of glucose. These results obtained are likely to suggest that this cultivar of soft dates does not cause a significant increase in postprandial blood sugar. Therefore, it is required in nutrition, especially for diabetics and obeses, but with controlling the quantity ingested.

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