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Research Article

GC/Mass Analysis of *Adiantium capillus veneris Linn*

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Abstract

Adiantium capillus veneris linn is a member of Adiantaceae family which has been used as a folk medicine in management of hyperglycemia and in bacterial resistance as they contain a large number of antioxidant compounds. Although there are some reports showing the phytochemical screening of methanolic and ethanolic extract but there is no phytochemical screening of the water extract even though it is the one used by people in folk medicine.

The powdered dried leaves of *A. capillus veneris L.* was extracted continuously by Soxhlet extractor. Furthermore the water extract of the whole leaves was introduced to Gas chromatography – Mass spectroscopy technique. GC/MS analysis revealed the presence of 105 compounds, 6 of them could not be identified.

Keywords: Adiantium cappillus veneris Linn; Gas Chromatography; Mass Spectroscopy; Phytochemical; Folk Medicine

Introduction

The knowledge about use of medicinal plants has been accrued through centuries time and such plants are still valued even today, although synthetics, antibiotics etc. have attained greater prominence in modern medicine. it is, however, a fact that these synthetics and antibiotics although they often show miraculous and often instantaneous results, prove harmful in the long run and this is why many synthetics and antibiotics have now gone out of use or suggested to be used under medicinal supervision. In the case of most medicine plants, however, no such cumulative derogatory effect has been recorded and many of medicines obtained from plants are widely used [1].

A. capillus veneris L. has potential importance in medicinal and nutritive purpose. It is used for chest complaints, cough, expectorant and for increasing lactation, colds, kidney function improvement, antiparasitic and dandruff. Also it is used for depurative, emetic, emollient, febrifuge, galactagogue, Alopecia and tonic [2]. Furthermore this plant reported to be useful as de-toxicant in alcoholism and to expel worms from the body [3], and to has positive modulation of oxidation-linked diseases such as diabetes [4].

Phytochemistry in the strict sense of the word is the study of phytochemicals. These are chemicals derived from plants. In a narrower sense the term is often used to describe a large number of secondary metabolic compounds found in plants [5].

Phytochemical screening of medicinal plants is very important in identifying new sources of therapeutically and industrially important compounds. A variety of herbs and herbal extracts contain different phytochemicals with biological activity. They have a valuable therapeutic index as demonstrated in the last decade by many researches [2,6,7].

Phytochemical screening of *A. capillus veneris L.* leaves were performed according to standard procedure [5] and since the 1960s, 124 compounds, including terpenoids, flavonoids, phenyl propanoids, steroids, alicyclic acids, lipids and long-chain compounds have been reportedly isolated from the genus. Triterpenoids and flavonoids are the dominant constituents within the genus Adiantum [8].

The GC-Mass Spectrometer has become one of the most sensitive and powerful instruments for the identification of organic compounds [9].

A study by Nakane*., et al.* in 1999 on the active principles in the *A. capillus veneris L.* whole plant Alcoholic extract by GC-MS analysis clearly showed the presence of six new Triterpenoid [10]. Another study by Ibraheim., *et al*. in 2011 on the alcoholic extract yielded seven compounds: four triterpenoid compounds were isolated from the hexane fraction and identified as isoadiantone, isoadiantol-B, 3-methoxy-4-hydroxyfilicane and 3,4-dihydroxyfilicane and three flavonoids were isolated from the ethyl acetate fraction and identified as: quercetin, quercetin-3-O-glucoside and quercetin-3-O-rutinoside some of the isolated compounds showed an anti-inflammatory activity while the hypoglycemic study of the total alcoholic extract showed a significant activity [11].

Until now there is no documentation for GC/Mass screening for *A. capillus veneris L*. aqueous extract. One of our aims in this study is to provide total GC/Mass screening for *A. capillus veneris L*.

Materials and Methods

Plant Collection and Identification

Samples of *A. cappillus veneris L*. were collected from the valleys of Derna – Libya during the winter of 2011-2012. The botanical identification of *A. cappillus veneris L.* was determined with the aid of the description given by the Libyan Flora [12] and was eventually confirmed by comparison with authentic samples obtained from herbarium of the Department of Botany University of Benghazi. The plant were allowed to dry at room temperature and the leaves were then ground into powder state using a commercial blender, and finally used for the preparation of different extracts.

Plant Extraction

Powdered plant (25g) was extracted with 250 ml of distilled water by Soxhlet extractor (size 29-24) for 24 hrs. Then evaporated to dryness at 70 - 80^{0}C by Rotatory evaporator (RE2000).

Gas chromatography mass spectroscopy techniques

Agilent 6890 gas chromatograph equipped with an Agilent mass spectrometric detector.

GC condition

Column: Fused silica capillary column HP-5MS (30m x 0.32 mm x 0.25 µm film thickness).

Gas carrier: Helium was used at approximately 1.0 ml/min.

Solvent condition: The solvent delay was 3 minutes and the injection size was 1.0 µl.

Injection temperature: 280ºC

Injector temperature: 250ºC

Column temperature: 50ºC (3 minutes) then elevated to 280ºC at rate of 8ºC/min.

MS condition

Analyser mode: Electron impact ionization mode with an ionizing energy of 70 e.v. scanning from m/z 50 to 500.

Ion source temperature: 230ºC.

The electron multiplier voltage (EM voltage): 1050v.

U.V Lamp

Model CE7400, Deuterium F 500 mA, Tungsten T5A, Logic F3A, Power T.3.15A, Volts 110 - 250.

Result and Discussion

Gas chromatography -Mass spectrometric analysis of aqueous extract of *A. capillus veneris L.*

Phytochemical studies to identify the chemical composition of *A. capillus veneris L.* The aqueous extract of *A. capillus veneris L.* showed the presence of phenolic compounds, flavonoids, terpenoids, fats and waxes, alkaloids, quaternary and N-oxides fiber and triterpenoids as hydroxyl adianton [13] that its structure was elucidated by gas chromatography, and mass spectrometry (GC/MS) analysis.

Gas chromatography and Mass spectrometry (GC/MS) is an analytical technique used for the identification and quantitation of a wide variety of volatile and/or semi-volatile organic compounds in a mixture. This technique is an indispensable tool for analytical sample type. GC/MS utilizes the compound's intrinsic affinity for "stationary phase" (solid support with specialized coating) and facilitates the separation of complex sample mixture into component parts.

Essentially, a sample is injected into a hot inlet, which volatilizes the components in the sample. Next, an inert gas carries the volatile compounds through a coated glass capillary column. the glass capillary is coated with "stationary phase" housed in a 30 to 60 meter glass capillary column. The time it takes a specific compound to pass through the column and to a detector is called "retention time". Retention time, is inherently related to a compound's affinity to the stationary phase, it can be used to identify the analyte in question when compared to a reference standard. In addition, detection methods, such as mass detection can provide secondary mean of identification.

After separation of the sample, the component are injected to a mass detector. Mass spectrometry detection (MS) is used to identify the various component from their mass spectra. Each component has a unique or near unique mass spectrum that can be compared with a mass spectral database and thus identified. Through the use of reference standards, verification and quantitation are also possible.

Electron Ionization (EI) is typically the ionization method of choice, although Chemical Ionization (CI) is also an option. These techniques are used to ionize and/or fragment the analyte just as it enters the mass detectors.

Once the ions are produced, they may be trapped using an Ion Trap (IP) and subjected to further fragmentation from which daughter ions may be observed. Any of the fragment ions may then be trapped and fragmented again producing a mass signature specific for a particular molecule (MSn).

Figure 1 shows a typical chromatogram from *A. capillus veneris L.* of the essential mixture. Data library is obtained through registration of MS of the isolated pure compounds into a computer system considering retention times and mass spectra. Although the figure shows the first 28-minutes, actual run times exceeded 5-minutes. No peaks of sufficient size are observed after 29-minutes.

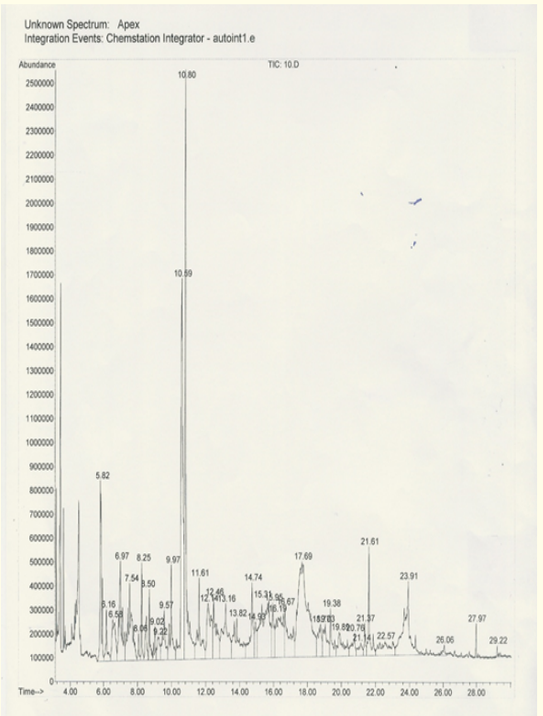


Figure 1: Typical chromatogram from *A. capillus veneris L.* of the essential mixture.

