Arab Gulf J. Scient. Res., **8** (1), pp. 15-24 (1990)

Chemical Composition of Some Date Palm Seeds (*Phoenix dactylifera* L.) in Saudi Arabia

Salim S. Al-Showiman

Department of Chemistry, College of Science,
King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia

ABSTRACT. Seeds of five date palm cultivars (*Phoenix dactylifera* L.) namely Barhey, Maktomey, Sekkeri, Fankha and Kasba, were chemically analyzed for their content of some organic and inorganic compounds. Qualitative phytochemical screening showed important contents. Fatty acids, sugars, minerals and other significant organic compounds were observed.

The date plams (*Phoenix dactylifera* L.) are widely distributed in Saudi Arabia and their benefits are well known as a staple food for thousands of years. The Kingdom of Saudi Arabia is considered to be one of the major date producing countries in the world. The number of these trees is estimated to be over 11 million of which 9 million are fruiting trees classified under over 400 different cultivars (1st. Symposium on the date palm 1982).

Most of the previously published work has been devoted to the nutritional value of the fruits. However, few reports have been concerned with other parts of the tree. Date palm seeds are potentially a good source of energy for animals. The analytical characteristics of date palm seeds have been subjected to few previous reports covering only a few cultivars in a certain area of the Kingdom of Saudi Arabia (Mossa *et al.* 1986, Al-Whaibi *et al.* 1985 and Al-Whaibi and Basalah 1986).

The objective of this work was to determine the chemical composition of different date palm seeds. The aim was to isolate, identify and determine the structure of the components using different modern techniques.

Results and Discussion

Lipids are important constituents of all plant and animal tissues. It has been known since 1929 that linoleic acid is a dietary requirement for the healthy growth

of animals and such acids have been designated as essential fatty acids (Gunston 1979). Fats and oils, the most abundant lipids, are the major constituents of storage fat cells in animals and plants. Therefore, this study focussed on the isolation and identification of fatty acids in date palm seeds from five cultivars.

The five cultivars investigated in this study were Barhey, Maktomy, Sekkeri, Kasba and Fankha. The first three cultivars were obtained from Al-Qaseem (Central region of Saudi Arabia) while the other two were obtained from Hail province (Northern region of Saudi Arabia). The percentage of seed in the fresh fruits (Table 1) ranged between 5.65 to 14.20% for the different cultivars.

Successive solvent extraction (Table 1) of dried seeds resulted in 5.22 to 7.91% petroleum ether extract, this represented the fixed oil content. Subsequently ether and chloroform seed extracts were small while ethanol extracts were large and ranged between 6.63 to 11.36% (Table 1). GLC analysis showed expected qualitative similarity between the petroleum ether, diethyl ether and chloroform extracts.

The fatty acid analysis was performed by GLC on the saponifiable petroleum ether extract after conversion to the volatile methyl esters according to an international standard method (ISO 1978). Table 2 shows the fatty acids separated by GLC for the five cultivars. The fatty acid names reported here are the common names. We were able to recognize ten saturated, four unsaturated and six unknown fatty acids (Table 2 and Fig. 1). It is clear that the major fatty acid found in those cultivars is oleic acid ranging from 42.57 to 59.94%. Fair amounts of lauric acid, myristic acid and palmitic acid ranging between 15.39 to 23.84, 7.42 to 11.76 and 6.69 to 10.15% were also observed (Table 2). Small amounts of other fatty acids were also found.

