

Effects of Dates Pulp Extract and Palm Sap (*Phoenix dactylifera* L.) on Gastrointestinal Transit Activity in Healthy Rats

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ABSTRACT The current study was performed to measure the chemical composition and the effects of dates pulp extract and palm sap on gastrointestinal transit (GIT) activity in healthy adult rats. In this respect, male Wistar rats fasted for 24 hours were used and received per orally (p.o.) sodium chloride (NaCl) (0.9%) (control group) or various doses of dates pulp extract (150 and 300 mg/kg, body weight [b.w.]) and palm sap (0.4 and 4 mL/kg, b.w.). Two other groups of rats (batch tests) received, respectively, clonidine (an alpha-2 adrenergic agonist, 1 mg/kg, b.w.) and yohimbine (an alpha-2 adrenergic antagonist, 2 mg/kg, b.w.). Chemical analysis showed that the dates pulp extract is more rich in sugars and minerals, especially potassium and sucrose, as compared with palm sap composition. On the other hand, *in vivo* study showed that the aqueous dates pulp extract significantly, and dose dependently, increased the GIT activity while the palm sap slightly increased it. Moreover, a converse effect has been observed using clonidine (decreased 68%) and yohimbine (increased 33%) on the GIT activity. These findings suggest that dates pulp extract and palm sap have a stimulating effect on GIT activity in rats and confirm their use in traditional Tunisian medicine for the treatment of constipation.

KEY WORDS: • dates pulp • GIT activity • minerals • palm sap • rat • sugars

INTRODUCTION

CONSTIPATION IS A MULTIFACTORIAL GASTROINTESTINAL disorder that affects adults^{1,2} and is a risk factor for colorectal cancer.³ This disease was characterized by a disruption of intestinal secretions leading to unexplained abdominal pain, discomfort, and bloating in association with altered bowel habits.⁴ Treatment varies according to the causes of disease. However, commercial drugs, such as senna and Gaviscon are frequently employed. The majority of these drugs induce severe diarrhea as a side effect and can also lead to colorectal cancer.⁵ For this reason, medicinal plants have been widely used for the treatment of such diseases.

The fruit of the palm tree (*Phoenix dactylifera* L.) is an important component of the diet in the Middle East and North Africa, including Tunisia.⁶ Dates fruit are a good source of sugars, fibers, and minerals,⁷ exhibiting many beneficial

health effects such as being antioxidant,⁸ antimutagenic,⁹ antibacterial,¹⁰ antitumoral,¹¹ and antifungal.¹² Recently, Zangiabadi *et al.*¹³ demonstrated that dates fruit extract treatment was effective in preventing diabetic deterioration and in improving pathological parameters of diabetic neuropathy. In addition, a gastroprotective properties of date fruit was shown by reducing ethanol-induced gastric ulcer in rats.¹⁴

Hence, the present study aimed to investigate the putative effect of the dates pulp extract and palm sap on GIT activity in healthy rats to confirm their traditional role in the treatment of constipation in Tunisia.

MATERIALS AND METHODS

Chemicals

Clonidine, yohimbine hydrochloride, gum Arabic, and charcoal meal were from Sigma Chemicals Co. (Germany). All other chemicals used were of analytical grade.

Preparation of dates extract

Palm fruit (Deglet-Nour variety) was harvested from the region of Gabes (South East Tunisia). The dates meats

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are manually separated and rapidly ground using liquid nitrogen. The aqueous extract is prepared with bidistilled water (3:1 v/w), incubated at 4°C for 48 hours with continuous stirring and stored at -80°C until use.

Minerals determination

The plant material was gathered and dried in an oven set at 80°C. One gram of sample (dates pulp) was placed in a stainless steel capsule and then calcined in a muffle furnace (Vecstar Furnaces, Chesterfield, UK) at 550°C for 4 hours. After cooling, the ash was combined with 5 mL of deionized water and 1 mL of hydrochloric acid and subjected to the boil. The content of the capsule is then filtered into a volumetric flask of 100 mL and adjusted with deionized water. The potassium, magnesium, sodium, iron, and zinc concentrations in the samples were assessed with an atomic absorption spectrophotometer (AVANTA GBC Scientific Equipment Pty., Ltd, Australia).

Analysis of sugars

Sugars were extracted from 3 g of dates pulp in 100 mL of ethanol 80%. The homogenate was heated on an electric heating mantle for 1 hour. This procedure was repeated two times. Thereafter, the obtained extract was evaporated using a rotary evaporator *in vacuo* and adjusted to 50 mL with ultrapure water. After centrifugation at 6000 g during 20 minutes, samples were analyzed by high-performance liquid chromatography (HPLC).

Assessment of dry matter and dietary fibers

Chemical analysis of dry matter (DM) and dietary fibers (DF) was conducted according to AOAC methods.¹⁵

Animals and treatment

Healthy adult male Wistar rats (200–220 g body weight, 15 weeks old) were purchased from the Pasteur Institute of Tunis and used in conformity with the local ethics committee of Tunis University for the use and upkeep of animals in accordance with the NIH recommendations. They were provided with food (standard pellet diet) and water *ad libitum* and maintained in animal house at controlled temperature (22 ± 2°C) with a 12-hour light-dark cycle.