GC/MS analysis

To obtain mass spectral information for the mixture number of component in the initial mixture, the amount injected purposely resulted in column overload for some constituents. As a consequence, 39 unique mass spectra were found. Obvious from the data, however, was the presence of additional constituents whose concentration did not yield the minimum requirement of the least four consecutive invariant mass spectra figure 1. These compounds were not targeted for analysis; see table 1 for the list of compound identified using Wiley's MS library. Despite these libraries, 6 of 105 compounds could not be identified. This mass spectral information was collected over a period by automating the entire analytical sequence.

NO.	Compounds	RT (min)	Main ion	Ion 1 (AR%)	Ion 2 (AR%)	Ion 3 (AR%)	Ion 4 (AR%)
1a	Pentamethyldisiloxane	5.82	133	177.10	147.10	55.10	135.10
1b	2,3,5,6-tetramethyl benzamide		(100%)	(95.92%)	(27.38%)	(23.37%)	(15.64%)
1c	2-Methyl-5-nitro-2H-indazole						
		6.16	191.10	133.10	147.10	163.10	55.10
2a	1,2-Bis(trimethylsilyloxy)ethane		(100%)	(65.49%)	(50.09%)	(47.55%)	(23.78%)
2b	2-Fluoro-5-(trifluoromethyl) propiophenone						
3a	Phenol	6.58	94.10	66.10	281.10	65.10	55.10
			(100%)	(32.84%)	(27.61%)	(25.28%)	(13.73%)
4-a	6,8-Dioxabicyclo[3.2.1]c7octane	6.97	57.10	58.20	84.10	55.10	56.20
4b	3-Azonia-5-hexene-1-ol		(100%)	(41.41%)	(12.03%)	(10.70%)	(6.06%)
4c	6-(tert-butylsulfonyl)-6-methyl heptan-3-ol						
5-a	2-hydroxy-3-methylcyclopenta-2-en-1-one	7.54	61.10	112.10	55.20	69.10	83.10
5b	2,3-dihydropyradine		(100%)	(69.62%)	(34.52%)	(27.49)	(20.66%)
5c	2,3-dihyroxypyrazine						
6-a	2,5-dimethyl-4-hydroxy-3(2H)-furanone	8.06	128.10	57.10	55.20	85.10	56.10
			(100%)	(76.93%)	(32.63)	(27.32%)	(15.62%)
7-a	Hexamethylcyclotrisiloxane	8.25	207.10	208.10	209.00	193.00	191.10
7b	6-methyl-2-phenylindole		(100%)	(20.35%)	(17.23%)	(14.34%)	(8.95%)
8-a	2-Methoxyphenol	8.50	109.10	124.10	81.10	95.10	85.20
8b	2-Methoxyguaiacol		(100%)	(87.51%)	(81.10%)	(46.91%)	(27.26%)
9-a	4,5-Diamino-2-hydroxypyradine	9.02	126.10	71.10	97.10	55.10	53.10
9b	3-Hydroxy-2-methyl-4-pyrone		(100%)	(38.84%)	(31.04%)	(30.67%)	(16.42%)
10-a	2-(1,1-Dimethyl-2-propyl)bicycle [2.2.1] heptane	9.22	95.10	67.10	107.10	55.10	68.10
10b	2-(1-Methylpropyl)bicycle[2.2.1] heptaneEndo-tricyclo[5.2.1.0(2.6)] decane		(100%)	(19.53%)	(14.83)	(14.11%)	(13.64%)
10c	2,3-Dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one						
11a	1-Deutero-4-phenylbut-1-ene-3-yne	9.57	144.10	101.10	72.10	73.10	55.10
			(100%)	(65.96%)	(42.28%)	(41.44%)	(41.36%)
12a	2-Hydroxy-3-chloropyradine						
12b	1-Methoxy-1-methyl-1-silacyclo hexane	9.97	142.10	84.10	129.10	101.10	143.10
12c	2-amino-5-chloro-4-picoline		(100%)	(79.29%)	(73.6%)	(36.64%)	(34.36%)
12d	2-methyl-pentanedioic acid						
13a	1,2-Benzenediol	10.59	110.10	64.10	63.10	81.10	53.10
			(100%)	(29.23%)	(16.22%)	(14.20%)	(10.09%)

14-a	4-Vinylphenol	10.80	120.10	91.10	119.10	65.10	63.10
14b	2,3-Dihydrobenzofuran		(100%)	(46.87%)	(25.13%)	(14.65%)	(9.19%)
15-a	7-Methoxy-3,6,9-trimethyl naphtha [1,8-bc] pyran	11.61	225.10	240.10	133.10	226.10	124.10
15b	5,4'-Dimethoxy-2-methylbibenzyl		(100%)	(39.02%)	(21.39%)	(18.76%)	(11.18%)
15c	4-chloro-6-methoxy-5-[(trimethy lsilyl)ethy-nyl] pyramidine						
16a		12.14	110.10	81.10	121.20	117.10	53.20
	Hydroquinone (1,4-benzenediol)		(100%)	(30.69%)	(26.69%)	(25.32%)	(23.75%)
17-a							
17b	2-Methoxy-4-vinylphenol	12.46	150.20	135.10	110.10	107.10	77.10
	2-Hydroxy-5-methylacetophenone		(100%)	(75.28%)	(58.59%)	(41.07%)	(39.56%)
18-a							
18b	1-Ethyl-2-methylbenzene	13.16	105.10	77.10	120.10	112.10	95.20
18c	1,3,5-Trimethylbenzene			(51.61%)	(51.42%)	(40.01%)	(32.65%)
18d	1,2,4-Trimethylbenzene						
	1-Phenyl-1-pentanone (Valerophenone)						
19-a							
19b	N,N-Diethylbenzeneamine	13.82		149.10	55.10	112.10	79.10
	4-tert-butylaniline			(51.02%)	(19.27%)	(16.32%)	(15.67%)
20-a							
20b	4-Butylphenol	14.74		77.10	150.20	108.10	53.10
20c	4-(2-Methylpropyl)phenol			(100%)	(17.41%)	(11.26%)	(6.24%)
20d	4-Pentylphenol						
	2-Butylphenol						
21a	1-Nitro-2-acetamido-1,2-dideoxy-d-monnitol	14.93	57.10	73.10	55.10	107.10	69.10
21b	1-O-Methyl-d-fructose		(100%)	(53.34%)	(38.05%)	(34.92%)	(32.02%)
22a	2-(2butoxyethoxy) ethylthiocyanate	15.30	57.10	73.10	281.00	87.10	74.10
22b	Tetradecamethylcycloheptasiloxane		(100%)	(82.64%)	(47.90%)	(43.43%)	(31.87%)
23a	Eicosamethylcyclodecasiloxane	15.96	137.10	103.10	180.20	122.10	57.10
23b	1-(4-Hydroxy-3-methoxyphenyl)-2-propa-none-4-Hydroxy-3-methoxy phenyl acetic acid (Homovanillic acid)		(100%)	(25.77%)	(23.14%)	(18.93%)	(18.13%)
23c							
24a	3-Hydroxybenzaldehdeoxime 1-dipropylami-no-1-fluoro methylenephosphane	16.18	73.10	103.10	57.10	143.10	55.10
	2-methyl-2-(1-methylethyl)1,3-oxathiolane		(100%)	(88.39%)	(69.62%)	(66.10%)	(62.52%)
24b	Sorbitol						
24c	3-oxabicyclo[4.1.0]heptanes-7-carboxylic acid-3-(2-hydroxyethyl) phenol						
24d	3-(2-Hydroxyethyl)phenol						
24e	4-ethyl-3,4-dimethyl-2,5-cyclohexa dien-1-one						
25a	2-methylbenzaldehyde	16.67	107.10	73.10	91.20	69.10	55.10
25b	(Z)-3-Phenyl-2-propanoic acid		(100%)	(98.95%)	(62.01%)	(60.63%)	(58.31%)
25c	2-methylborneol						
25d							

