



المؤتمر العالمي الرابع للطب النبوي

4th INTERNATIONAL CONFERENCE IN
PROPHETIC MEDICINE RESEARCH



جامعة الجوف
Jouf University

Metabolic analysis of various dates: Nutritional value



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Team work

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Date palm in Hadith

- **The date palm, mentioned more than any other fruit-bearing plant in the Qur'an, is a symbol often associated with Islam and Muslims. Throughout the month of Ramadan, dates are a common ingredient in the Muslim diet.**
- **In another Hadith, the Prophet stressed the importance of dates as a major food item, saying, "People in a house without dates are in a state of hunger." (Muslim)**

- **Date palm is the most successful and commercially important crop in the hot-arid regions of the world, e.g., Saudi Arabia, Emirates and Egypt.**
- **A large number of date palm cultivars are known, however, only a few of these cultivars have been evaluated for chemical composition and nutritional quality**

- **The aim of this study was to evaluate the biological activity and nutritional quality of 12 date varieties from different geographical locations in Saudi Arabia:**

1- In this study, we used (HPLC) coupled to electrochemical and diode array detection and mass spectrometry (HPLC/PDA/MS) techniques. These techniques enabled us to analyze a wide range of metabolites including sugars, amino acids, fatty acids, organic acids, phenolics and flavonoids, and antioxidants.

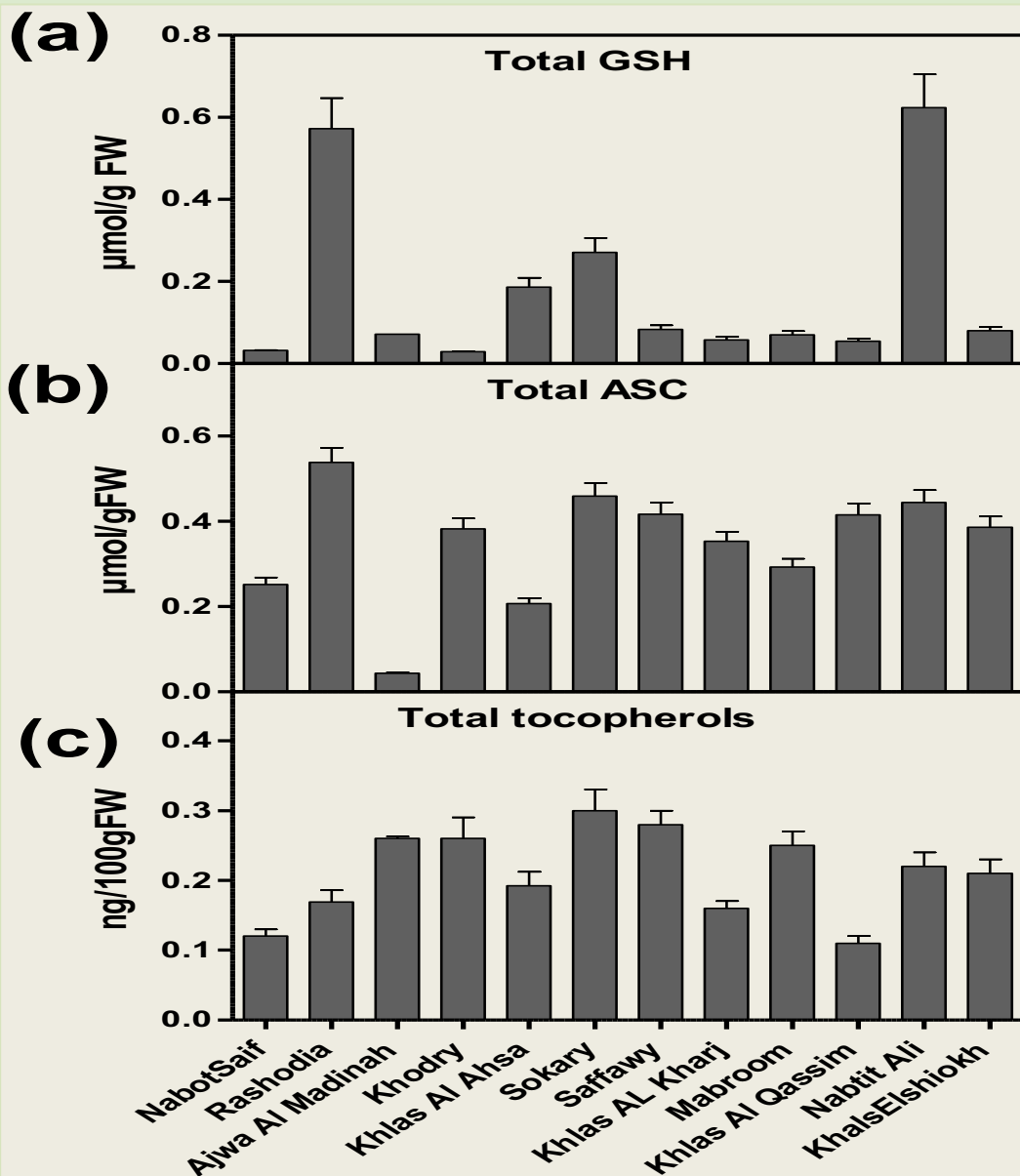
2- We also assessed the macro- and microelemental mineral profile and hydrophilic and lipophilic antioxidant contents of these cultivars. To acquire statistical correlations among all the measured parameters and different palm cultivars, we performed principle component analysis (PCA) and hierarchical clustering analysis (HCA).

