

Volatile oil composition of *Carthamus Tinctorius* L. flowers grown in Kazakhstan

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Abstract

Introduction and Objective. *Carthamus tinctorius* L. is commonly known as Safflower. *C. tinctorius* extracts and oil are important in drug development with numerous pharmacological activities in the world. This plant is cultivated mainly for its seed which is used as edible oil. For a long time, *C. tinctorius* has been used in traditional medicines as a purgative, analgesic, antipyretic and an antidote to poisoning. It is a useful plant in painful menstrual problems, post-partum haemorrhage and osteoporosis.

Objective. The subject of this study is the seeds of Kazakhstan species of 'Akmai' safflower, collected in the flowering stage in Southern Kazakhstan. Volatile oil was carried out to study the component composition of Kazakhstan 'AkMai' safflower flowers.

Materials and Method. Pale yellow oily extracts were obtained by varying the process parameters. The volatile oil obtained by hydrodistillation of the petals *Carthamus tinctorius* L. was analyzed by gas chromatography/mass spectrometry (GC/MS). The yield of the oil was 0.175 % (v/w). 20 compounds representing 99.81% of the oil were characterized. The volatile oil was found to be rich in undecanoic acid, octane, 2-nonen-1-ol, hexadecanal, dodecanal, dec-2-en-1-ol, nonanoic acid, tetradecanoic acid, 2-pentadecanone, 6,10,14-trimethyl, 1,2-benzenedicarboxylic acid, isobutyl-beta-phenylpropionate, 1,3-cyclohexadiene, myrtenic acid, octadecanoic acid, heneicosanoic acid, 2(3H)-furanone, 4,4-dipropylheptane, hexacosane, 1-icosanol, as well as heptacosane.

Results. Volatile oil from the flowers of the Kazakhstan safflower species 'Ak-Mai' were investigated by GC/MS which allowed the detection of 20 compounds. Biologically active complex of the flower of the Kazakhstan safflower species 'Ak-Mai' was released for the first time by using this oil.

Key words

Carthamus tinctorius, Asteraceae, Safflower, phytochemistry, volatile oil

INTRODUCTION

Carthamus tinctoris (Safflower *C. tinctorius*) belongs to Asteraceae family in the order of Asterales which contains about 22,750 genera and more than 1,620 species. The *Carthamus* species probably originated from Southern Asia and is known to have been cultivated in China, India, Iran and Egypt, almost from prehistoric times. During the Middle Ages it was cultivated in Italy, France, and Spain, and was introduced into the United States in 1925 from the Mediterranean region. *C. tinctorius* has been known as 'Golrang' in Iran. It is grown for the red/orange pigment in the flower petals which is used for colouring rice and bread, and for dyeing cloth. After synthetic aniline dyes took over this market in the 1800s, the crop was grown as an oilseed [1]. The seeds contain 30% oil, 20% protein, and 35% crude fibre. The seeds are also a rich source of minerals (Zn, Cu, Mn, and Fe), vitamins (Thiamine and B-carotene), and the

tocopherols (alpha, beta, and gamma) [2]. Safflower leaves, petals, and seeds have tremendous medicinal and therapeutic significance, and the petals are also used for extracting dye for colouring textiles and foodstuffs [3]. It contains a high amount of polyunsaturated fatty acid linoleic acid (70%) and monounsaturated oleic acid (10%), with small amounts of stearic acid [4]. The flowers of *C. tinctorius* are an important medicinal material in prescriptions used for cardiovascular, cerebrovascular and gynecological diseases. In China, the water extract of *C. tinctorius* has been developed as an intravenous injection, which is extensively applied to treat cardiovascular diseases clinically [5]. Its dye is mainly used as a colouring agent [6].

OBJECTIVE

The aim was to study the biological activity and chemical composition of the essential oil of *C. tinctorius*. The oil was studied by GC-MS which allowed detecting 23 compounds. The biologically active complex of flower of the Kazakhstan safflower species 'Ak-Mai' was released for the first time by using this oil.

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MATERIALS AND METHOD

Plant material and authentication. Flowers of *C. tinctorius* were collected from the Southern Kazakhstan region during the flowering stage in the summer of 2013. The plant was identified by Konyrbekov M, taxonomist of the station. A voucher specimen was deposited at the herbarium Krasnovodopadskaya Breeding Experimental Station, Ministry of Agriculture, Republic of Kazakhstan. The plant material (seeds and petals) which includes fresh green leaves which were washed, shade and dried at 18 °C for 15 days.