The alcohol extract was rich in carbohydrates, protein, alkaloids and possibly other more polar constituents. The extracts acquired a red color on standing for a few weeks possibly due to the presence of some compounds that undergo

Table 1. Seeds percentage based on wet weight of the fruit and the weight of the dried seeds and of four organic solvent extracts

No.	Cultivar	Seed %	Pet. ether	Diethyl ether	$CHCl_3$	EtOH	Fiber dry wt. %
1.	Barhey	9.15	6.11	0.64	0.44	7.14	20.50
2.	Maktomey	10.35	7.80	0.46	0.48	10.30	21.65
3.	Sekkeri	14.20	7.91	0.64	0.33	11.36	22.37
4.	Fankha	5.62	5.70	0.83	0.41	7.15	18.28
5.	Kasba	7.65	5.22	0.94	0.38	6.63	17.43

oxidative changes on exposure to light by time. Analysis of the alcohol extract showed that the sugar content was high in this extract. The GLC analysis of the silylated material (compared with silylated authentic sample of different sugars) of the different cultivars revealed the presence of mannose, glucose, fructose, sucrose, and maltose (Table 3 and Fig. 2). It is clear from the results (Table 3) that the most available sugar is sucrose in the range 29.50 to 51.40%. Mannose and glucose were significant in amount while maltose was present in less amounts.

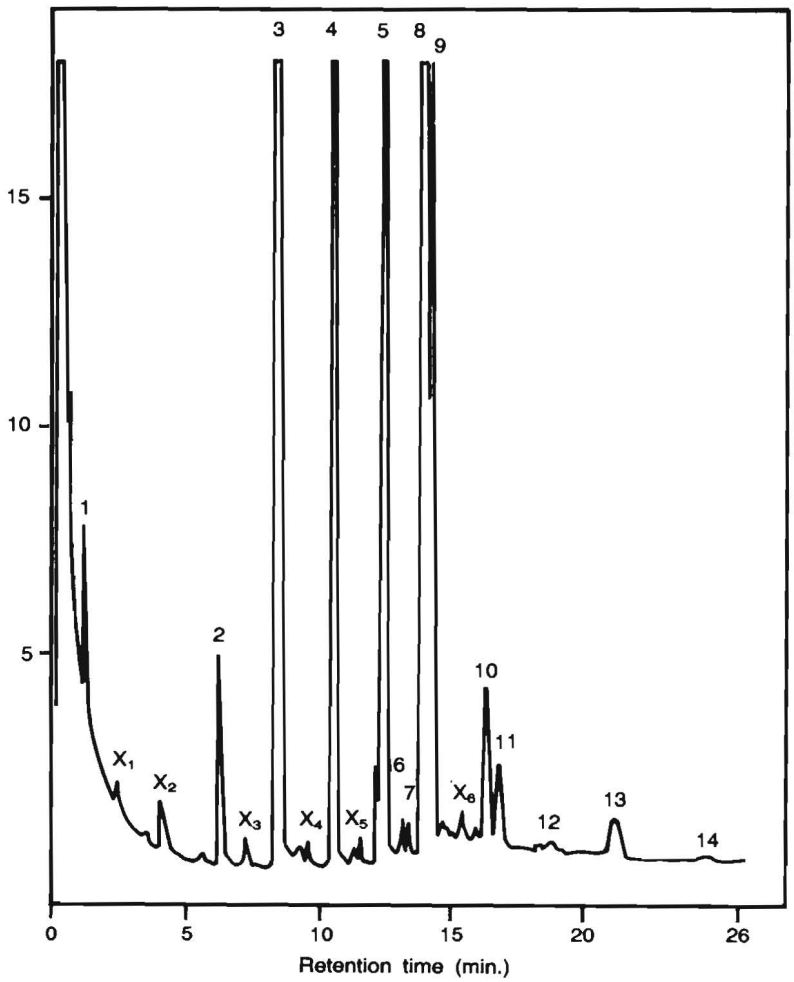

Fig. 1.GLC of methyl esters of the following fatty acids of Date Seeds (Maktomey cultivar)

1. Stearic
2. Capric
3. Lauric
4. Myristic
5. Palmitic
6. Palmitoleic
7. Margaric
8. Oleic A.
9. Linoleic
10. Arachidic
11. Linolenic
12. Heneicosanoic
13. Behenic
14. Tricosanoic

$X_1 - X_6$ (unknown)

Water content of the seeds of the different cultivars was found to be in the range 5.15 to 10.11% (Table 4). The water content of Sekkeri cultivar is highly significant when compared with the other cultivars. These results suggest that the ionic content of the seeds should be reported on a specified dry weight so that comparison of chemical composition of the seeds is justified.