26a	D(-)-Quinic acid	17.69	60.10	57.10	71.10	55.20	73.10
26b	(z)-6-acetylbicyclo[4.4.0]dec-2-en-4-one		(100%)	(97.71%)	(71.84%)	(65.61%)	(62.67%)
26c	3,5-diethyl-[1,2]-dithiolane-1,1-dioxide						
27-a	2-Methoxy-4-propylphenol	18.77	37.10	196.10	107.10	122.10	73.10
27b	3-(4-Hydroxy-3-methoxyphenyl) propanoic acid		(100%)	(17.82)	(16.76%)	(15.52%)	(15.30%)
27c	4-Hydroxy-3-methylbenzeneacetic 1-deuteri-oformyl-2-methoxy Benzene						
27d	Homovanillyl alcohol						
28-a	2-(4-Methoxyphenyl)glycolic acid methyl ester	19.03	137.10	73.20	107.10	57.20	55.10
28b	(2-Methoxyphenyl)glycolic acid		(100%)	(78.66%)	(66.18%)	(64.94%)	62.74%)
28c	4-(1-deuteroethyl)benzyl alcohol						
29-a	1,3-Dihydroxy-3,5,5trimethylcyclo hexyli-dene-4-acetic acid lactone	19.13	111.10	78.10	57.20	107.10	95.10
			(100%)	(75.13%)	(54.65%)	(52.45%)	(48.61%)
30-a	2-phenyl-4-methyl-2,3 -diazaphosphole	19.89	137.10	176.10	55.10	73.10	107.10
30b	4-[3-(4-tertbutylphenyl)-2-methyl propyl]-2,6-dimethylmorpholine		(100%)	(40.35%)	(35.11%)	(34.37%)	(29.41%)
30c	4-(2,2,6-trimethyl-7-oxabicyclo [4.1.0] hept-4-en-1-yl)pent-3-en-2-one						
31-a	1-(2-Admantylidene)semicarbazide	20.76	73.10	55.10	57.10	164.10	135.10
31b	N,N'-Bis(salicylindene)-1,2-diaminopropane		(100%)	(92.74%)	(79.36%)	(73.28%)	(65.12%)
31c	6-Diazo-2,4-cyclohexadien-1-one						
32a	4,8-Dimethyl-3,7-nonadien-2-ol	21.14	55.20	73.10	57.10	125.20	6920
32b	(1Ar,4R,4aS,7R,7aS,7bS)-1,1,4,7-tetra-methyl-2,3,4a,5,6,7,7a,7b-octahydro-1aH-cyclopropa[e] azulen-4-ol {Ledol}		(100%)	(88.47%)	(72.55%)	(68.78%)	(64.20%)
32c	(Z,1'RS,2'RS,3'RS)-1-(2',3'-epoxy-2',6',6'trimethylcyclohexyl) -3-methyl-1,3-butadiene.						
32d	Methyl arsenic acid						
33a	Z-11-Hexadecanoic acid {Palmatic acid}	21.37	55.20	73.10	57.20	69.10	97.20
33b	1-Octadecanoic acid		(100%)	(73.76%)	(66.96%)	(64.45%)	(57.98%)
34a	n-Hexadecanoic acid {Palmatic acid}	21.61	73.10	60.10	57.20	55.20	129.20
34b	tetradecanoic acid {Myristic acid}		(100%)	(71.08%)	(67.18%)	(65.83%)	(48.79%)
35-a	Stearic acid	22.57	73.10	55.10	60.10	57.20	71.20
35b	n-Pentadecanoic acid		(100%)	(92.83%)	(63.96%)	(60.28%)	(43.44%)
35c	Hexadecanoic acid {Palmatic acid}						
36-a	Octadecanoic acid {stearic acid }	23.91	73.10	55.10	57.20	60.10	284.30
			(100%)	(77.64%)	(76.98%)	(76.91%)	(61.60%)

37-a	Octadecanoic acid {stearic acid }	26.0	73.10 (100%)	55.10 (92.26%)	57.20 (91.18%)	60.10 (75.77%)	6920 (63.96%)
38-a 38b	Di-iso-octyl phthalate Dioctylphthalate	27.97	149.10 (100%)	167.10 (35.17%)	57.20 (23.15%)	71.20 (14.44%)	150.10 (13.54%)
38c	(E)-3-(((2-ethylhexyl)oxy) carbonyl)-2-methylenepent-3-enoic acid						
39-a 39b	4-propyl-1,2,3,4,5,6-hexahydro-1,5-methano-4,1-benzaza phosphocine-1-oxide Trimeprimine	29.22	55.10 (100%)	73.10 (99.65%)	249.10 (82.35%)	57.20 (76.46%)	207.10 (69.84%)

Table 1: List of compounds identified using Wiley's MS library

The results showed in the previous table was expected although the commercial library was based on pure compounds. Moreover, some commercial libraries used relative abundance acceptance criteria as high as 40%.

No library source provides all the data needed to provide comprehensive characterization of sample provides the means to identify compounds despite ion ratios that might differ from ideality.

Each sample component identified by means of a GC/MS separation, is listed along with its corresponding retention time, target ions, and relative abundances in table 1.

Despite the peak maximum for these compounds differing by less than 5 seconds, their mass spectral fingerprint is straightforward when little ion fragment overlap exists. For example, only one disiloxane ion at m/z 133. See corresponding table 2 and figure 2. In contrast, all four confirmation ions at m/z 177, 147, 135 and 55 encountered interference from the same ions produced by electron impact ionization of mixture sample. Actual and expected relative abundance were well within the accepted values.

NO.	Compounds	RT (min)	Main ion	Ion 1 (AR%)	Ion 2 (AR%)	Ion 3 (AR%)	Ion 4 (AR%)
1a	Pentamethyldisiloxane	5.82	133	177.10	147.10	55.10	135.10
1b	2,3,5,6-tetramethyl benzamide		(100%)	(95.92%)	(27.38%)	(23.37%)	(15.64%)
1c	2-Methyl-5-nitro-2H-indazole						

Table 2: List of compounds identified using Wiley's MS library at Retention Time (RT) of 5.82 min.

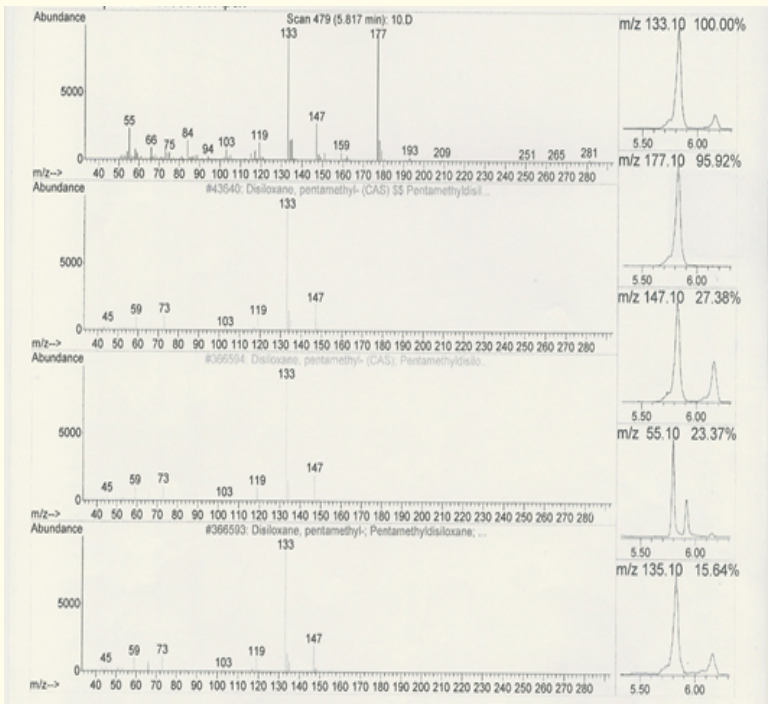
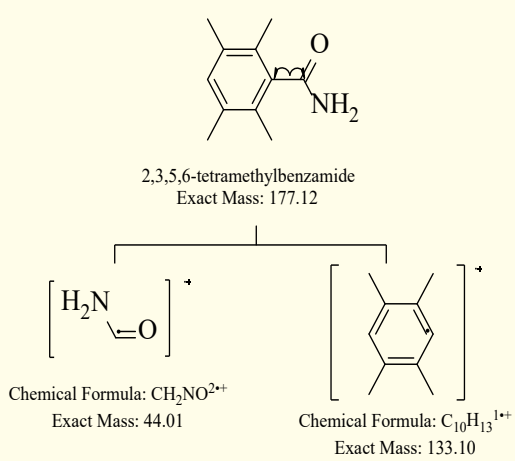
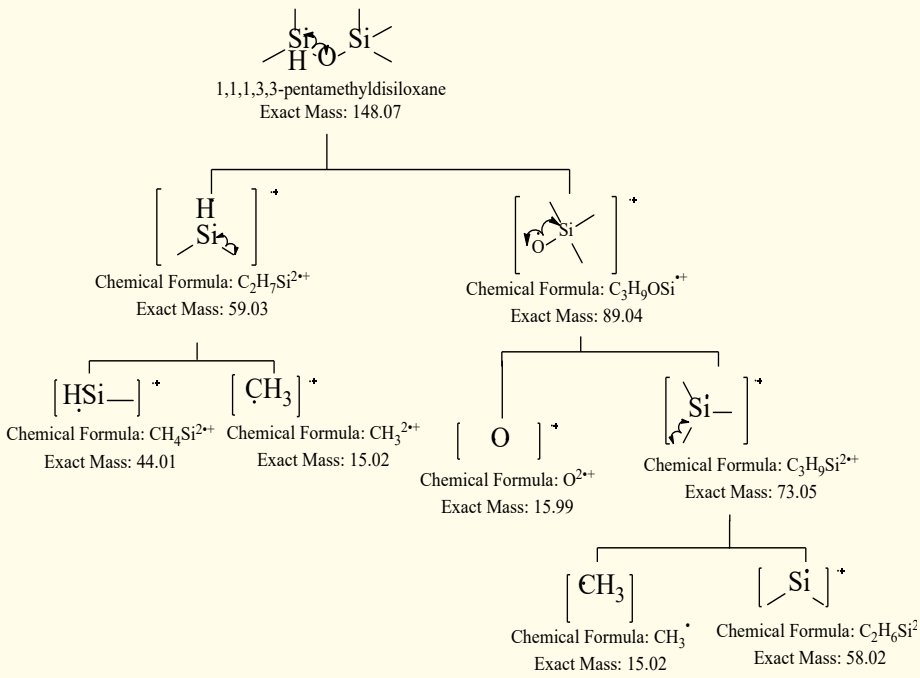