Animals were divided into seven groups of 10 animals each: Group 1 served as a control and received 1 mL of physiological solution (NaCl, 0.9%, p.o.); Group 2 received yohimbine (1 mg/kg, b.w., intraperitoneal [i.p.]); Group 3 received clonidine (2 mg/kg, b.w., i.p.); Groups 4 and 5 were pre-treated with aqueous dates pulp extract (150 and 300 mg/kg, b.w., p.o.); Groups 6 and 7 were pre-treated with palm sap (0.4 and 4 mL/kg, b.w., p.o.).

Gastrointestinal propulsion

GIT activity was measured using the charcoal meal test as described by Ali and Bashir.¹⁶ Briefly, two hours after

the treatment, different groups of rats received the standard charcoal meal (10% charcoal in 5% gum Arabic). Animals were anesthetized 30 minutes later with urethane (1.25 g/kg, i.p.), laparotomy was performed, and the small intestine was rapidly dissected out and put on a clean surface. The small intestine was carefully inspected and the distance traveled by the charcoal meal from the pylorus was measured.

The gastrointestinal transit was calculated according to the following rules:

$$GIT = \frac{\text{Distance moved by charcoal (cm)}}{\text{total intestinal length (cm)}} \times 100$$

Data were analyzed by unpaired Student's *t*-test or one-way analysis of variance (ANOVA) and are expressed as means ± standard error of the mean (SEM). Data are representative of ten independent experiments. All statistical tests were two-tailed and a *P* value of .05 or less was considered significant.

RESULTS

Minerals in palm fruit and sap

Table 1 shows that potassium is the most abundant element in dates pulp extract and the magnesium comes in second place, respectively, 686.4 and 86.8 mg/100 g of DM. In contrast to sodium, magnesium and iron present a low amount. We also showed that palm sap contains a large amount of potassium but it has a very low content of other minerals.

Sugars and fibers in palm fruit and sap

Sugars analysis by HPLC (Table 2) showed that the dates pulp extract is richer in total sugars, reduced sugar, and sucrose, respectively, 65.78, 39.13, and 26.65 mg/100 g of DM compared with palm sap that gives a modest amount of sugars, respectively, 24.79, 9.25, and 15.57 mg/100 g of DM. The examination of dietary fibers also demonstrated that dates extract is much richer than palm sap (respectively, 7.20% vs 4.38%).

Gastrointestinal propulsion

We further looked at the effects of palm sap and fruit as well as pharmacological agents on GIT activity (Table 3).

TABLE 1. CONTENT OF MINERALS IN DATES PULP EXTRACT PALM SAP

	Dates pulp extract	Palm sap
Minerals (mg/100 g)		
Sodium	3.85 ± 0.34	2.85 ± 0.04*
Potassium	686.4 ± 19.39	65.28 ± 4.06*
Magnesium	86.8 ± 8.04	0.54 ± 0.01*
Zinc	0.69 ± 0.02	0.37 ± 0.03*
Iron	1.28 ± 0.04	0.27 ± 0.01*

The data are expressed as means ± standard error of the mean (SEM) (*n* = 10).

**P* < .05 compared to dates pulp extract.

TABLE 2. CONTENTS OF REDUCED SUGARS, SUCROSE, TOTAL SUGARS, AND DIETARY FIBERS IN DATES PULP EXTRACT AND PALM SAP

	Dates pulp extract	Palm sap
Sugar analysis (mg/100 g)		
Total sugars	65.78 ± 1.16	24.79 ± 2.43*
Reduced sugars	39.13 ± 1.47	9.25 ± 2.04*
Sucrose	26.65 ± 1.75	15.57 ± 1.65*
Dietary fibers (%)	7.20 ± 0.68	4.38 ± 0.81*

The data are expressed as means ± standard error of the mean (SEM) ($n=10$).

* $P < .05$ compared to dates pulp extract.

In a control group treated with saline solution (0.9%), the charcoal meal travelled 66% of the total length of the small intestine. In rats treated with increasing doses (150 and 300 mg/kg, b.w.) of aqueous dates pulp extract, intestinal transit was significantly, and dose-dependently, increased compared with control group. However, intestinal transit was slightly increased in a dose-dependent manner in rats treated with increasing concentrations of palm sap (0.4 and 4 mL/kg, b.w.). Both pharmacological agents used for testing our methodology showed that yohimbine (an $\alpha 2$ adrenergic antagonist) and clonidine (an $\alpha 2$ adrenergic agonist) respectively increased (33%) and decreased (68%) the intestinal transit.

DISCUSSION

In the present study, we have evaluated the chemical composition of the dates pulp extract and palm sap in sugars and minerals as well as their effects on GIT activity in healthy adult rats.