Results

Sugars

Dates contain a high concentration of sugars, which are considered the main component. Most of the studied cultivars had higher glucose and fructose concentrations, conversely Nabtit Ali, Sokary and Rashodia cultivars has higher sucrose levels.

Cultivars	Glucose	Fructose	Sucrose
Nabot Saif	50.1 ± 0.0	58.8 ± 1.8	26.55 ± 0.0
Rashodia	42.5 ± 0.6	53.0 ± 0.0	112.5 ± 0.0
Ajwa Al Madinah	35.4 ± 0.5	39.4 ± 2.5	13.45 ± 0.2
Khodry	58.1 ± 0.0	69.16 ± 2.1	19.42 ± 0.0
Khlas Al Ahsa	58.2 ± 3.6	74.1 ± 4.7	17.9 ± 0.27
Sokary	1.5 ± 1.8	59.5 ± 3.7	138.5 ± 5.0
Saffawy	47.3 ± 0.07	54.26 ± 2.4	28.7 ± 1.04
Khlas Al Kharj	95.40 ± 0.0	112.7 ± 3.4	31.9 ± 0.0
Mabroom	46.30 ± 0.70	62.0 ± .00	20.1 ± 0.0
Khlas Al Qassim	79.6 ± 0.0	101.2 ± 0.0	26.1 ± 0.0
Nabtit Ali	21.08 ± 0.3	23.20 ± 1.47	150.5 ± 2.2
Khals El Shiokh	58.2 ± 0.0	71.29 ± 2.2	9.23 ± 0.0



- GSH content showed a variation among the cultivars, ranging from 0.011 to 0.295 $\mu\text{mol}\cdot\text{g}^{-1}$ FW.
- The highest GSH and ASC contents was observed for the Rashodia.
- Sokary had the highest content of tocopherols.

Antioxidant metabolites content: (a) Total glutathione (GSH); (b) total ascorbate (ASC); (c) total tocopherols of 12 Saudi date cultivars.

- **Organic Acids**

- The average content of total organic acids in dates of tested varieties were 17 to 26 mg·g⁻¹ FW. Six organic acids were identified, among which malic acid was the predominant organic acid, followed by lesser amounts of succinic acid, isobutyric acid, citric acid, oxalic acid and formic acid.

- **Phenolics and Flavonoids**

- We recorded high total phenolic contents. Ajwa Al Madinah had the highest content. Different classes of **flavonoids** were identified. Total flavonoid content was in the range of 1.22 and 2.82 mg/100 g DW.