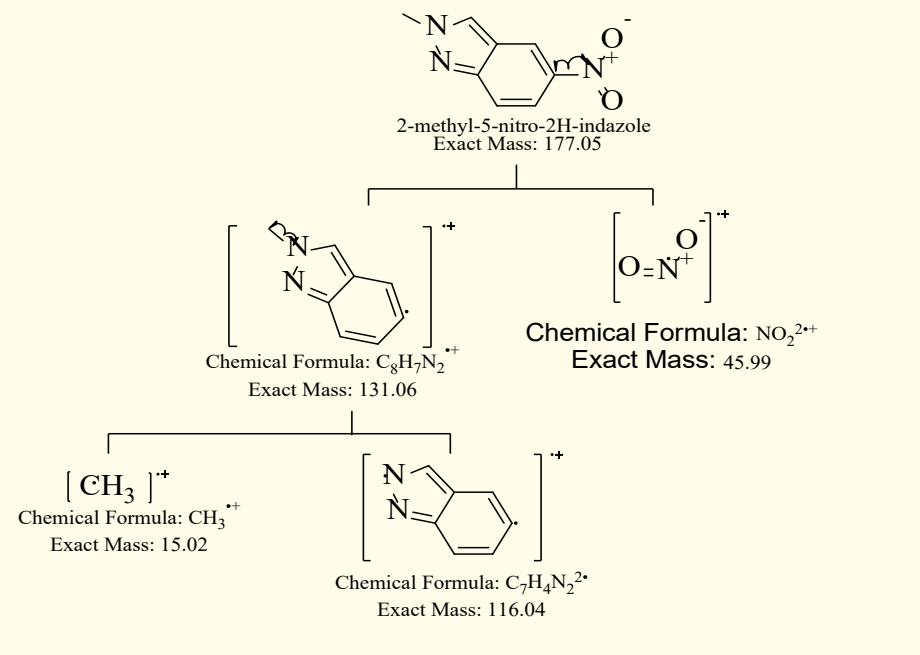
Figure 2: Spectra at RT of 5.28 min for *A. capillus veneris L.*



Scheme 2: Ion fragmentation for 2,3,5,6-tetramethyl benzamide.



Scheme 1: Ion fragmentation for Pentamethyldisiloxane.



Scheme 3: Ion fragmentation for 2-Methyl-5-nitro-2H-indazole.

The spectrum in figure 2 shows additional ion fragments that are not present in figure 1.

Tables 3-7 show the list of compounds identified using Wiley's MS library at retention time (RT) of 10.59, 10.80, 21.61 and 29.22 respectively, and figures 3-7 show the ion fragments for the previous RT respectively.

NO.	Compounds	RT (min)	Main ion	Ion 1 (AR%)	Ion 2 (AR%)	Ion 3 (AR%)	Ion 4 (AR%)
13a	1,2-Benzenediol	10.59	110.10 (100%)	64.10 (29.23%)	63.10 (16.22%)	81.10 (14.20%)	53.10 (10.09%)

Table 3: List of compounds identified using Wiley's MS library at Retention Time (RT) of 10.59 minutes

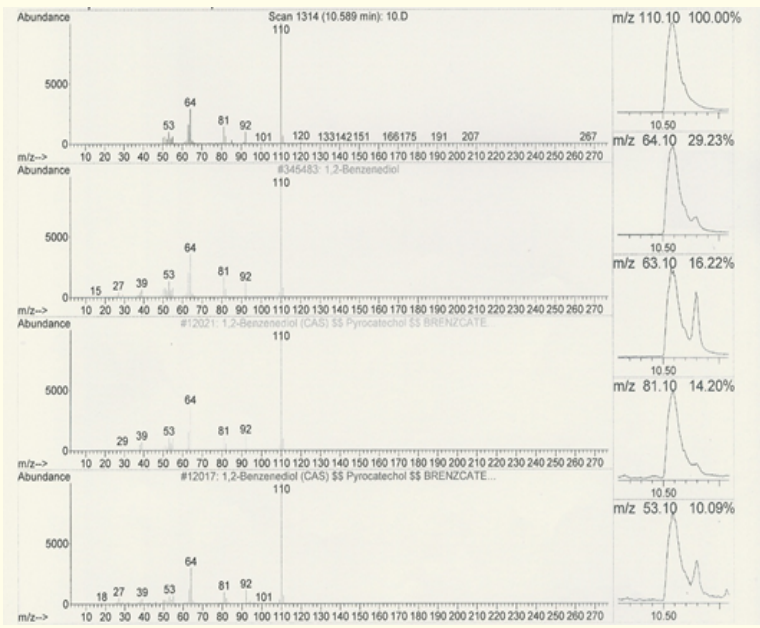
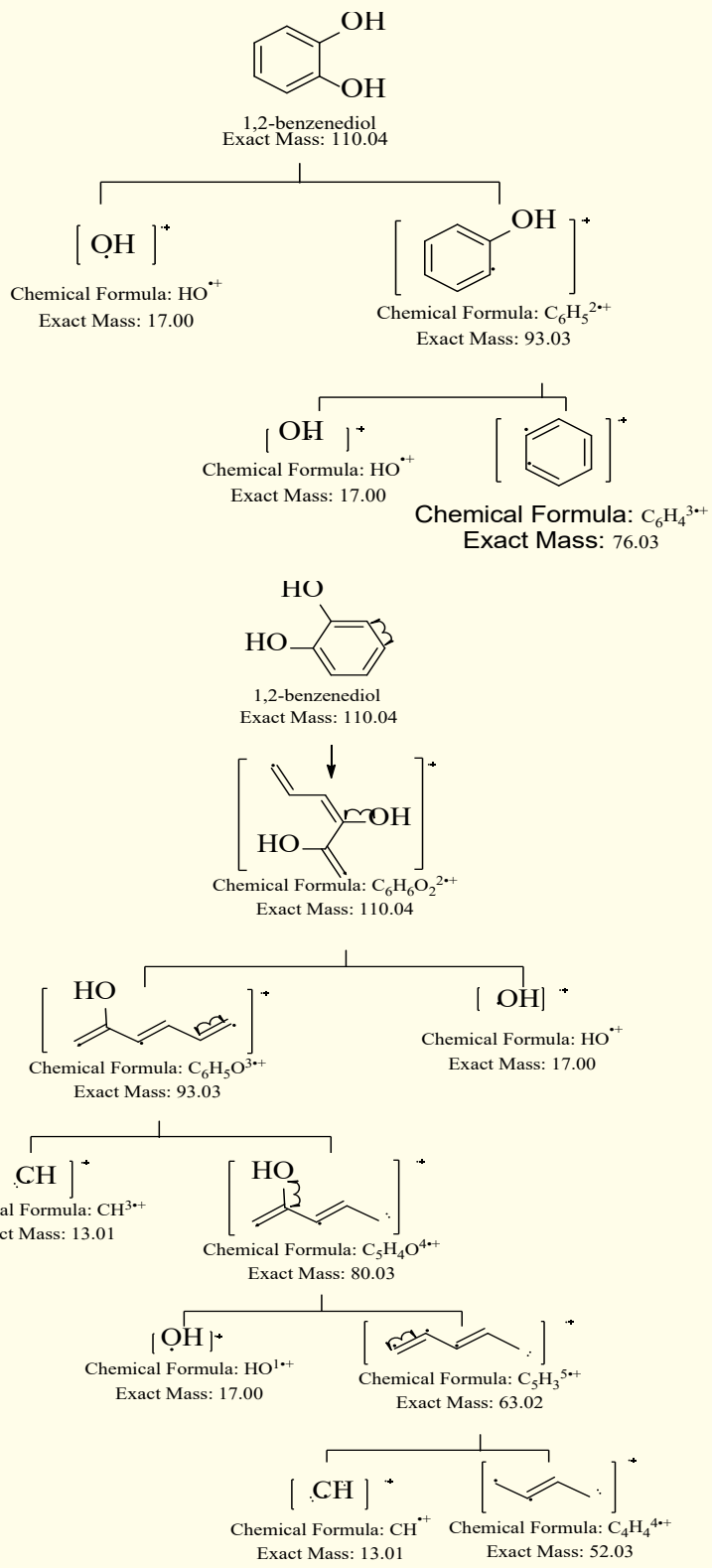


Figure 3: Spectra at RT of 10.59 min for *A. capillus veneris l.*



Scheme 4: Ion fragmentation for 1,2-Benzenediol.

