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Research Article

# Chemical Composition and Antimicrobial Activity of Volatile Oil of *Phoenix dactylifera* Staminate Flower Spikes

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**ABSTRACT**

Context: *Phoenix dactylifera* L. (Arecaceae) staminate flower spikes have been used in Persian traditional medicine and food products for a long time. Objective: The goal of this study it analysis of chemical constitutes and antimicrobial activity of this volatile oil. Materials and methods: Its volatile oil was analyzed by GC/MS and antimicrobial activity (MIC) against four gram positive, five gram negative, two yeasts and two fungi were examined. Results: Thirty components (96.2%) were identified, and the major components were linalool (57.4%), hexyl caproate (5.8%), and β-fenchyl alcohol (4.2%). and the volatile oil has shown good antimicrobial activity against some food pathogens. Discussion and conclusion: There is no high concentration of any toxic compound in this volatile oil, and the volatile oil shows good antimicrobial activity, so it can be suggested that this volatile oil can be used as a safe preservative.

**Keywords:** *Phoenix dactylifera* L., Arecaceae, linalool, antimicrobial activity, volatile oil, GC/MS.

## INTRODUCTION

*Phoenix* is a genus from Arecaceae family. It has 15 species widely distributed in the tropic and subtropics. *Phoenix dactylifera* L. is one of the economic interest species from the Arecaceae family (Evans, 2002)[4]. Date gardens are found on the south of Iran. The finest fruit is produced when the tree is between thirty and forty years old. Over a hundred varieties are known, and it seems that the origin of this tree in this part of the world is Iran. The numerous uses of the date are proverbial. The fruit yields syrup, used in making the local spirit, "aragh-i-khorma" The female inflorescence is given as an infusion for colic and sunstroke in Ahwaz (Parsa, 1960)[7]. Taruneh is a hydrosol from *Phoenix dactylifera* staminate flowers spike which is used in Persian traditional medicine, moreover its syrup is also used as a beverage, mostly in hot seasons. In Persian folklore medicine the staminate flowers spike are collected and the hydrosol distilled by traditional hydrodistillation apparatus. This hydrosol is used as a beverage, disinfectant, carminative, for treating jaundice, liver disorders, for rheumatism treatment, nerve and heart tonic, anti insomnia, hematopoietic and expectorant. To the best of our knowledge there is not any report about *P. dactylifera* staminate flowers spike volatile oil which is used as the source for Taruneh production.

## MATERIALS AND METHODS

*Plant Material*

*P. dactylifera* staminate flowers spike were collected from plants growing wild in Jahrom, Iran, on January 2006. Plant material was identified by A. Mohagheghzadeh and a voucher specimen (Pm 10) is deposited in the Herbarium of the Shiraz Faculty of Pharmacy.

*Distillation*

Air-dried plant materials were powdered (25 g) and subjected to hydrodistillation (250 mL water) for 4 h using a Clevenger-type apparatus (manufactured by Ashk-e-shisheh Co.) according to the method recommended in British Pharmacopoeia (1988)[3].

*Analysis of Essential Oil*

The GC/MS analyses were carried out using a Hewlett-Packard 6890.The gas chromatograph was equipped with a HP-5M capillary column (phenyl methyl siloxan, 25 m × 0.25 mm i.d., Hewlett–Packard Part No. 190915.433, USA). The oven temperature was programmed from 50°C (3 min) to 250°C at the rate of 3°C/min and finally held for 10 min at 250°C. The carrier gas was helium with the flow rate of 1.2 ml/min. The mass spectrometer (Hewlett-Packard 5973, USA) was operating in EI mode at 70 eV. The interface temperature was 250°C; mass range was 30-600 m/z. Identification of components was based on a comparison of their RI and mass spectra with Wiley (275) and Adams libraries spectra (Mohagheghzadeh et al., 2007; Adams, 2004 )[1,6].