The ionic content of the different cultivars was analyzed by atomic absorption (Table 4). The results indicate the presence of many cations such as Al^{+++}; Ca^{++}; Cd^{++}; Cu^{++}; Fe^{+++}; K^{+}; Mg^{++}; Na^{+} and Zn^{++}. The calcium content is highly significant ranging from 270.08 to 489.19 μg/g of the dry seeds under investigations, K^{+}; Na^{+} and Mg^{++} come in the second place where the other cations are in small or trace amounts (Mossa *et al.* 1986 and Al-Whaibi *et al.* 1985).

Phytochemical and chromatographic screening showed qualitative indications of other organic compound such as protein, alkaloids, steroidal compounds,

Table 2. Fatty acids from seeds of five date palm cultivars (as % of total fatty acids after hydrolysis). Numbers in parantheses correspond to numbering of the peaks of figures

Fatty Acids* \ Cultivars	Barhey	Maktomey	Sekkeri	Fankha	Kasba
Saturated					
Stearic (1)	0.32	0.15	0.27	0.25	1.35
Capric (2)	0.50	0.38	0.53	0.38	0.32
Lauric (3)	24.67	20.60	23.84	20.60	15.39
Myristic (4)	11.76	10.04	11.43	11.41	7.42
Palmitic (5)	8.64	7.89	9.61	10.15	6.69
Margaric (7)	0.06	0.05	0.46	0.38	–
Arachidic (10)	0.48	0.49	1.29	0.67	0.45
Heneicosanoic (12)	0.06	0.05	0.52	0.60	0.06
Behenic (13)	0.53	0.23	0.84	2.16	0.35
Tricosanoic (14)	0.05	0.04	–	0.12	–
Unsaturated					
Palmitoleic (6)	0.04	0.06	0.50	–	0.06
Oleic A. (8)	48.47	56.94	42.57	50.2	55.91
Linoleic (9)	3.29	1.90	3.43	0.24	2.78
Linoleic (11)	0.40	0.28	1.25	0.71	0.41
Unknown					
X_1	0.06	0.03	0.07	0.10	0.30
X_2	0.30	0.12	0.50	0.30	0.18
X_3	–	0.05	–	0.06	–
X_4	0.04	0.03	0.05	0.29	0.08
X_5	0.04	0.03	0.08	–	0.09
X_6	0.07	0.14	0.29	0.23	–

* Numbers between parantheses represent peaks in fig. 1.