NO.	Compounds	RT (min)	Main ion	Ion 1 (AR%)	Ion 2 (AR%)	Ion 3 (AR%)	Ion 4 (AR%)
14a	4-Vinylphenol	10.80	120.10	91.10	119.10	65.10	63.10
14b	2,3-Dihydro benzofuran		(100%)	(46.87%)	(25.13%)	(14.65%)	(9.19%)

Table 4: List of compounds identified using Wiley's MS library at Retention Time (RT) of 10.80 minutes.

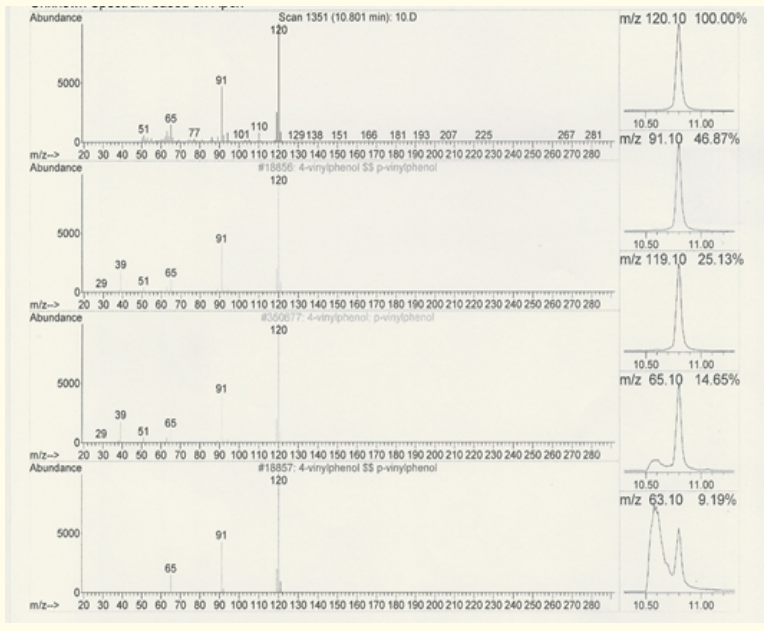
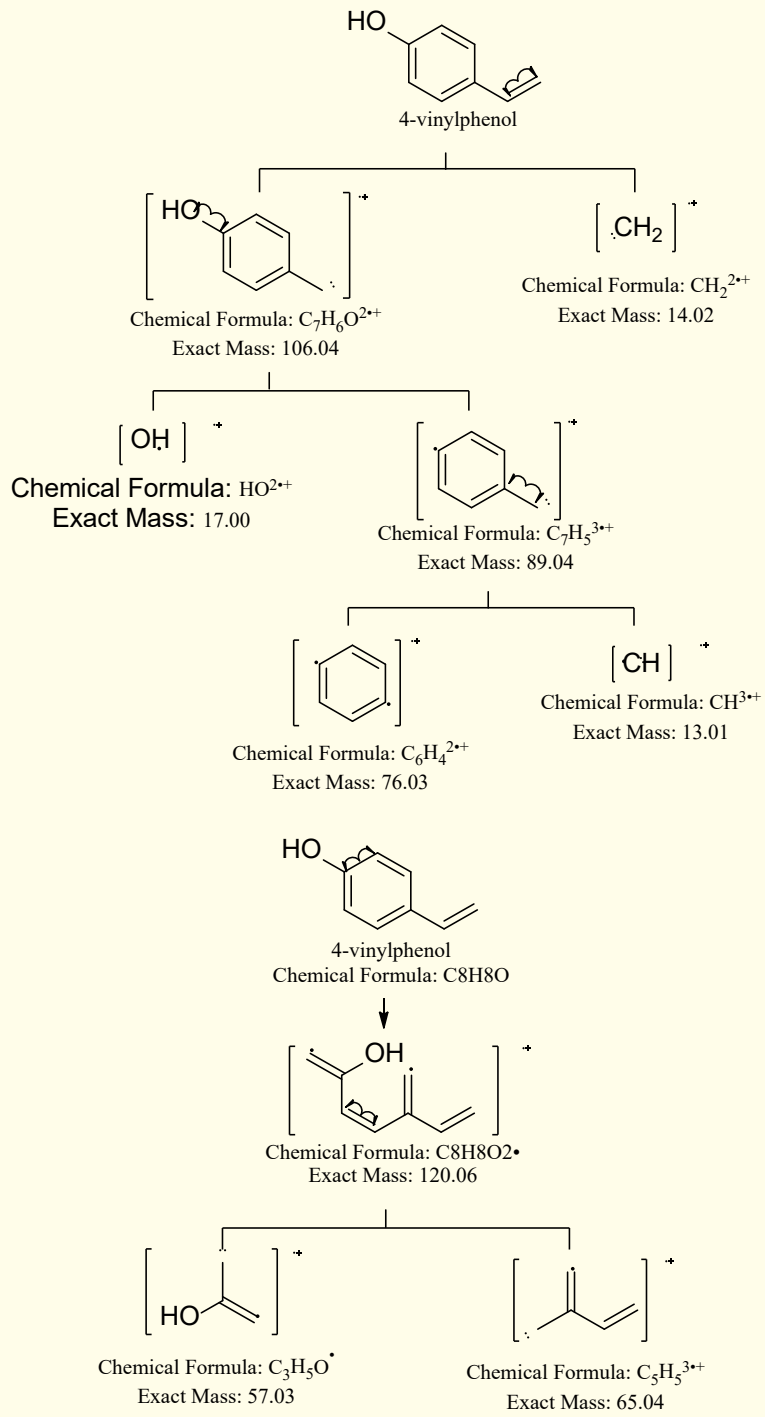
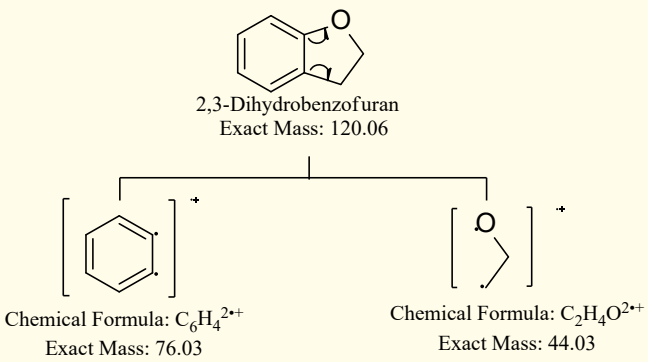


Figure 4: Spectra at RT of 10.80 min for *A. capillus veneris L.*



Scheme 5: Ion fragmentation for 4-Vinylphenol.



Scheme 6: Ion fragmentation for 2,3-Dihydro benzofuran.