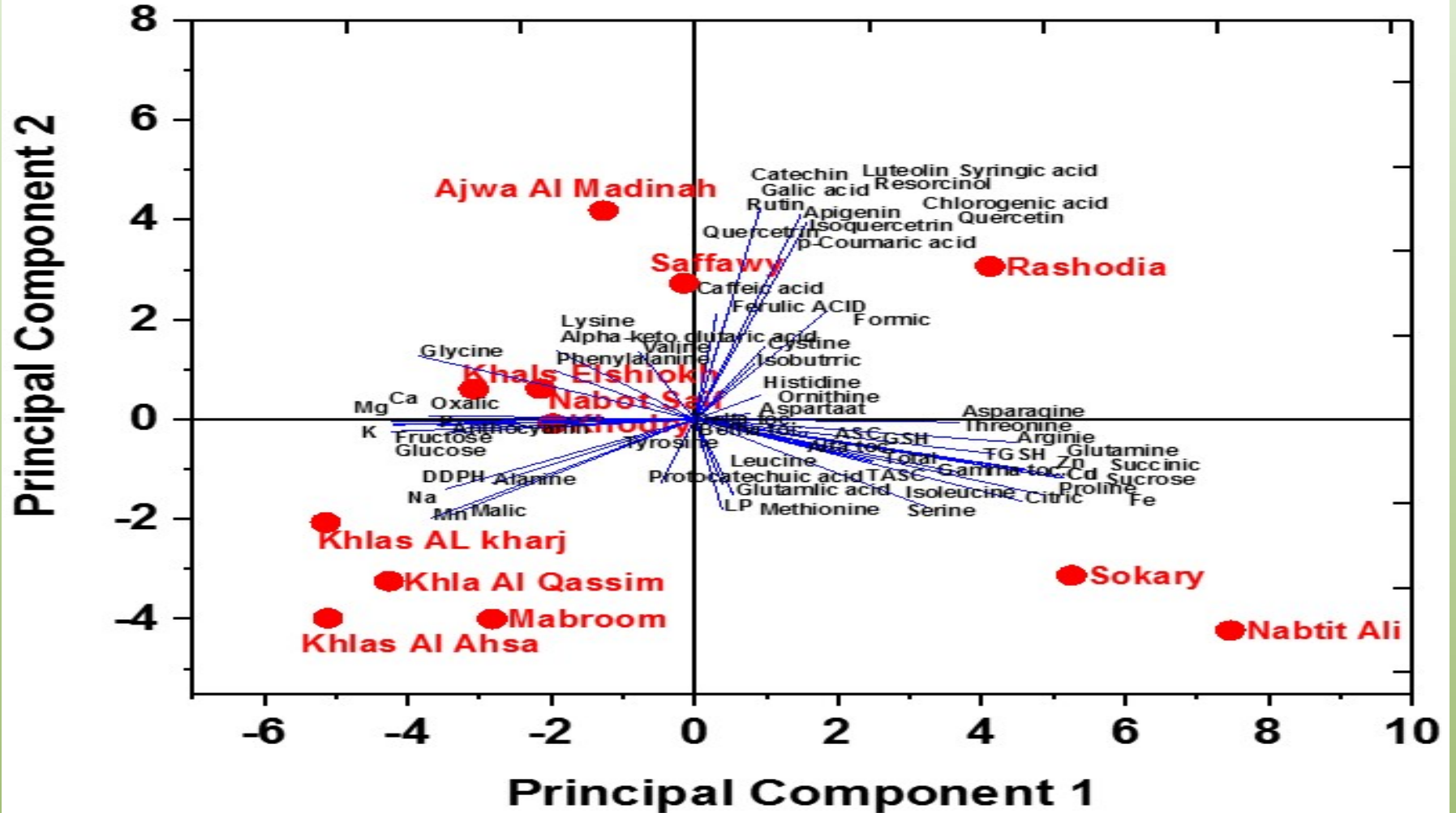
Table 4. Concentrations of phenolic compounds (mg/100 g DW) in 12 Saudi date cultivars.

