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Full Length Research Paper

The essential oil composition of *Carthamus tinctorius* L. flowers growing in Iran

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The composition of the essential oil obtained from the dried flowers of *Carthamus tinctorius* L. growing in Iran was analyzed by gas chromatography (GC) and gas chromatography-mass spectrophotometry (GC-MS). 29 compounds were identified in the oil. The major compounds of the oil were 1-hydroxy-3-propyl-5-(4-methyl-penten)-2-methylbenzene (25.2%), 2,5,5 trimethyl-3-propyl,tetra hydro 1- naphtol (19.8%) and benzaldehyde (8.0%).

Key words: *Carthamus tinctorius* L., Asteraceae, essential oil composition, flower.

INTRODUCTION

Carthamus tinctorius L. (Asteraceae family) commonly known as safflower, is described as a bushy, herbaceous annual plant possessing several branches, which are categorized as primary, secondary and tertiary, with each terminating into a globular structure called capitulum. Stem and branches are encompassed with leaves having numerous spines. Safflower is mainly grown under dry land conditions as an oilseed crop. Each branch produces a globular flower capitulum, which is enclosed by tightly attached bracts. The flowering period in safflower lasts for a month. Traditionally, safflower has been grown for centuries from China to the Mediterranean region and all along the Nile valley up to Ethiopia (Weiss, 1971). Presently, it was grown commercially in India, the U.S.A, Mexico, Ethiopia, Kazakhstan, Australia, Argentina, Uzbekistan and China. Pakistan, Spain, Turkey, Canada and Iran also grow safflower to a limited extent. Safflower has been grown for the orange-red dye extracted from its brilliant florets and its high-quality edible oil rich in poly-unsaturated fatty acids, which helps in reducing the cholesterol level in blood. Safflower seed oil is nutritionally similar to olive oil, as it contains high levels of linoleic or oleic acid. The monounsaturated fatty acid like oleic acid is also known to reduce low-density lipoprotein (LDL; bad cholesterol) without affecting high-density lipoprotein (HDL; good cholesterol) in blood (Smith, 1996). In addition to its seed, safflower has been known and grown since ancient times for its brilliantly colored flowers, which were used to extract yellow and orange dyes for food and fabrics. Recently, interest in safflower flowers as a source of color for use in food has gained importance owing to a recent ban on the use of synthetic colors in food in the European countries and elsewhere. The water-soluble yellow dye, carthamidin, and a water-insoluble red dye, carthamin, which is readily soluble in alkali, can be obtained from safflower flowers (Weiss, 1983). The flowers are also reported to have medicinal properties to cure several chronic diseases, like hypertension, cardiovascular diseases, arthritis, spondylitis and sterility in both men and women. Detailed information on clinical uses of safflower flowers has been given in the monograph on safflower written by Li and Mundel (1996). All essential amino acids except tryptophan are present in safflower flowers (Singh, 2005). Two new quinochalcone C-glycosides, hydroxysafflor yellow and tinctormine together with safflor yellow B and safflomin C were reported from *C. tinctorius* (Meselhy et al., 1993). Since there have been no attempts to study the chemical composition of the essential oil from *C. tinctorius* flowers in Iran up to now, we were prompted to investigate it from plants which grow in central parts of Iran.

MATERIALS AND METHODS

Flowers of *C. tinctorius* were collected from Isfahan Iran, in August 2011. The plant was identified by Dr. Salehi Surmaghi. A voucher

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Table 1. Chemical composition of the essential oil of *C. tinctorius* flower.