NO.	Compounds	RT (min)	Main ion	Ion 1 (AR%)	Ion 2 (AR%)	Ion 3 (AR%)	Ion 4 (AR%)
26a	D(-)-Quinic acid	17.69	60.10	57.10	71.10	55.20	73.10
26b	(z)-6-acetylbicyclo [4.4.0]dec-2-en-4-one		(100%)	(97.71%)	(71.84%)	(65.61%)	(62.67%)
26c	3,5-diethyl-[1,2]-dithiolane-1,1-dioxide						

Table 5: List of compounds identified using Wiley's MS library at Retention Time (RT) of 16.69 minutes

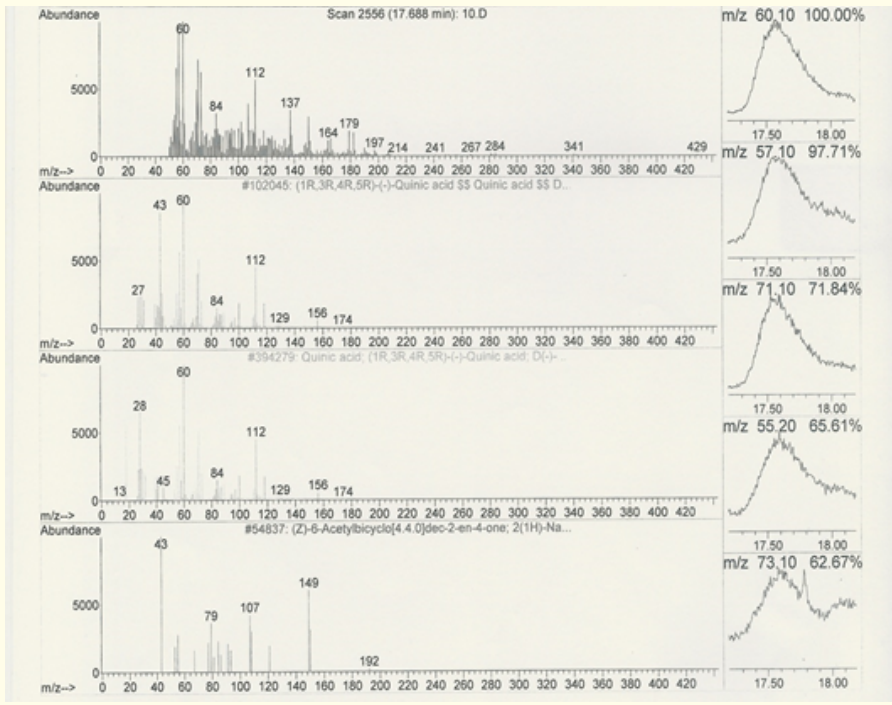
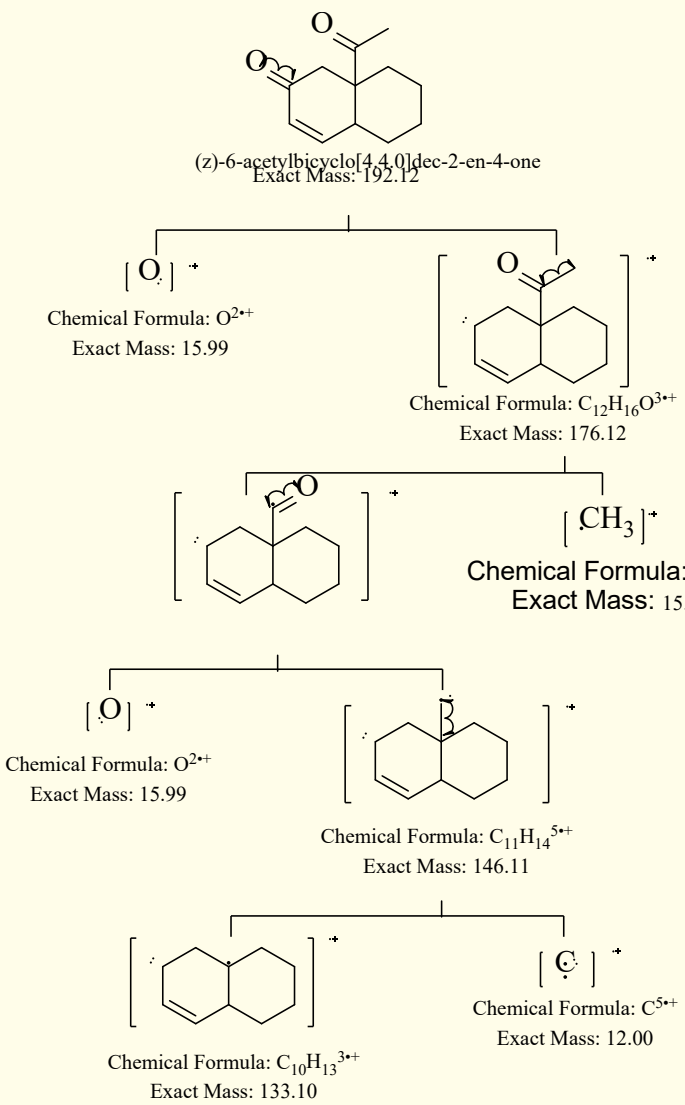


Figure 5: Spectra at RT of 17.69 min for *A. capillus veneris L.*



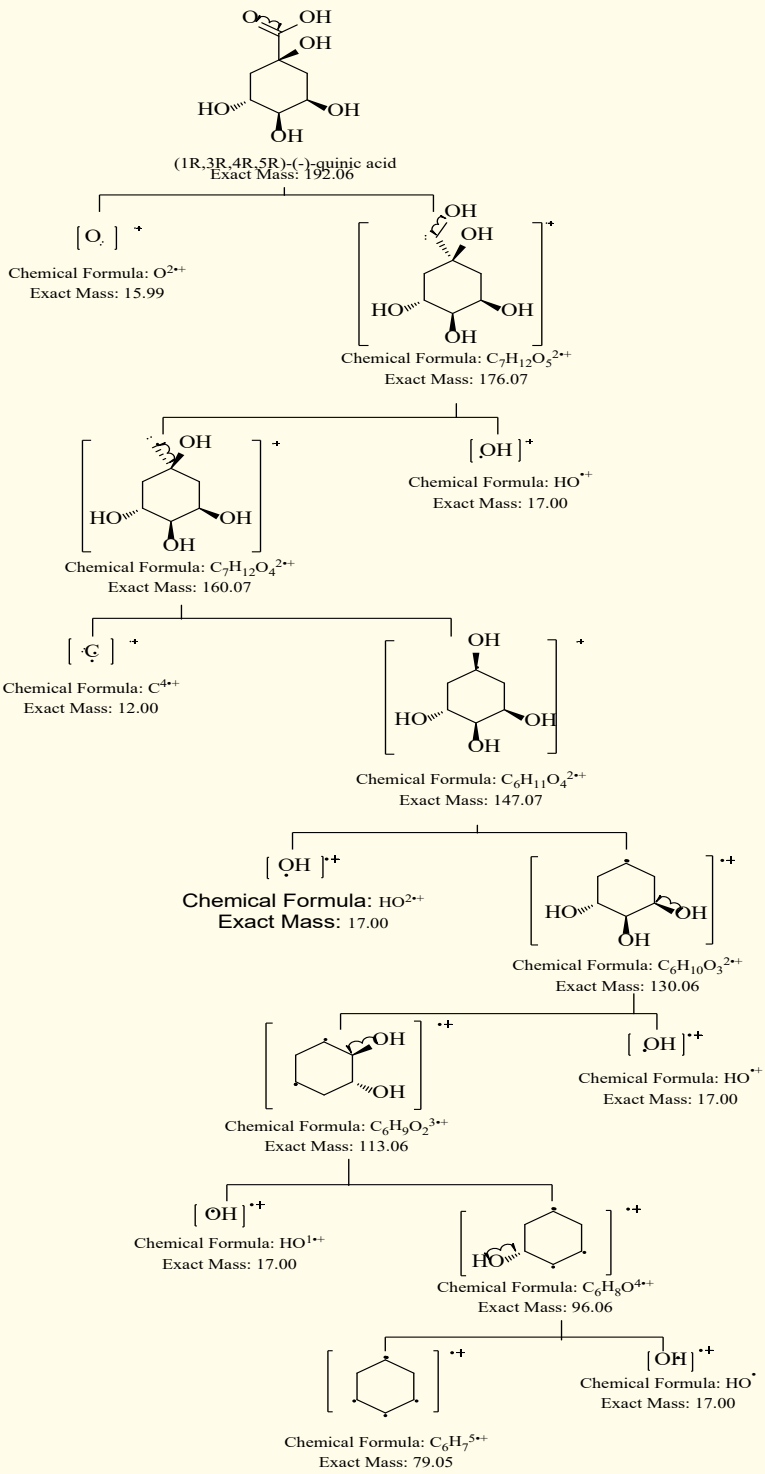
Scheme 7: Ion fragmentation for (Z)-6-*Acetylbicyclo*[4.4.0]dec-2-en-4-one.