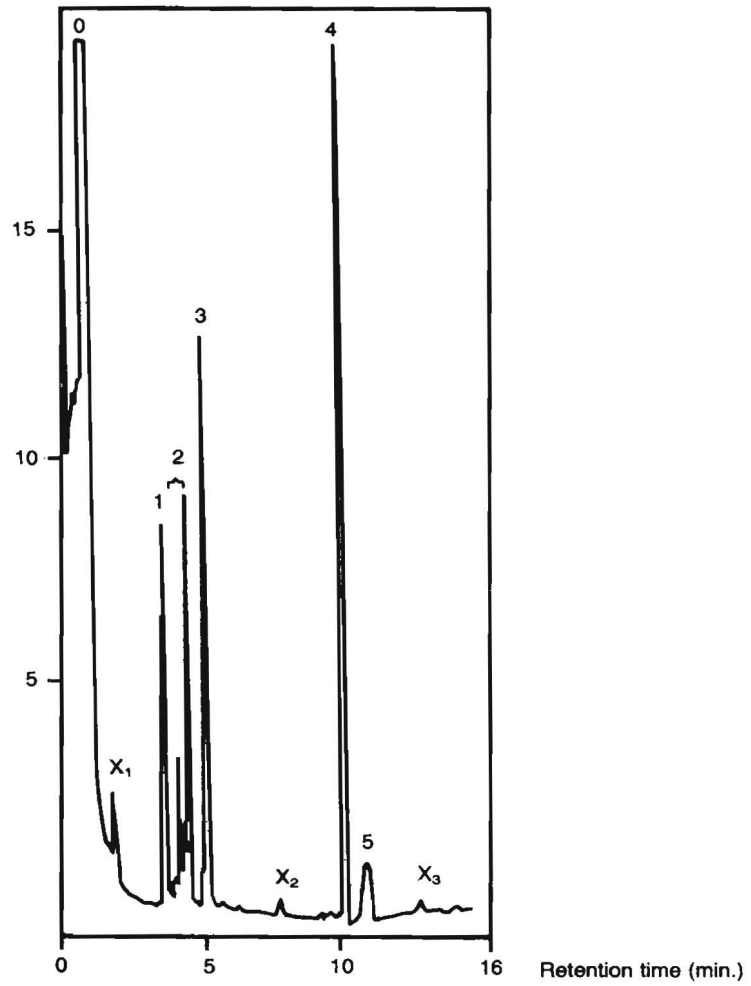

Fig. 2.GLC of silated sugar contents of date seeds (Fankha cultivar)

1) Mannose 2) Glucose 3) Fructose
4) Sucrose 5) Maltose X_1; X_2; X_3) Unknown

Table 3. Sugar present in the alcohol extract of seeds from five date palm cultivars (Relative %)

No.	Sugar / Cultivars	Barhey	Maktomey	Sekkeri	Fankha	Kasba
1.	Mannose	11.31	4.43	17.47	10.12	19.47
2.	Glucose	10.77	6.40	15.06	8.62	14.58
3.	Fructose	7.34	7.37	22.20	9.35	14.55
4.	Sucrose	51.40	30.80	29.50	30.12	43.92
5.	Maltose	5.21	12.11	13.50	5.67	4.50

Table 4. Ash %; Water %; and mineral contents μg/g of the seeds under investigations

Elements \ Cultivar	Barhey	Maktomey	Sekkeri	Fankha	Kasba
Water %	8.30	7.25	10.11	6.50	5.15
Ash %	0.80	1.42	1.21	1.05	0.96
Al^{+++}	1.25	2.0	1.65	1.40	1.37
Ca^{++}	458.33	489.13	476.19	312.00	270.08
Cd^{++}	0.45	1.02	0.25	0.09	0.31
Cu^{++}	2.34	1.33	1.63	1.52	0.93
Fe^{+++}	7.5	15.45	4.13	8.13	9.24
K^{+}	112.10	87.30	66.70	81.20	55.40
Mg^{++}	76.50	68.14	70.12	60.89	54.13
Na^{+}	25.06	31.45	34.80	17.38	20.50
Zn^{++}	14.81	7.35	12.53	7.36	5.16

vitamins, phenols triterpenes and other classes of compounds. A detail study on the nature of these compounds is in progress.

In conclusion, this work shows the diverse range of fatty acids and minerals found in these cultivars indicating the potential of using these seeds as complementry diet for livestock.

Experimental

Seed Material

The seeds of the five cultivars under investigation were collected and isolated from their corresponding mature fruits. Among these cultivars, the Kasba and Fankha were obtained from Hail Province (Northern region) while the Barhey, Maktomey and Sekkeri were collected from Al-Qaseem, (Central region) of Saudi Arabia. The seeds were washed thoroughly with distilled water and air dried, and their relative percentage weight was compared with the weight of the fresh fruits. Seeds were further dried at about 60°C and then powdered.

Methods

The preliminary phytochemical screening of the powdered seeds of five cultivars under investigation were analyzed similar to the method of Farnsworth (Farnsworth 1966). To test for alkaloids, the alcohol extract residue of the cultivars, Maktomey and Sekkeri (about 5 g) were dissolved individually in the minimum of ethanol and treated with Mayer and Dragendroff reagnets separately. The results were positive suggesting the presence of alkaloids. For

organic analysis about 100 g portions of each cultivar was sequentially extracted with the organic solvent spectroleum ether (60-80°C), diethyl ether, chloroform and alcohol. Solvent extracts were evaporated under reduced pressure and the relative percentages of the residue was calculated.