Cultivars	Caffeic acid	Ferulic acid	Protocatechuic acid	Catechin	Gallic acid	<i>p</i> -Coumaric acid	Resorcinol	Chlorogenic acid	Syringic acid	Total phenolic
Nabot Saif	0.018 ± 0.004	1.94 ± 0.42	0.162 ± 0.028	0.574 ± 0.12	15.227 ± 3.3	3.275 ± 0.720	0.033 ± 0.007	0.2 ± 0.044	0.58 ± 0.6	22.00 ± 5.35
Rashodia	0.013 ± 0.001	1.44 ± 0.09	0.115 ± 0.007	0.426 ± 0.02	11.312 ± 0.7	2.433 ± 0.154	0.025 ± 0.002	0.149 ± 0.009	0.66 ± 0.0	16.58 ± 1.05
Ajwa Al Madinah	0.026 ± 0.001	2.52 ± 0.11	1.217 ± 0.057	0.526 ± 0.02	13.973 ± 0.6	3.087 ± 0.004	0.030 ± 0.002	0.184 ± 0.009	0.82 ± 0.0	22.11 ± 1.10
Khodry	0.024 ± 0.005	2.56 ± 0.57	1.094 ± 0.243	0.473 ± 0.10	12.564 ± 2.7	2.702 ± 0.601	0.028 ± 0.006	0.165 ± 0.037	0.63 ± 0.2	20.13 ± 4.21
Khlas Al Ahsa	0.018 ± 0.004	1.94 ± 0.42	0.527 ± 0.588	0.353 ± 0.07	9.370 ± 2.05	2.015 ± 0.443	0.021 ± 0.005	0.123 ± 0.027	0.55 ± 0.1	14.92 ± 3.75
Sokary	0.019 ± 0.003	2.01 ± 0.34	0.893 ± 0.119	0.386 ± 0.05	10.24 ± 1.36	2.309 ± 0.324	0.022 ± 0.004	0.135 ± 0.018	0.60 ± 0.0	17.10 ± 2.84
Saffawy	0.026 ± 0.001	2.52 ± 0.11	1.217 ± 0.057	0.526 ± 0.02	13.973 ± 0.6	3.005 ± 0.142	0.030 ± 0.002	0.184 ± 0.009	0.82 ± 0.0	21.99 ± 1.27
Khlas Al Kharj	0.024 ± 0.005	2.56 ± 0.57	1.094 ± 0.243	0.333 ± 0.09	8.829 ± 2.48	1.302 ± 0.290	0.013 ± 0.003	0.080 ± 0.018	0.74 ± 0.1	14.97 ± 1.28
Mabroom	0.018 ± 0.004	1.94 ± 0.42	0.527 ± 0.588	0.353 ± 0.07	9.370 ± 2.05	0.971 ± 0.213	0.010 ± 0.002	0.059 ± 0.013	0.55 ± 0.1	13.80 ± 3.50
Khla Al Qassim	0.013 ± 0.001	1.44 ± 0.09	0.606 ± 0.038	0.262 ± 0.01	6.9610.441	0.721 ± 0.046	0.008 ± 0.001	0.044 ± 0.003	0.41 ± 0.0	10.47 ± 0.63
Nabtit Ali	0.019 ± 0.003	2.01 ± 0.34	0.893 ± 0.119	0.386 ± 0.05	10.246 ± 1.3	1.062 ± 0.141	0.011 ± 0.001	0.065 ± 0.009	0.60 ± 0.0	15.80 ± 2.69
Khals El Shiokh	0.026 ± 0.001	2.52 ± 0.11	1.217 ± 0.057	0.526 ± 0.02	13.973 ± 0.6	1.448 ± 0.068	0.015 ± 0.001	0.089 ± 0.004	0.82 ± 0.0	20.37 ± 1.17
<i>p</i> value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.049	0.00