Compound[a]	RI[b]	RI[c]	Percentage
n-Octane	974	800	0.3
n-Decane	1180	999	0.3
γ-Terpinene	1251	1062	0.3
Linalool	1289	1098	0.5
Terpinen-4-ol	1379	1177	0.7
Decanone <3>	1384	1186	0.2
α-Terpineol	1390	1189	0.4
Benzaldehyde	1443	1257	8.0
Thymol	1482	1290	2.6
1,3-Cyclohexadiene-1-carboxaldehyde, 2,6,6-trimethyl aldehyde	1489	1293	0.9
Carvacrol	1493	1298	2.9
α-Terpinyl acetate	1547	1340	3.2
Eugenol	1557	1356	0.7
α-Copaene	1588	1376	0.3
α-Elemene	1620	1391	0.6
β-Caryophyllene (z)	1638	1404	4.3
α-Humulene	1672	1454	0.3
Curcumene	1682	1483	0.3
β-Lonone	1690	1485	0.6
β-Bisabolene	1707	1509	0.3
Myristicin	1724	1520	0.5
Lauric acid	1746	1568	5.1
Spathulenol	1797	1576	0.6
Caryophyllene oxide	1807	1581	6.5
Caryophylla-4(12), 8(13)- diene-5-beta-ol	1859	1639	2.8
β-Tumerone	1868	1664	1.0
Myristic acid	1943	-	0.5
1-Hydroxy-3-propyl -5-(4-methyl-panten)- 2-methyl (benzene)	2016	-	25.2
2,5,5 Trimethyl 3-n propyl, tetra hydro1-naphtol	2034	-	19.8
Total			89.7

[a]Compounds listed in order of elution; [b]RI (retention index) measured relative to n-alkanes (C9-C18) on the non-polar DB-5 column under condition listed in the materials and methods section; [c]RI, (retention index) from literature; -, not found in literature.

specimen was deposited at the herbarium of Department of Pharmacognosy, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran, Iran under code number 74. The dried flowers were submitted to hydro distillation in a Clevenger-type apparatus for 4 h. At the end of distillation, the oil was collected, dried with anhydrous Na_2SO_4, measured and transferred to glass flasks that were filled to the top and kept at a temperature of -18°C for further analysis.

Analysis of the essential oils

Oil sample analyses were performed on a Hp-6890 gas chromatograph (GC) equipped with a flame ionization detector (FID) and a DB-5 capillary column, 30 m x 0.25 mm, 0.25 µm film thickness, temperature programmed as follows: 60 to 240°C at 4°C/min. The carrier gas was N_2 at a flow of 2.0 ml/min; injector port and detector temperature were 250 and 300°C, respectively. Samples were injected by splitting and the split ratio was 1:10. Gas chromatography-mass spectrophotometry (GC-MS) analysis was performed on a Hewlett-Packard 6890 /5972 system with a DB-5 capillary column (30 m x 0.25 mm; 0.25 µm film thickness. The operating conditions were the same conditions as described above but the carrier gas was He. Mass spectra were taken at 70 eV. Scan mass range was from 40 to 400 m/z at a sampling rate of 1.0 scan/s. Quantitative data were obtained from the electronic integration of the FID peak areas. The components of the oil were identified by their retention time, retention indices, relative to C9-C28 n-alkanes, computer matching with the WILEY275.L library and as well as by comparison of their mass spectra with those of authentic samples or with data already available in the literature (Adams, 2007). The percentage of composition of the identified compounds was computed from the GC peaks areas without any correction factors and was calculated relatively.

RESULTS AND DISCUSSION

The hydro distillation of *C. tinctorius* flowers gave yellowish oil with a yield of 1.2% (V/W), on fresh weight basis. The oil was analyzed by GC/MS. 29 components were identified in the oil, which represented about 89.7% of the total detected constituents. The general chemical profiles of the tested oil, the percentage content of the individual components, retention indices and retention times are summarized in Table 1.