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Table 1. Constituents of *Phoenix dactylifera* volatile oil.

| Compound [a] | % [b] | KI | Compound | % | KI |
|---|---|---|---|---|---|
| 1,8-Cineole | 0.5 | 1023 | Germacrene D | 1.2 | 1469 |
| trans-Linalool oxide | 0.5 | 1073 | δ- Selinene | 0.4 | 1479 |
| cis- Linalool oxide | 0.7 | 1088 | Benzoic acid butyl ester | 0.7 | 1571 |
| Linalool | 57.4 | 1102 | Caprylate | 4.5 | 1577 |
| Hexyl isobutyrate | 2.5 | 1148 | β- Eudesmol | 1.9 | 1643 |
| β-Fenchyl alcohol | 4.2 | 1190 | Palmatic acid | 2.2 | 1976 |
| Hexyl 2-methyl isobutyrate | 1.7 | 1235 | | | |
| Hexyl isovalerate | 3.9 | 1240 | Identification | 96.2 | |
| p- Anisaldehyde | 1.6 | 1256 | Grouped components | | |
| Anethol | 2.1 | 1283 | Monoterpene hydrocarbons | 0 | |
| δ- Elemene | 0.8 | 1331 | Oxygen-containing monoterpenes | 67 | |
| Hexyl caproate | 5.8 | 1382 | Sesquiterpene hydrocarbons | 6 | |
| Longipinene | 3.2 | 1409 | Oxygen-containing sesquiterpenes | 1.9 | |
| □- Elemene | 0.4 | 1465 | Others | 21.3 | |

[a] The retention index of compounds on the HP-5MS was determined.
[b] Percentage were calculated based on the concentration obtained on the same column.

Table 2: Results of minimum inhibitory concentration (MIC) for *Phoenix dactylifera* volatile oil

| Microorganism | MIC , μL/mL | Microorganism | MIC , μL/mL |
|---|---|---|---|
| *Staphylococcus aureus* | 2.50 | *Pseudomonas aeruginosa* | 1.25 |
| *Staphylococcus epidermidis* | 5.00 | *Salmonella typhi* | 1.25 |
| *Bacillus subtilis* | 5.00 | *Candida albicans* | 2.50 |
| *Enterococcus faecalis* | 1.25 | *Candida kefyr* | 1.25 |
| *Escherchia coli* | 1.25 | *Aspergillus niger* | 5.00 |
| *Shigella sonnei* | 1.25 | *Aspergillus fumigatus* | 5.00 |
| *Proteus vulgaris* | 2.50 | | |

*Antimicrobial screening*

Screening of the antimicrobials was investigated on Gram positive bacteria (*Staphylococcus aureus* PTCC 1112, *Staphylococcus epidermidis* PTCC 1114, *Bacillus subtilis* PTCC 1023, *Enterococcus faecalis* ATCC 8043), Gram negative bacteria (*Escherchia coli* PTCC 1338, *Shigella sonnei* PTCC 1235, *Proteus vulgaris* PTCC 1312, *Pseudomonas aeruginosa* PTCC 1047, *Salmonella typhi* PTCC1609), yeasts (*Candida albicans* ATCC 14053, *Candida kefyr* ATCC 3826) and fungi (*Aspergillus niger* PLM 1140, *Aspergillus fomigatus* PLM 712). Briefly, a microdilution broth susceptibility assay was used to evaluate antimicrobial activity of the essential oil. To do this, 2 ml of a microbial suspension containing $5\times10^5$ CFU/ml of nutrient broth was prepared. Then according to the serial dilution different amounts of the essential oil was added to each tube. One of the tubes contained no essential oil and it was kept as positive control and the other one as a negative one which contained no microorganism. After incubation for 24 h for bacteria at 37° C, the first tube without turbidity was determined as the minimal inhibitory concentration (MIC) (NCCLS 2008)[2].

## RESULTS AND DISCUSSION

In this work *P. dactylifera* staminate flowers spike volatile oil was analyzed by GC/MS. Thirty components (96.2%) were identified (Table 1). Yield of the oil was 0.6% (v/dry weight). The main group was oxygen containing monoterepenes (67.0%). The major components were linalool (57.4%), hexyl caproate (5.8%), and β-fenchyl alcohol (4.2%). The volatile oil has shown a good antimicrobial activity against *Enterococcus faecalis*, *Escherchia coli*, *Shigella sonnei*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Candida kefyr* (Table 2). Linalool is more than 50% of this volatile oil. It is used as a flavoring and carminative agent (Heinrich, 2004)[5]. Most of microorganisms that this volatile oil inhibits their growth are food pathogens. So maybe it can be used as a food preservative. Pharmacological activities may be related to high content of linalool and in the other hand it can be used as a source of linalool. As results shown in Table 1 and Table 2 demonstrate, there is no high concentration of any toxic compound in this fraction, and the volatile oil shows good antimicrobial activity. It is evident that these results are insufficient to demonstrate the safety, but its long use in traditional medicine and these preliminary results indicate its potential as a future flavoring and preservative of foods.

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## DECLARATION OF INTEREST

The authors report no declarations of interest. The authors alone are responsible for the content and writing of the paper.

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