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GC-MS analysis and Antioxidant Activity of *Foeniculum vulgare* Mill.

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Abstract

Fruit of Foeniculum vulgare was subjected to extraction of essential oil by hydro distillation in Clevenger apparatus. The compositions of essential oil so collected were determined by GC-MS analysis and it showed the presence of four different compounds. The most abundant were Anethole (77.58%), D-Limonene (11.19%) and Fenchone (10.47%). Antioxidant activity of the essential oil of Foeniculum vulgare was studied. Plant extract also showed efficient DPPH antioxidant activity with IC_{50} = 99.2 ± 2.1 mg/mL.

***Keywords**: Foeniculum vulgare Mill., Essential oil, GC-MS, Antioxidant*

Introduction

Foeniculum vulgare (fennel) belongs to the family Umbelliferae (Apiaceae). It is used to impart flavor to a number of foods, such as soups, sauces, pickles, breads, cakes etc.[1] Fennel is annual, biennial or perennial herbs distributed in central Europe and Mediterranean region. It is widely cultivated throughout the temperate and tropical regions of the world for its aromatic fruits.[2]

Foeniculum vulgare has two commercially important fennel types: bitter fennel and sweet fennel. [3] It is growing to a height ranging from 70 to 200 cm.[4] Fennel plant is glabrous herb with pinnately dissected and segmented linear leaves. Flowers are in compound umbels and yellow.[5]

The major components of fennel are phenylpropanoid derivates: trans-anethole and methyl chavicol. Other major components of fennel include α-phellandrene, fenchone, and α-pinene.[3] Some phenolic compounds such as chlorogenic acid, quercetin-3-O-rutinoside, quercetin-3-O-glucuronide, kaempferol-3-O-glucuronide, isoquercitrin, and isorhamnetin-3-O-glucoside are found on fennel.[6]

Fruits of fennel are sweet, acrid, bitter, emollient, alexipharmic, expectorant, haematinic, opthalmic, alexipharmic, expectorant, haematinic, opthalmic, intellect-promoting, anthelmintic, carminative, digestive, stomachic, antiemetic, cardiac stimulant, diuretic, vermicidal, galactogogue, antimicrobial and tonic. It is also used to control flatulent dyspepsia and colic in children.[5,7] Herbal drugs and essential oils of fennel have hepatoprotective, antispasmodic, anti-inflammatory, analgesic and antioxidant activities.[3]

Experimental Methods

Collection of Plant Materials

The fruit of fennel plant was collected from Karnali, Nepal. The plants were identified by Department of Botany, Amrit Campus, Lainchour, Kathmandu, Nepal.

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Extraction of Essential Oil

About 0.95 Kg of *Foeniculum vulgare* fruits were crushed for hydro distillation and subjected to a Clevenger apparatus at 4000ml of distilled water about four hours. By this process about 6ml of pale yellow essential oil was collected and stored in a sealed glass vials at low temperature (0-4 °C) prior to analysis.

GC-MS Analysis

The essential oils sample of *Foeniculum vulgare* was subjected to GC-MS analysis. GC-MS analysis was performed on a gas chromatography mass spectrometer GCMS-QP2010 under the following condition: injection volume 1μL with split ratio 1:50; Helium as a carrier gas with a Rtx-5MS column of dimension 30m×0.25mm×0.25μm, temperature programmed at 40, 200 and 280 ^{o}C with a hold time of 2.0, 3.0 and 4.0 min identification was accompanied by comparison of MS with those reported in NIST 05 and FFNSCI.3 libraries. It was performed in Department of Food Technology and Quality Control, Nepal Government, Babarmahal, Kathmandu, Nepal.