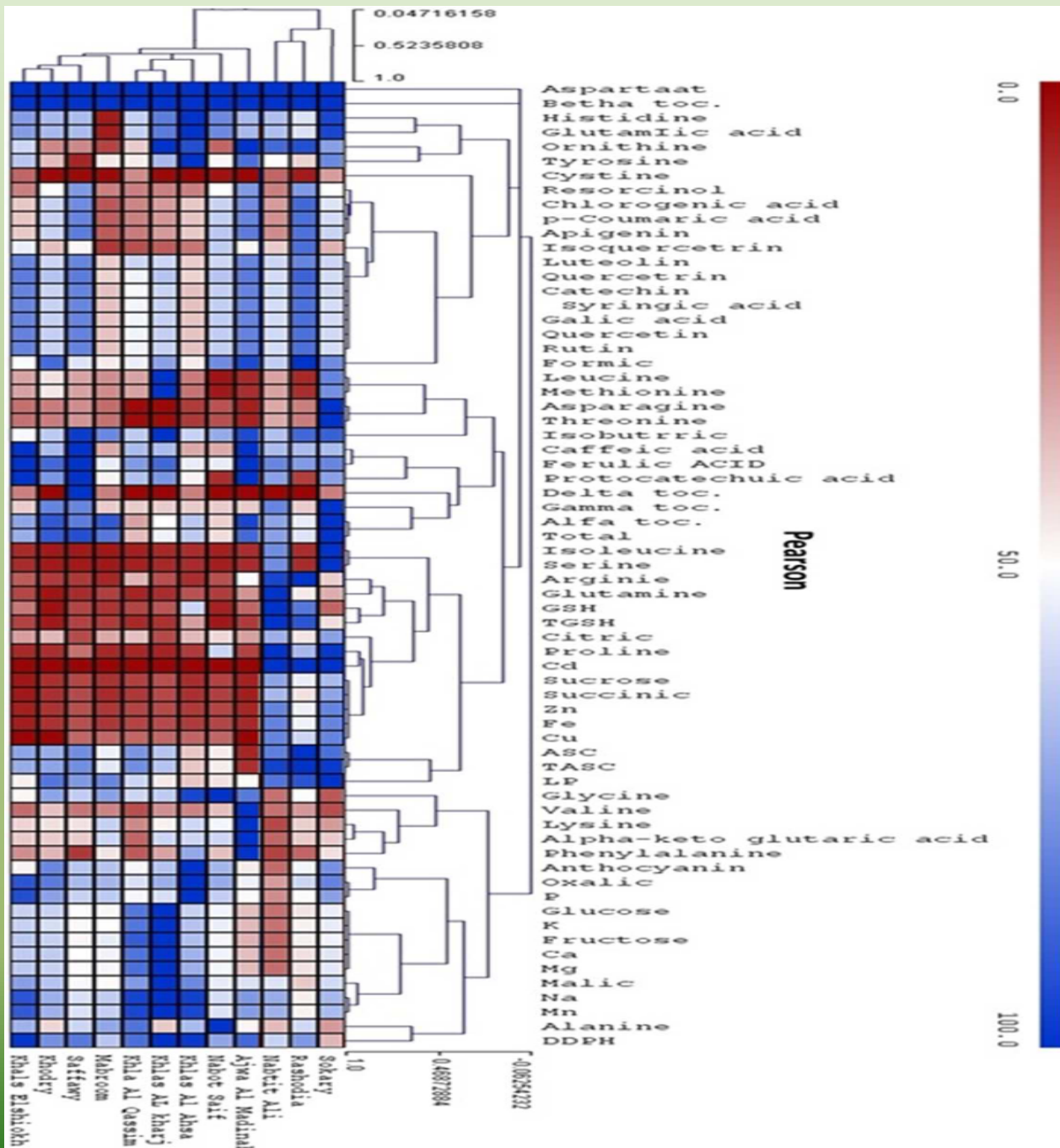
- **Elemental Profiling (Macro- and Micronutrients)**
 - **Our tested date cultivars contained significant amounts of minerals. In particular, the potassium content was the highest, followed by phosphorus, magnesium, and sodium.**
 - **The results indicated that tested dates cultivars contained significant amounts of minerals.**

Principal Component Analysis (PCA) and Hierarchical Clustering (HCA)

- All the measured metabolites (amino acids, sugars, organic acids, phenolics, flavonoids, antioxidants, and macrominerals and trace elements) were subjected to principal component analysis (PCA) to identify differences in metabolite profiles among the studied date cultivars.

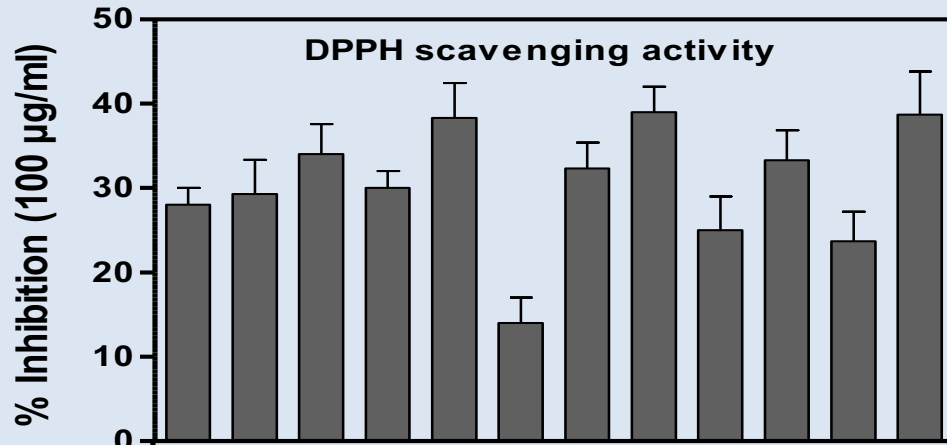


PCA revealed that the first two principal components (PC1 and PC2) accounted for 49.6% of the total variance within the data set. PC1 explained 28.3%, and PC2 explained 21.3% of the data variation. These two principal components separated the studied cultivars into four different groups.