According to our data, dates pulp (Deglet-Nour variety) are richer in minerals especially potassium and magnesium compared with palm sap. These results are in line with a previous report which showed that the potassium content of

TABLE 3. EFFECT OF DATES PULP EXTRACT AND PALM SAP ON GASTROINTESTINAL TRANSIT IN RATS

	GIT (%)	% of increase or decrease
Control (NaCl 0.9%)	68.46 ± 1.88	
Yohimbine (2mg/kg)	91.22 ± 3.2*	33.24
Clonidine (1mg/kg)	21.62 ± 2.13*	68.41
Dates pulp extract 1 (150 mg/kg)	74.02 ± 1.02*	8.12
Dates pulp extract 2 (300 mg/kg)	81.02 ± 2.33*	18.34
Palm sap 1 (0.4 ml/kg)	71.39 ± 1.47*	4.27
Palm sap 2 (4 ml/kg)	74.01 ± 0.92*	8.10

Animals ($n=10$) were pre-treated with aqueous date extract, palm sap, reference molecules (yohimbine and clonidine), or vehicle (NaCl 0.9%). Two hours after, rats received the standard charcoal meal (10% charcoal in 5% gum Arabic).

* $P < .05$ compared to control group.

GIT, gastrointestinal transit; NaCl, sodium chloride.

other Tunisian varieties (Kenta and Allig) are ranging from 500 to 900 mg/100 g of DM.¹⁷ The same quantity of potassium was obtained by Ahmed *et al.*¹⁸ in Iraq dates varieties. Our data confirmed the previous work of Al-Farsi *et al.*¹⁹ who, by analyzing the composition of three varieties of Oman dates, suggest the importance of potassium, magnesium, iron, and selenium in their antioxidant properties. The sodium content of palm fruit and sap was very low. These outcomes are comparable to those obtained by Ben-Salah²⁰ and Bouabidi *et al.*²¹ However, this wealth of minerals in the dates pulp shows that this health food probably participates into the nutritional balance in the human organism, particularly in the ionic balance.

The comparison of the total sugar composition of dates and palm sap showed a higher content in the pulp fruit. These findings are in line with previous studies who report that soft dates are rich in reducing sugars and low in sucrose.²² Similar levels of total sugars were obtained by Al-Farsi *et al.*¹⁹ by analyzing the composition of three varieties of Omani dates. Our results are also comparable with those of Ben-Cheikh²³ by studying the same variety as ours. In addition, a great similarity in the rate of reduced sugars is reported in Iraqi and Saudi varieties.^{24,25}

Importantly, we showed in this work that aqueous dates pulp extract is more efficient than palm sap to GIT activity in healthy rats. GIT activity has been shown to be increased by many plant extracts as *Musa sapientum* leaves,²⁶ *Poncirus trifoliata*,²⁷ *Mareya micrantha*,²⁸ and *Urginea indica*²⁹ or isolated molecules as jatrorrhizine³⁰ and melatonin.³¹ According to the literature, our results are in agreement with those of Al-Qarawi *et al.*³² who demonstrated that, depending on the method of extraction, the Saudi dates extracts may exert an increase or a decrease of GIT activity in mice. The same authors also showed that dates extracts have an ameliorating effect on ethanol-induced gastric ulcer and hepatotoxicity in rats.³³ However, to our knowledge, our study is the first one to deal with Tunisian dates extract and palm sap on GIT activity in a rat model. Tunisian dates were recently demonstrated to have antioxidant capacity⁸ as well as a protective effect on dimethoate-induced oxidative stress in rat liver.³⁴

Concerning the mechanism of action of the dates pulp extract, we showed in this work its richness in minerals and sugars, especially potassium and reduced sugars. However, the mineral content in the digestive system can affect the processes of secretion and gastrointestinal absorption of water and electrolytes. Furthermore, both mineral deficiency and mineral excess can lead to digestive disorders associated with alterations in transport gastrointestinal water and ions.³⁵ Consequently, dates pulp extracts could be used to correct the minerals content deregulation during constipation disorders. In addition, our results showed that dates pulp is rich in sucrose, a sugar known for its positive effect on intestinal transit.¹⁴ The implication of sugars in accelerating gastrointestinal motility is well known.³⁶ On the other hand, dates pulp was recently shown for its richness in phenolic compounds.³⁷ Indeed, these molecules are the major source of antioxidant ability of palm fruit, by scavenging free

radicals as hydroxyl radical (OH) which leads to digestive system disorders.³⁸

More importantly, we also demonstrated in the present investigation that the dates pulp extract is richer in dietary fibers than palm sap. The data from the literature have demonstrated the importance of dietary fibers (6.4–11.5%) in dates especially insoluble fibers (84–94% of total fibers).³⁹ These fibers are capable of accelerating GIT activity and reducing the risk of constipation. Dates fibers have also a preventive effect against some diseases, particularly the digestive system cancers.^{40,41}

CONCLUSION

In conclusion, our findings clearly demonstrate that dates pulp extract and palm sap have a stimulating effect on GIT activity in healthy rats. More importantly, our results contribute toward the validation of the traditional use of dates pulp and palm sap for the treatment of digestive system disorders as constipation.

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AUTHOR DISCLOSURE STATEMENT

The authors alone are responsible for the content of this paper and they declare no competing financial interests.

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