From Table 1, it is evident that the major constituents of *C. tinctorius* flower oil were 1-hydroxy-3-propyl-5-(4-

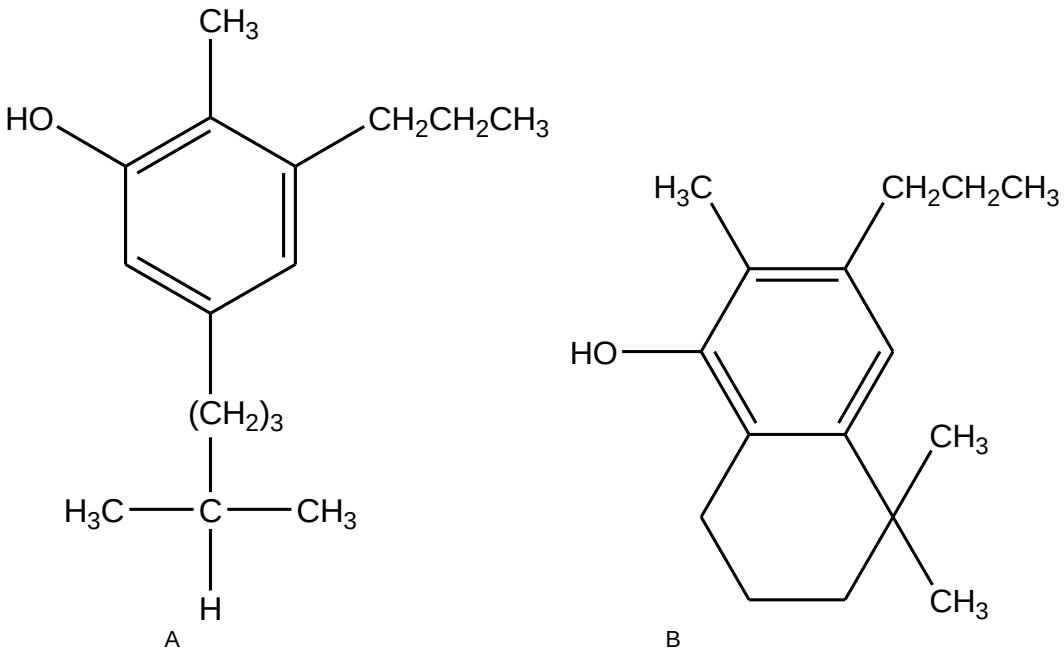

Figure 1. Structures of 1-Hydroxy-3-propyl-5-(4-methyl-penten)-2-methylbenzene (A) and 2,5,5 trimethyl-3-propyl,tetra hydro 1-naphtol (B) from the essential oil of *C. tinctorius* flowers.

methyl-penten)-2-methylbenzene (25.2%), 2,5,5 trimethyl-3-propyl,tetra hydro 1-naphtol (19.8%), benzaldehyde (8.0%), caryophyllene oxide (6.5%) and lauric acid (5.1%). Other components were present in amount less than 5% (Table 1).

The mass spectrum apart from the molecular ion peak at m/z 234 [m+] showed fragments at m/z 95.0510 base peak, corresponding to $C_{16}H_{26}O$ for 1-hydroxy-3-propyl-5-(4-methyl-penten)-2-methylbenzene. The structure was elucidated by spectroscopic method. The other fragment peaks at m/z were 219, 206, 192, 177, 163, 149, 132, 117, 103, 91, 77, 57 and 41.

The mass spectrum for the second major compound of the oil, 2,5,5 trimethyl-3-propyl,tetra hydro 1-naphtol which had [M]+ at 232 m/z suggested the molecular formula $C_{16}H_{24}O$. The other fragment peaks at m/z were 217, 203, 189, 175, 161, 147, 130, 115, 105, 91, 77, 57 and 41.

These two structures were elucidated just by mass spectra. The most possible and inexhaustible structures were determined for these two compounds (Figure 1). Further phytochemical investigations are suggested to elucidate their exact molecular structures. The major components of the essential oil under study were not the same as those of the plants *C. tinctorius* investigated before.

Daily variations in essential oil composition of the flowers of different accessions from *C. tinctorius* L. cultivated in Sichuan Province of China have been analyzed (Shao et al., 2011). Among 48 compounds, caryophyllene, p-allyltoluene, 1-acetoxytetralin and heneico-sane were the major components whose relative percentage contents to total essential oil were from 51.66 to 76.69%.

The differences in chemical composition of essential oil of the present study and previous research may be because of the geographic and climatic factors, chemo types, drying conditions and mode of distillation.

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