NO.	Compounds	RT (min)	Main ion	Ion 1 (AR%)	Ion 2 (AR%)	Ion 3 (AR%)	Ion 4 (AR%)
36a	Octadecanoic acid{stearic acid}	23.91	73.10 (100%)	55.10 (77.64%)	57.20 (76.98%)	60.10 (76.91%)	284.30 (61.60%)

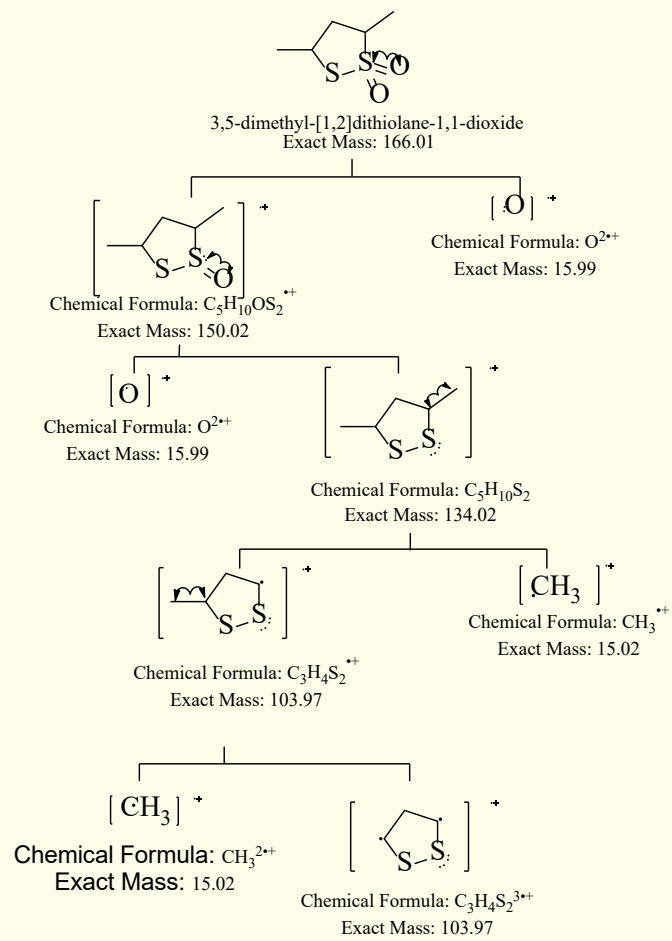
Table 6: List of compounds identified using Wiley's MS library at Retention Time (RT) of 23.91 minutes.

NO.	Compounds	RT (min)	Main ion	Ion 1 (AR%)	Ion 2 (AR%)	Ion 3 (AR%)	Ion 4 (AR%)
39a	4-propyl-1,2,3,4,5,6-hexa-hydro-1,5-methano-4,1-benza-zaphosphocine-1-oxide	29.22	55.10 (100%)	73.10 (99.65%)	249.10 (82.35%)	57.20 (76.46%)	207.10 (69.84%)
39b	Trimeprimine						

Table 7: List of compounds identified using Wiley's MS library at Retention Time (RT) of 29.11 minutes.



Scheme 8: Ion fragmentation for D(-)-Quinic acid.



Scheme 9: Ion fragmentation for 3,5-Diethyl-[1,2]-dithiolane-1,1-dioxide.

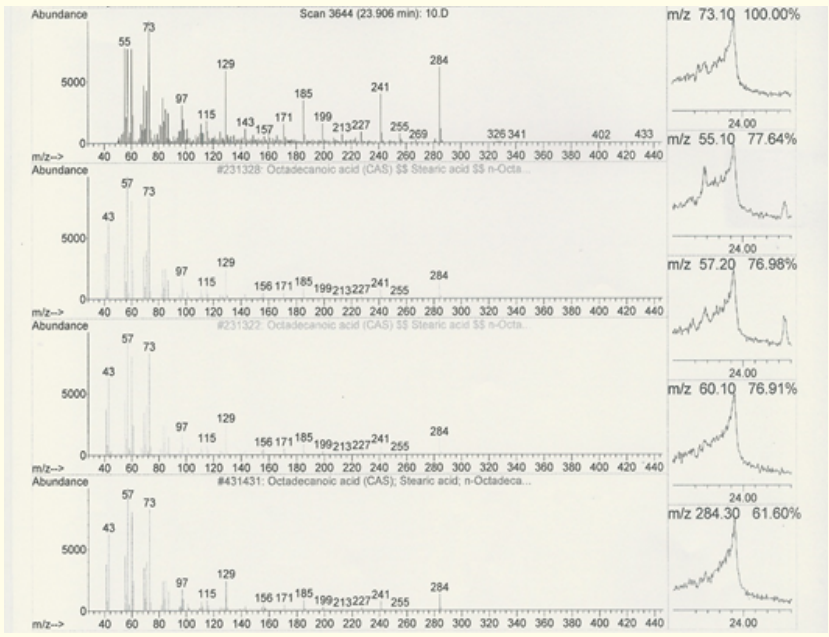
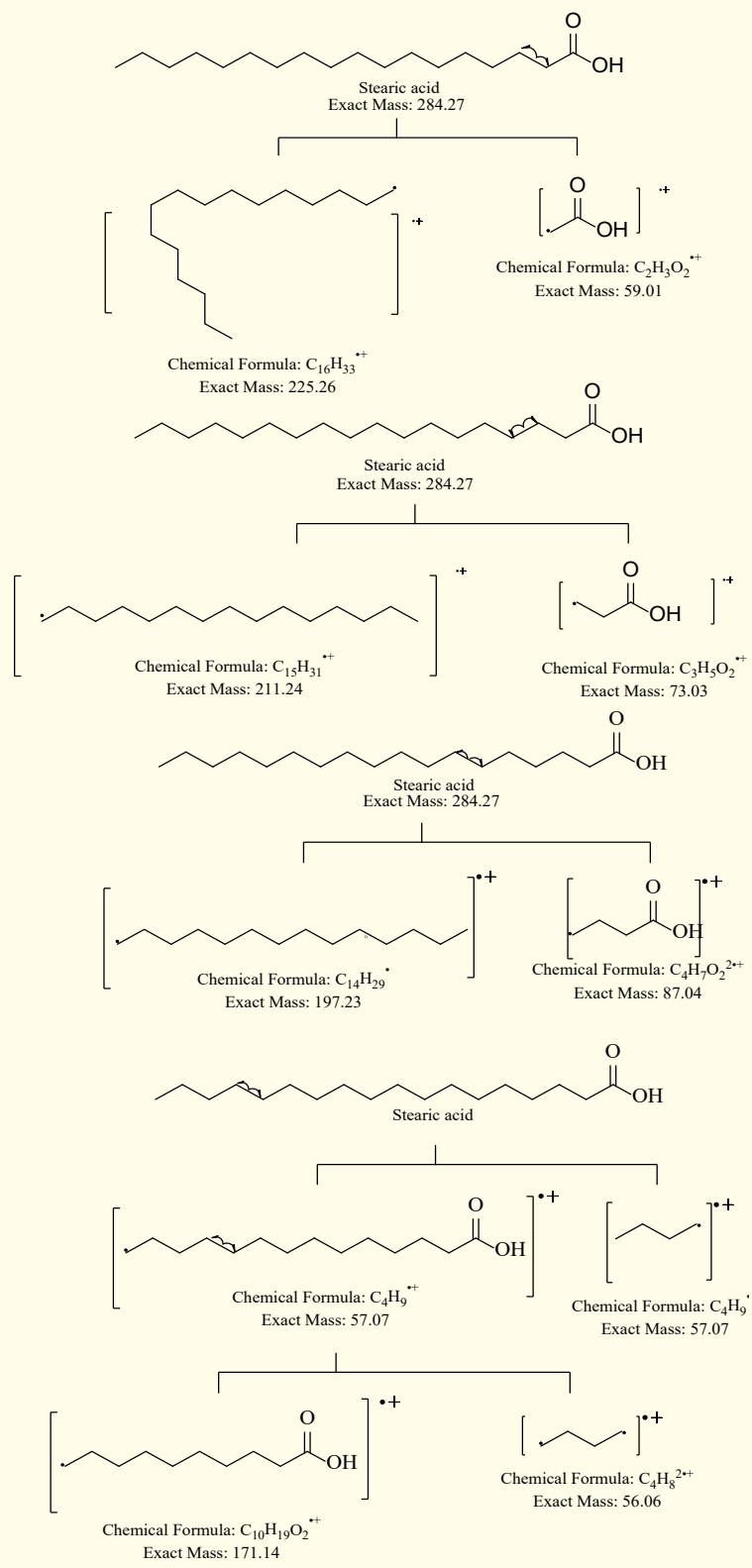


Figure 6: Spectra at RT of 23.91 min for *A. capillus veneris L.*



Scheme 10: Ion fragmentation for Octadecanoic acid.