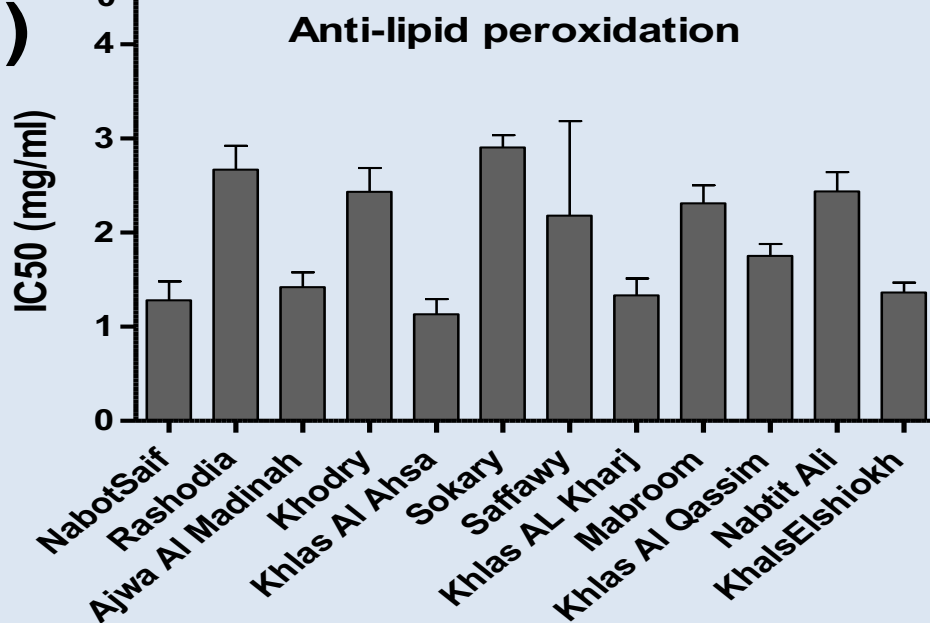


- Heat maps of the metabolite profiles of 12 Saudi date cultivars.
- It is clear that some of the changes in metabolites (aspartate and beta-tocopherol) are almost similar in all cultivars. HCA indicated two main clusters.

(a)



(b)

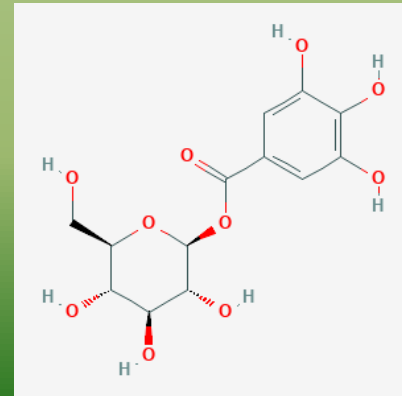


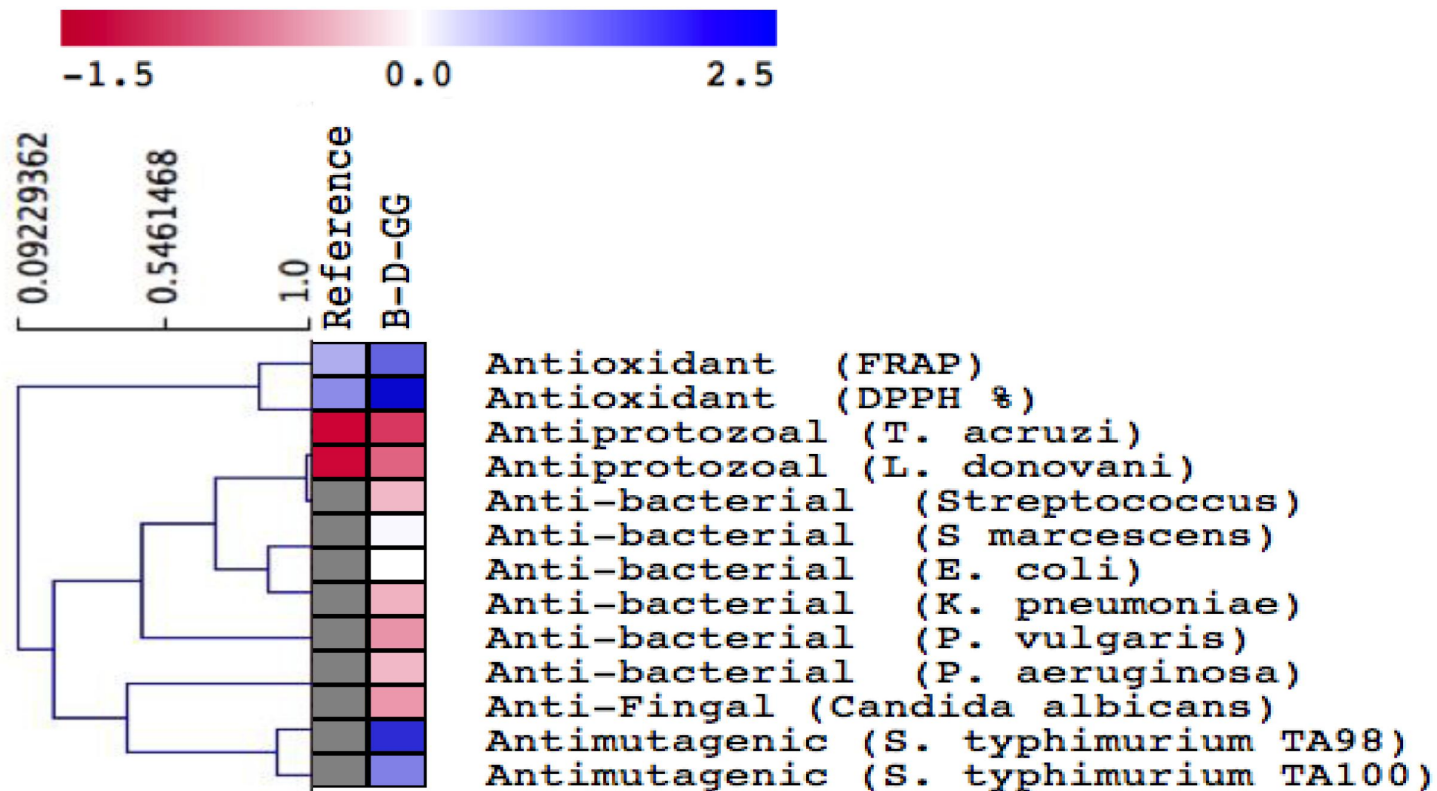
Overall, all date varieties showed DPPH scavenging ability and almost all the tested palm date extracts inhibited lipid peroxidation.