Antioxidant Assay (DPPH method)

The working solutions (25, 50, 100 and 200) mg/ml of the *F. vulgare* oil were prepared in methanol. 0.1mM of DPPH solution was prepared in dark bottle by mixing 2mg of DPPH powder in 50ml of methanol. Briefly 1.5ml of DPPH solution was mixed in 0.5ml of different concentrated sample. The mixture was shaken and kept for 30 minutes at room temperature. Their absorbance was taken at 517nm against DPPH as a blank. DPPH (1.5ml of 0.1mM) and methanol 0.5ml was used as blank. DPPH Radical Scavenging Activity (% inhibition) was calculated. IC_{50} values were measured from % inhibition versus concentration graph.

Results and Discussion

GC-MS Analysis

GC-MS analysis of essential oils of fruits of *F. vulgare* shows the presence of four different compounds. The chemical compounds identified in essential oils of the fruits of the *F. vulgare* plant are presented below:

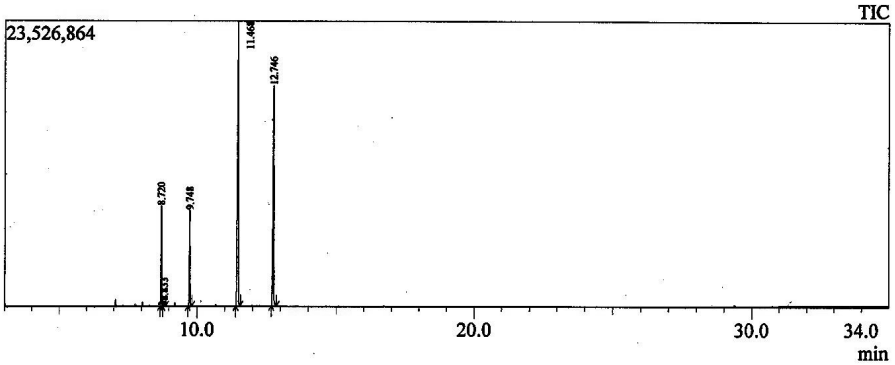

Figure 1: *Chromatogram of essential oils of F. vulgare*

The major constituents present in the essential oils sample were Anethole (77.58%), D-Limonene (11.19%) and Fenchone (10.47%). Constituents of essential oils of *F. vulgare* are tabulated as follows.

Table 1: List of compounds in essential oils of *F. vulgare*

S.N.	Name of the compounds	Molecular Formula	Molecular Weight	Retention Time	Area %	Height %
1.	D-Limonene	$C_{10}H_{16}$	136	8.720	11.19	14.21
2.	β-Pinene	$C_{10}H_{16}$	136	8.833	0.76	0.69
3.	Fenchone	$C_{10}H_{16}$	152	9.748	10.47	13.53
4.	Anethole	$C_{10}H_{16}O$	148	11.468	44.68	40.37
5.	Anethole	$C_{10}H_{16}O$	148	12.746	32.90	31.21
					100.00	100.00

The mass spectral data of individual compounds are given below.