Isolation of volatile oil. The petals of *C. tinctorius* (350 g) were hydro-distilled for 220 minutes with a Clevenger apparatus. The yield of volatile oil obtained was 0.175%. The light yellowish-coloured volatile oil was collected in a graduate tube. The resulting volatile oil was dried with anhydrous Na₂SO₄, measured band transferred to glass vials and kept at a temperature of 4±2 °C for further analysis.

Solvents and chemicals. Gallic acid, Ascorbic acid, 1,1-diphenyl-2-picrylhydrazyl (DPPH), Ciprofloxacin, Amphotericin-B Chloroquine, Pentamidine were obtained from Sigma Aldrich. Analytical grade solvents were used during the experiments (Merck Chemicals, Mumbai, India, and Sigma Aldrich).

GC-MS analysis. The oil was analysed by GC-MS on a Varian CP-3800 GC coupled to a Varian Saturn 2000 MS/MS. The GC was equipped with a DB-5 fused silica capillary column (30mm x 0.25 mm, with a film thickness of 0.25 um) operated under the following conditions: injector temperature, 240 °C, column temperature, 60–240 °C at 3 °C per minute, then held at 240 °C for 5 min; carrier gas, He; injection volume, 1 µL (splitless). The MS mass ranged from 40–650 m/z, filament delay of 3 min, target TIC of 20,000, a pre-scan ionization time of 100 µ sec, an ion trap temperature of 150 °C, manifold temperature of 60 °C, and a transfer line temperature of 170 °C.

Identification. The individual peaks/constituents were identified by gas chromatography by comparison of their retention indices (R.I.) either with those of authentic compounds available in the author's laboratory, or with those in the literature in close agreement to R.I [7–10]. Identification was then made by comparison of fragmentation pattern of mass spectra obtained by GC-MS analysis with those stored in the spectrometer database of libraries and published literature [11–12]. Retention indices of the components were determined relative to the retention times of a series of n-alkanes relative to C9–C20.

RESULTS

The hydro distillation of *Carthamus tinctorius L* flowers gave a yellowish oil with a yield of 1.6 % (V/W), on fresh weight basis. The oil was analysed by GC/MS. 20 components were identified in the oil, which represented about 99.81% of the total detected constituents. The general chemical profiles of the tested oil, the percentage content of the individual components, retention indices and retention time are summarized in Table 1, which shows that the major

Table 1. Chemical composition of volatile oil *Carthamus tinctorius L*.

No.	Compound name	RI	Area %
1	1,3-cyclohexadiene	617	1.07
2	myrtenoic acid	617	0.71
3	4,4-dipropylheptane	746	0.51
4	isobutyl-beta-phenylpropionate	633	1.89
5	2(3H)-furanone	747	0.79
6	1,2-benzenedicarboxylic acid	754	3.01
7	octane	837	1.17
8	undecanoic acid	838	7.79
9	heneicosanoic acid	867	4.29
10	tetradecanoic acid	872	1.52
11	octadecanoic acid	887	1.8
12	nonanoic acid	891	17.94
13	dec-2-en-1-ol	918	14.30
14	2 pentadecanone, 6,10,14-trimethyl	919	6.12
15	hexadecanal	930	0.20
16	2-nonen-1-ol	943	0.47
17	hexacosane		0.40
18	heptacosane	961	34.75
19	1-icosanol	966	0.15
20	Total		99.81

constituents of *Carthamus tinctorius L*. flower oil are: undecanoic acid, octane, 2-nonen-1-ol, hexadecanal, dodecanal, dec-2-en-1-ol, nonanoic acid, tetradecanoic acid, 2 pentadecanone, 6,10,14-trimethyl, 1,2-benzenedicarboxylic acid, isobutyl-beta-phenylpropionate, 1,3-cyclohexadiene, myrtenoic acid, octadecanoic acid, heneicosanoic acid, 2(3H)-furanone, 4,4-dipropylheptane, hexacosane, 1-icosanol, and heptacosane.

Table 2. Inhibitory effect of extracts on PTRIB

Sample	IC ₅₀ (µg/ml)
<i>Carthamus tinctorius L</i> .	13.73398±0.040706

Pale yellow oily extracts were obtained by varying the process parameters. Volatile oil from the flowers of Kazakhstan safflower species 'Ak-Mai' were investigated by GC/MS. The mass spectrum of the oily extract showed the peak at which 20 compounds were found (Fig. 1).