Antioxidant activity: DPPH scavenging activity and anti-lipid peroxidation activity of 12 Saudi date cultivars.

Biological Activity

- Extraction, Fractionation, and Isolation of β -D-Glucogallin from **Ajwa Al Madinah** by thin layer chromatography (TLC).
- IR, ^1H , and ^{13}C NMR spectra were used to identify the pure isolated phenolic compound β -D-glucogallin
- Evaluate the bioactivity of an isolated phenolic compound, β -D-glucogallin



B

Hierarchical clustering medicinal bioactivities of β -D-Glucogallin.

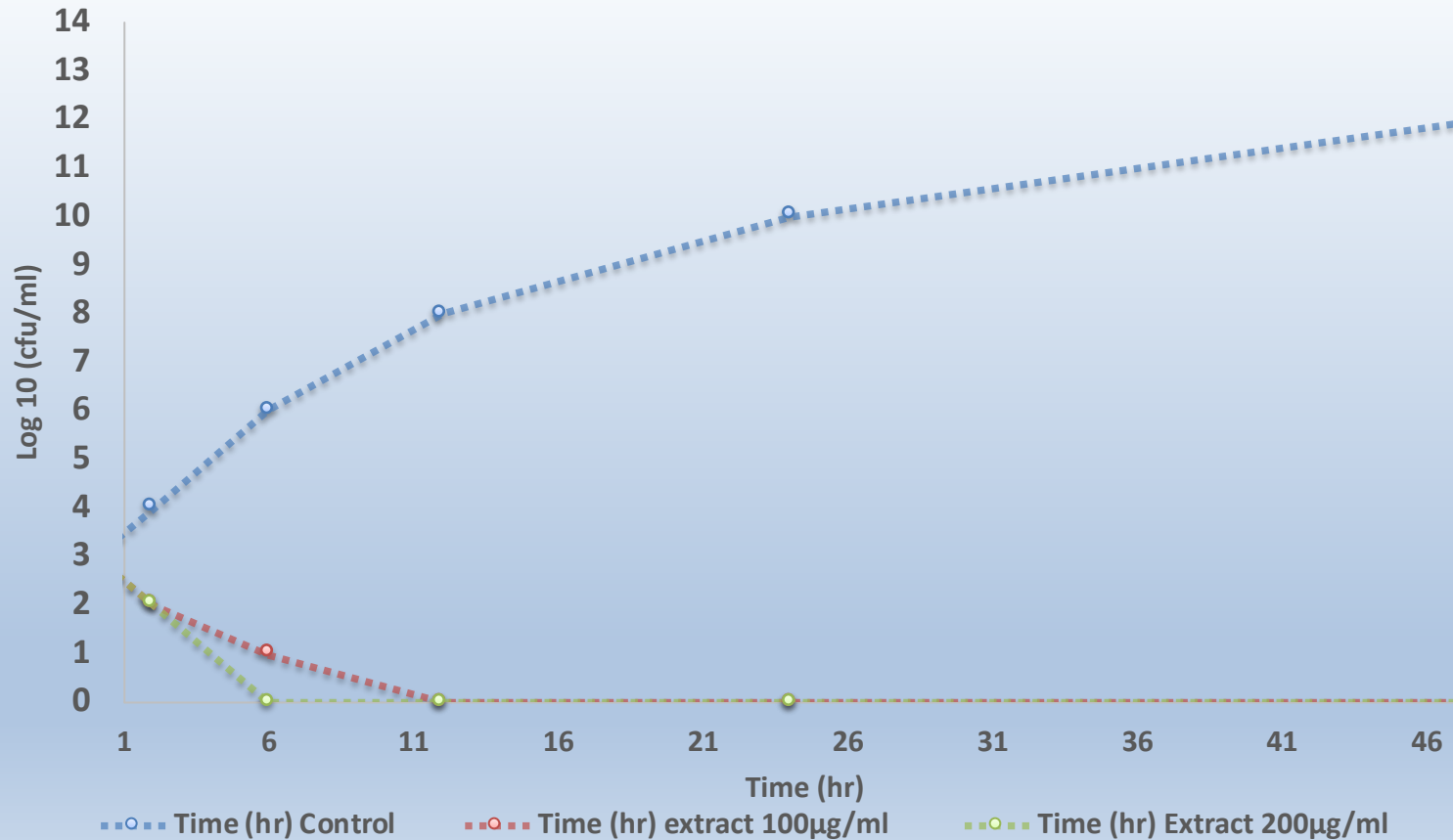
Medical Bioactivity of the Isolated β -D-Glucogallin