Fatty acid extraction

The method used was similar to that of Floch *et al.* (1957). In general, the powdered seeds of each cultivar was saponified by extracting 20-fold with chloroform: methanol (2:1) at 40-60°C. The extract was washed subsequently three times with 0.2 of its volume of 2% aqueous $CaCl_2$ solution and subjected to drying under vacuum. The fatty acids were hydrolysed by mixing with 100 ml of methanolic– KOH (3N KOH + MeOH 2:1) and refluxing on a boiling water bath for one hour. The unsaponifiable matter was removed out by extracting with light petroleum ether. The saponified solution of the hydrolysate, containing fatty acids, was acidified with concentrated HCl to pH 4, extracted with diethyl ether, and dried under vacuum after removing the ether.

Esterification of fatty acids

The international standard ISO-5509-1978(E) was applied for esterifications of fatty acids to be used later in the gas-liquid chromatography analysis. Generally the esterification of each cultivar was treated in the presence of boron trifluoride (BF_3). The residue of fatty acids of each cultivar was added with methanolic-HCl (10 ml) in a 100 ml round-bottomed flask attached with condenser and magnetic stirrer. The flask was immersed in a water-bath and refluxed for about two hours (Kates 1982). An additional amount of methanol–H_2O in the ratio of (9:1 v/v) was added with stirring for a few minutes. The fatty acids were extracted with diethyl ether which was evaporated under vacuum. The form residue was redissolved in a minimum of diethyl ether (1 ml) together with 1.5 ml of dry benzene and 2.5 ml of boron trifluoride (BF_3). The whole mixture was heated in a flask attached with a condenser and magnetic stirrer at a temperature of 90-100°C for about an hour. After being cooled to room temperature about 1 ml of distilled water was added. The sample was preserved in a well-stoppered sample tube and stored in a refrigerator to be used for GLC.

The identifications of the fatty acids as methyl esters were carried out on a Pye Unicam Series 304 chromatograph GLC instrument equipped with a data system and FID (flame ionization detector) using a coiled glass column (2m × 2mm I.D) packed with 3% OV1 on chromosorb W. The column temperature was programmed from 70°C to 220°C and increased by 6°C/min. The FID was set at 250°C, while the injector temperature was 200°C. The carrier gas was N_2 (40 ml/min) with hydrogen and air for the detector (30 ml/min and 300 ml/min respectively). The tentative identifications were achieved based on retention time

and by comparing with authentic standards analyzed under the same conditions.

Sugar Analysis

The well dried alcohol extract of each cultivar (5 mg) was silylated in Tri-Sil-Z reagent (1 ml) (a mixture of trimethylsilylimidazole in dry pyridine) by warming in water-bath at 60-70°C with frequent shaking to dissolve the sugar contents as much as possible. GLC analysis of the silylated products was carried out by a Pye Unicam Series 304 chromatograph instrument equipped with a data system of FID (Flame ionization detector) and compared with the authentic standards under the following conditions:

The column (2 m × 2 mm I.D) was Packed with 3% OV 17 on chromosorb W. The column temperature was programmed from 150°C to 320°C at 10°C rise/ per min. The injector temperature was 400°C while the FID was set at 250°C. Oxygen free nitrogen (40 ml/min) was used as the carrier gas, and the flow rate of hydrogen and air for the detector were 40 ml/min and 300 ml/min respectively.

Analysis of Minerals

The mineral constituents present in the date seeds of each cultivar were analysed separately using an atomic absorption spectrophotometer of the Varian model AA-1475 Series. To remove the carbon, about 5 g powdered portion of each cultivar in a porcelain container was ignited and ashed in the Muffle furnace (Heraeus Electronic) at about 700-750°C for 15 hours. The percentage of the total ash was calculated after the ignition. The ashe was dissolved in 5 ml conc. HNO_3, filtered from impurities, and transferred quantitatively into a 100 ml volumetric flask using deionized water. This solution was analyzed for its elemental composition in the above said instrument with the comparison of calibration absorptions of the standards of corresponding elements.