The *in vitro* PTPIB activity assay was performed based on a protocol previously described by Taghibiglou et al [13]. PTPIB reaction system contained 5 mM pNNP 0.09 µM his-PTPIB₁₋₃₂₁ and buffer containing 20 mM HEPES, 150 mM NaCl, and 1 mM EDTA (PH 7.0). After incubation of extracts for 10 min, the reaction was initiated by the addition of pNNP. The amount of produced pNP was measured by detection absorbance at 405 nm using microplate spectrophotometer (SpectraMax M5/M5e, America). IC₅₀ value was calculated by fitting data with Origin software.

The *in vitro* activity experimental system was established according to literature methods (Burke TR, Ye Jr B, Yan X, et.al. *Biochemistry* 1996, 35, 15989–15996) and applied to detect the inhibitory ability of the extracts. NaVO₃ was used as positive control. The IC₅₀ of NaVO₃ was 1.8038 ± 0.0248(µg/ml).

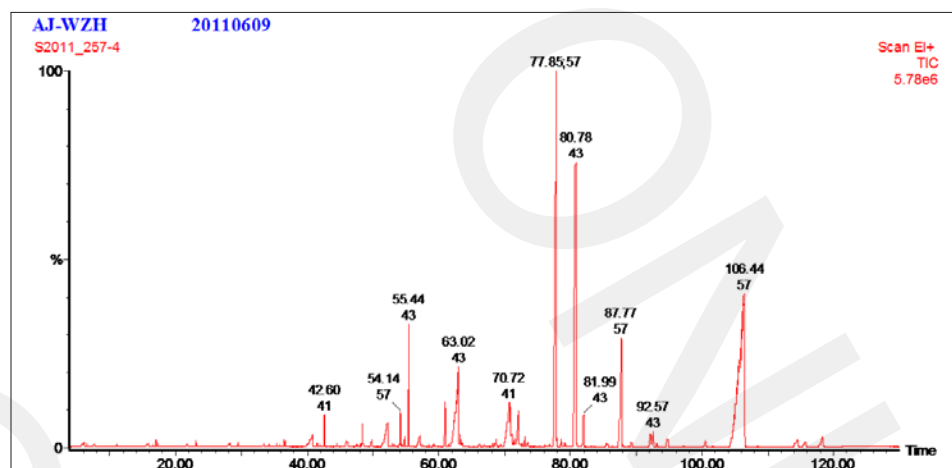


Figure 1. GC/MS spectra of volatile oil *Carthamus tinctorius* L.

DISCUSSION

A number of chemical constituents, such as flavonoids, phenylethanoid glycosides, coumarins, fatty acids and steroids have been isolated from different parts of the plant [5]. There are records that it is used for reducing ailments from the neurotropic, cardiotropic, haemopoietic, and diaphoretic systems. Many clinical and laboratory studies support the use of the medicine properties of safflower for menstrual problems, cardiovascular disease, pain, and swelling associated with trauma [14]. Safflower flowers produce red and yellow pigments which are mainly used as dye material [15]. Flavonoid glycosides, carthamin, a flavonoid type dye, and safflower yellow are the main constituents in the flower of *C. tinctorius* [6]. The flowers also contain carthamidin, isocarthamidin, quercetin, kaempferol, 6-hydroxykaempferol and its glycosides, chalcones including hydroxysafflor yellow A, safflor yellow A, safflamin C and safflamin A, and safflomin-A [16–17].

Safflower is useful for the treatment of diabetes and its complications. The flower can reverse the metabolic disorders occurring in alloxan induced diabetes. Considering these effects on these lipid components, it can be assumed to be a potential hypolipidemic agent, which will be a great advantage both in diabetic conditions as well as the associated atherosclerosis or hyperlipidemic conditions [18].

CONCLUSIONS

From the results of the presented study, it can be concluded that the safflower collected from the southern region of Kazakhstan is one of the best genotypes available. In conclusion, 20 chemicals in *Carthamus tinctorius* L. essential oils can be identified by GC-MS analysis. The essential oils from safflower have PTP1B anti-diabetic activity. The results obtained show that the essential oil is worth investigating further. Hence, it is important primarily in order to expend the natural source of PTP1B antidiabetic activity, and it is useful for the rational utility and further study of *Carthamus tinctorius* L.

Therefore, further research should be carried out on the isolation and identification of components of the extract from *Carthamus tinctorius* L.

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