Test organism	Standard (Benznidazole, Miltefosine)	β -D-glucogalline
<i>Trypanosoma cruzi</i>	0.056±0.00	4.84±1.50
<i>Leishmania donovani</i>	0.301±0.03	8.63±5.87

The antiprotozoal activity, β -D-glucogallin showed high activity against *T. cruzi* and *L. donovani*

Antioxidant test	Standard (Gallic acid)	β -D-glucogalline
DPPH (%)	34.86±4.21	49.25±5.32
FRAP (nmol /gFW)	31.34±2.62	39.44±2.20

DPPH radical-scavenging activity and FRAP of β -D-glucogallin extracted from date palm fruits were higher than the one recorded for gallic acid (49.2 and 39.4 for DPPH and FRAP, respectively).



Strong antimicrobial activities of β -D-glucogallin were recorded against *S. aureus* .

Our results also signify that Ajwa date fruit was a good source of the natural bioactive compound. β -D-glucogallin, which showed significant antioxidant activity as well as promising action against microbial and protozoal growth.

Publication

Molecules 2015, 20, 13620-13641; doi:10.3390/molecules200813620

OPEN ACCESS

molecules

ISSN 1420-3049

www.mdpi.com/journal/molecules

Article

Metabolic Analysis of Various Date Palm Fruit (*Phoenix dactylifera* L.) Cultivars from Saudi Arabia to Assess Their Nutritional Quality

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Molecules (IF: 3.060)

frontiers
in Plant Science

ORIGINAL RESEARCH
published: 11 April 2019
doi: 10.3389/fpls.2019.00424



Vermicompost Supply Modifies Chemical Composition and Improves Nutritive and Medicinal Properties of Date Palm Fruits From Saudi Arabia

OPEN ACCESS

Edited by:
Antonio Ferrante

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Front. Plant Sci. (IF: 4.106)

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Science of the Total Environment 665 (2019) 690-697

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Utilization of actinobacteria to enhance the production and quality of date palm (*Phoenix dactylifera* L.) fruits in a semi-arid environment

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HIGHLIGHTS

- Utilization of actinobacteria resulted in improved soil fertility and yield of date palms.
- Treated palm fruits showed enhanced nutritive and health-promoting values.
- Major phenolics, flavonoids, vitamins, EAA and PUFA have significantly improved.
- Actinobacteria are a promising approach for supporting functional food value of plants.

GRAPHICAL ABSTRACT

Science of the Total Environment
(IF: 5.589)

Acknowledgments

- **This work was funded by Y.A. Jameel Scientific Chair of Prophetic Medical Applications, King Abdulaziz University, Kingdom of Saudi Arabia.**



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