Acknowledgements

The author would like to thank the Research Center, College of Science, King Saud University, for financial support of the project Chem/1407/21 and Mr. A. BaOsman for technical assistance.

References

Al-Whaibi, M.H., and **Basalah, M.O.** (1986) Fatty acids in seeds of four cultivars of date-palm trees, *J. Coll. Sci., King Saud Univ.,* **17:** 27-35.

Al-Whaibi, M.H., Basalah, M.O., and **Ackhal, I.E.** (1985) Chemical composition of some date palm seeds, *J. Coll. Sci., King Saud Univ.,* **16:** 23-29.

Farnsworth, N. (1966) Biological and phytochemical screening of plants, *J. Pharm. Sci.,* **55:** 225-276.

Floch, J., Less, M., and **Sloane, G.H.** (1957) A simple method for the isolation and purifications of total lipids from animal tissues, *J. Biol. Chem.* **226:** 497-509.

Gunstone, F.D. (1979) *Comprehensive organic chemistry,* (Haslam E. editor), Pergamon, Oxford, **5:** 587 p.

International Standard (1978) Animal and vegetable fats and oils-preparation of methyl esters of fatty acids, first edition ISO 5509 (E). International Organization for Standardization - Switzerland.

Kates, M. (1982) *In technique of lipiodology* (Work T.C. and Worle E. editor), Elsevier, New York, **2:** 362.

Mossa, J.S., Hifnawy, M.S. and **Mekkawi, A.G.** (1986) Phytochemical and biological investigation on date seeds (*Phoenix dactylifera* L.) produced in Saudi Arabia, *Arab Gulf J. Scient. Res.* **4:** 495-507.

Proceedings of the first symposium on the date palm (1982) Published by King Faisal University, Al-Hassa, Saudi Arabia.

(Receivd 04/07/1988;
in revised form 04/12/1989)

التركيب الكيميائي لنوى بعض أصناف النخيل في المملكة العربية السعودية

سالم شويمان الشويمان

قسم الكيمياء ـ كلية العلوم ـ جامعة الملك سعود
ص . ب ٢٤٥٥ ـ الرياض ١١٤٥١ ـ المملكة العربية السعودية

تم تحليل المكونات العضوية وغير العضوية لنوى خمسة أصناف من النخيل وهي : برحي ، مكتومي ، سكري ، فنخة ، كسبه بوساطة جهاز الكروماتوجرافي الغازي . لقد وجد أن هذه الأصناف تحتوي على عدد كبير من الحموض الدهنية بنسب متفاوتة ويمثل حمض الألوييك فيها الحمض الرئيسي إذ تتراوح نسبته ما بين ٤٢,٥٧ ـ ٥٦,٩٤٪ بينما يأتي حمض اللوريك في المركز الثاني حيث تراوحت نسبته ما بين ١٥,٣٩ ـ ٢١,٦٧٪ .

وبالنسبة للسكريات فقد تم تقدير المانوز، الجلوكوز، الفركتوز، السكروز والمالتوز الا أن نسب هذه السكريات كانت مختلفة في جميع الأصناف . أما بالنسبة للألياف فقد كانت نسبتها متفاوتة في جميع الأصناف . كذلك تم التعرف على بعض المكونات العضوية الأخرى كالبروتينات ، القلويدات ، الستيرويدات ، الفيتامينات ، الفينولات ، والتربينات .

أما بالنسبة للمكونات غير العضوية فقد وجد أن هذه الأصناف تحتوي كل من أيونات الألمنيوم ، الكالسيوم ، الكادميوم ، النحاس ، الحديد ، البوتاسيوم ، المغنيسيوم ، والزنك بنسب مختلفة .