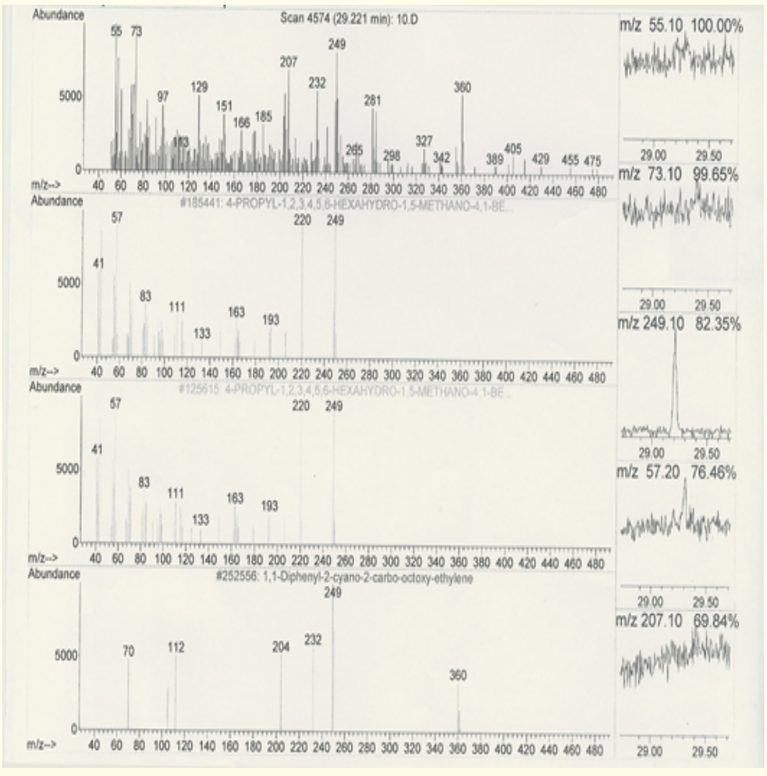
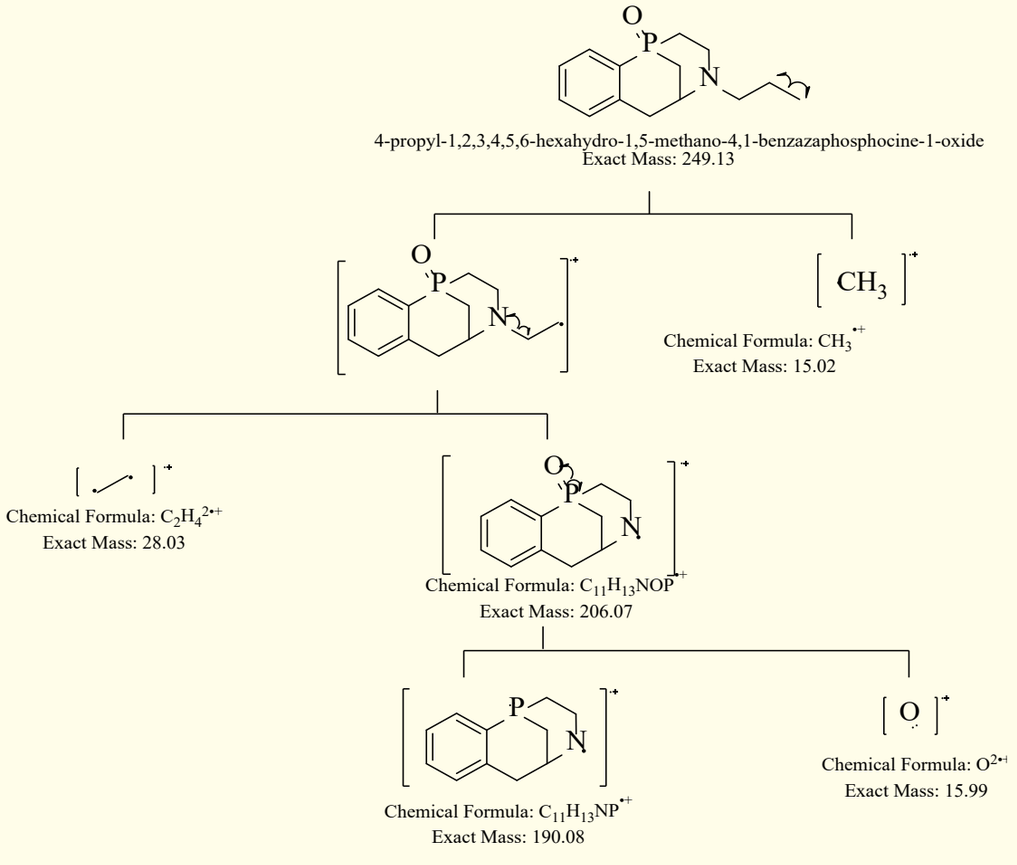
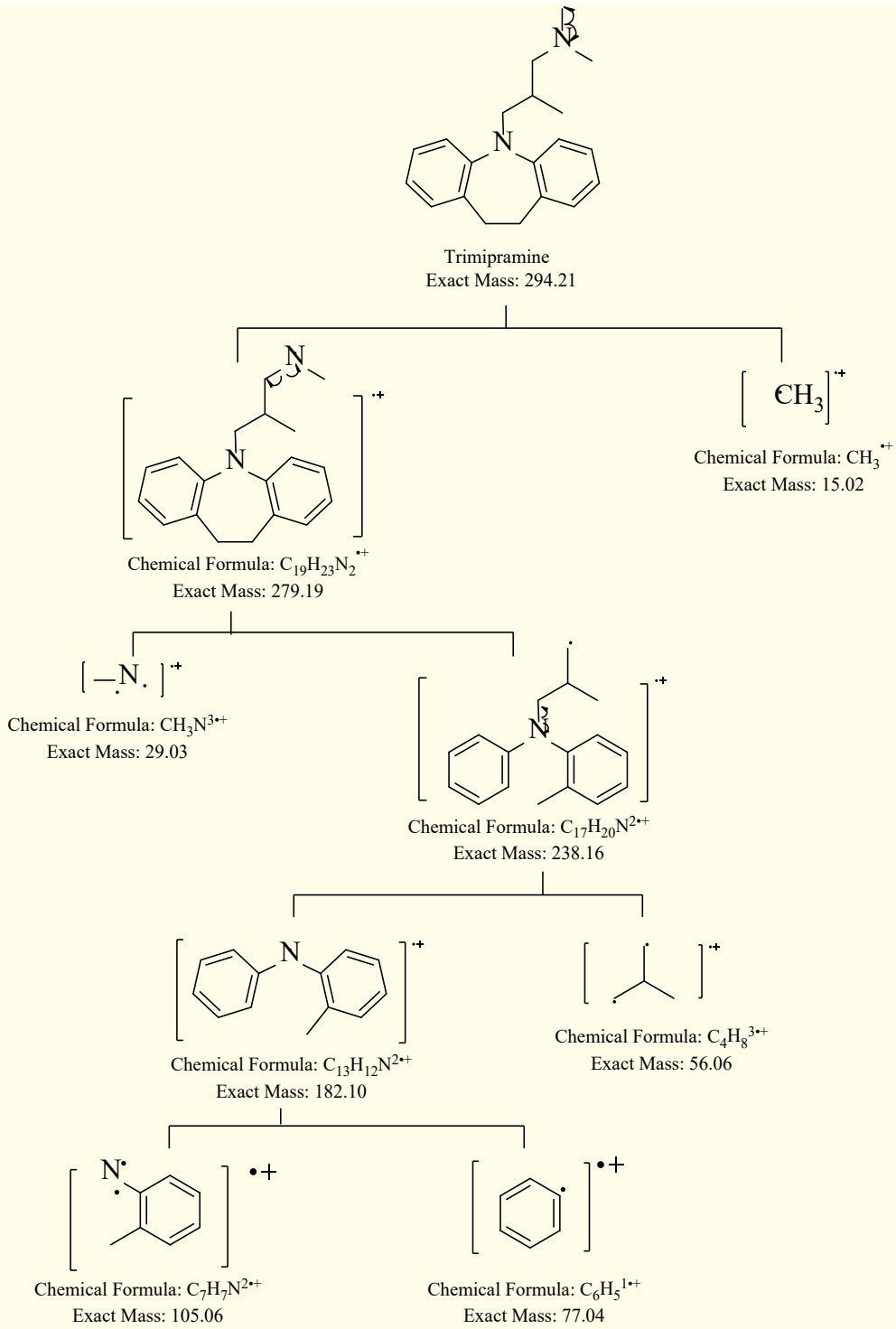


Figure 7: Spectra at RT of 23.91 min for *A. capillus veneris L.*



Scheme 11: Ion fragmentation for 4-propyl-1,2,3,4,5,6-hexahydro-1,5-methano-4,1-benzazaphosphocine-1-oxide.



Scheme 12: Ion fragmentation for Trimipramine.

GC in combination with MS can be used for determination of very specific trace compounds in the complex. Due to the high specificity, MS offer much more accurate determination of complex mixture of compounds present in the essential oil extracted of *A. capillus veneris L.*

Conclusions

The present study gave an insight into the effectiveness of different extracts of the plant *A. cappillus veneris L.* which is used as folk medication in the management of hyperglycemia and as antibacterial herb, Particularly phytochemical screening of the water extract.

Gas chromatography – Mass spectroscopy analysis of the water extract revealed the presence of 105 compounds. Wiley's MS library was used to identify the different compounds. Despite these libraries, 6 of 105 compounds could not be identified. Some of the identified compounds are considered major compounds, other minor compounds were also identified.

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