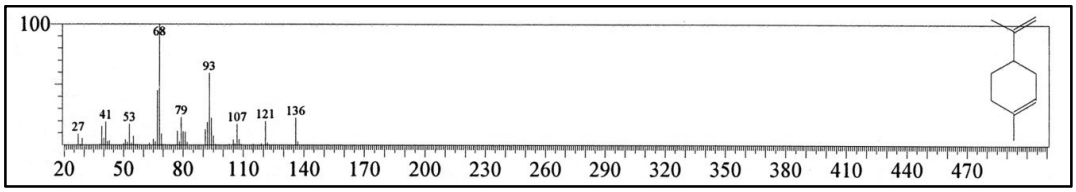

Figure 2: *Mass spectral data of D-Limonene*

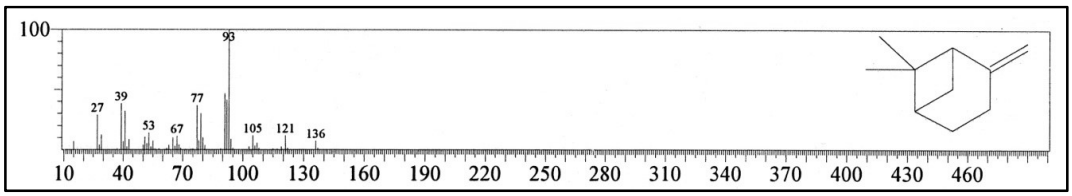

Figure 3: *Mass spectral data of β-Pinene*

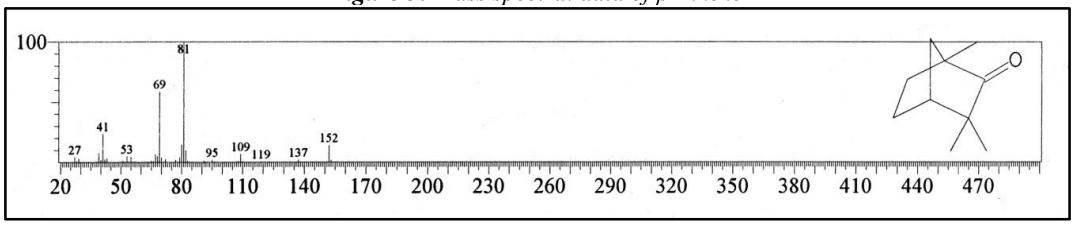

Figure 4: *Mass spectral data of Fenchone*

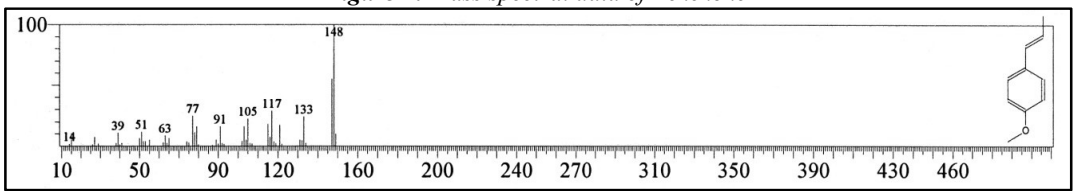

Figure 5: *Mass spectral data of Anethole*

Antioxidant Activity

The antioxidant potential is in an inverse relation with IC_{50} value, which can be calculated from linear regression of the % inhibition verses antioxidant activity. Lower the IC_{50} value indicates high antioxidant activity.

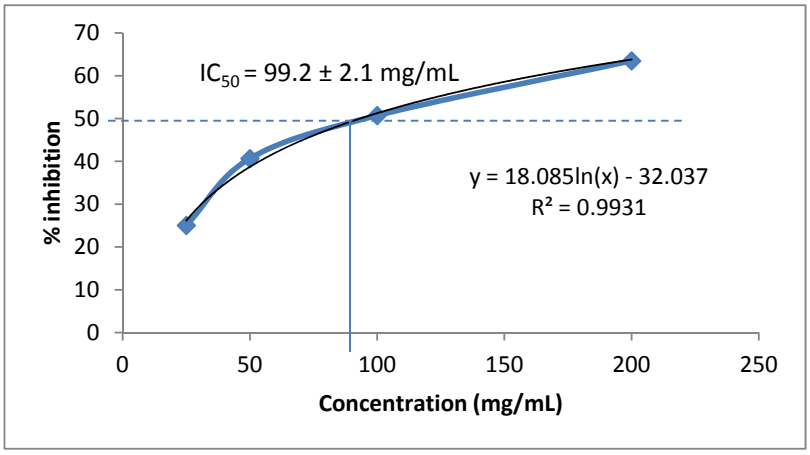

Figure 6: *Graphical representation of DPPH assay of the methanolic extract of F. vulgare*

The IC_{50} ± SEM of the oil was found to be 99.2 ± 2.1 mg/mL and the standard quercetin was 2.28 ± 0.1 µg/mL.

Conclusion

GC-MS analysis of essential oils of fruits of *F. vulgare* showed the presence of 4 different compounds. The major constituents present in the essential oils sample were Anethole (77.58%), D-Limonene (11.19%) and Fenchone (10.47%). The IC_{50}±SEM of the essential oil was found to be 99.2 ± 2.1 mg/mL.

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