Innovare Academic Sciences

International Journal of Pharmacy and Pharmaceutical Sciences

ISSN- 0975-1491 Vol 6, Issue 7, 2014

Original Article

STUDY ON *AMPELOCISSUS LATIFOLIA* (ROXB.) PLANCH AND ITS DIFFERENT LEAF EXTRACTS BY FOURIER TRANSFORM INFRARED SPECTROSCOPY

PARAG A. PEDNEKAR[1], VANITA KULKARNI[1], BHANU RAMAN[1]

[1]Department of Chemistry, K.J. Somaiya College of Science and Commerce, Vidyavihar, Mumbai 400077
Email: paragpednekar81@gmail.com, vanitakulkarni2@gmail.com

Received: 08 June 2014 Revised and Accepted: 20 Jul 2014

ABSTRACT

Objective: To compare the various categories of chemical constituents in 14 different soxhlet extracts and leaf powder of *Ampelocissus latifolia* (Roxb.) Planch. with the help of Fourier transform infrared spectroscopy (FT-IR).

Methods: It includes preparation of 14 different polar and nonpolar extracts by soxhlet extraction for the detailed identification of the active functional groups by FT-IR analysis.

Results: The functional groups of each 14 extracts and leaf powder were identified.

Conclusion: The FT-IR method was a good tool to investigate the fingerprint and to predict the composition of 14 different soxhlet extracts and leaf powder of *Ampelocissus latifolia.*

Keywords: Fourier transform infrared spectroscopy (FT-IR), Soxhlet extracts, *Ampelocissus latifolia* (Roxb.) Planch.

INTRODUCTION

Ampelocissus latifolia belongs to family Vitaceae, is climber with annual stems. In ayurveda it has been reported to be used as Kustha, Kamala, Sotha, and Vrana [1]. It is used for wound healing [2]. The stem bark is used in stomach pain and bone fracture [3, 4]. The roots are used in skin diseases, wound healing, rheumatic affections, fractures, diuretic, gonorrhoea, syphillis, eye diseases, menstrual troubles and also as a tonic [2-11]. Dried root powder of *Ampelocissus latifolia* extracts were tested for anti-inflammatory activity in carrageenan induced paw edema in rat by oral and topical application. The results showed that there was inhibition of inflammation in orally administered and topically applied extracts and also suggest that hydro alcoholic extract given orally is more effective than topically applied extract [12]. Elemental concentrations of methanolic soxhlet leaf extracts of *Ampelocissus latifolia* was measured by the ICP-AES technique. 41 elements Na, Mg, Si, Cl, K, Ca, Cr, Mn, Fe, Ni, Cu, Zn, Co, Cd, Se, Al, S, Pb, Ba, Hg, As, B, P, Sr, Br, Ti, Bi, Ge, In, La, Li, Mo, Pd, Sb, Sc, Sn, Te, V, W, I, Th were screened. Elements and their role in treating various diseases are discussed in this research paper [13]. Spectral differences are the objective reflection of componential differences [14]. By using the macroscopic fingerprint characters of FT-IR spectrum, we can conclude the origin of different extracts accurately and effectively, trace the constituents in the extracts, identify the medicinal materials authenticity and eventualy the quality of medicinal raw materials [15]. The FT-IR offers rapid and nondestructive investigation to fingerprint herbal extracts or powder. The FT-IR spectrum is used to identify the functional groups of the active components based on the peak value in the region of infrared radiation. The FT-IR spectra (4000-400cm^{-1}) of different soxhlet extracts were recorded and the specific wave numbers and intensities were considered.

MATERIALS AND METHODS

Plant collection and authentification

The leaves of *Ampelocissus latifolia* were collected from Mumbai, Maharashtra. The identification of the plant was done at the Blatter Herbarium, St. Xavier's College, Mumbai. The *Ampelocissus latifolia* (Roxb.) Planch specimen matches with the Blatter Herbarium specimen no. Shah-l of G. L. Shah. The leaves were thoroughly washed with distilled water, dried in an oven at 40°C and grounded into fine powder by using a mechanical grinder.

Apparatus

Bruker Vertex 80 FT-IR System with Opus software was used. The scan range was taken from 400 to 4000 cm^{-1} with a resolution of 0.2 cm^{-1}.

Chemicals

Chloroform, toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, methanol, acetone, 2-propanol, petroleum ether (60-80°C), 2-butanone, dichloromethane, ethyl ether were all A.R. grade of Merck, India. KBr was obtained from Sigma Aldrich. Distilled water from Millipore was used.

Preparation of the plant extract

The leaf powder of *Ampelocissus latifolia* (20 gms) was extracted with 250 ml each of polar and nonpolar solvents by soxhlet extraction for 8 hrs. The extracts obtained were later kept for evaporation to remove the excess solvents. These extracts were then stored in plastic bottles in refrigerator for FT-IR analysis.

Powdered leaf material was extracted using water, chloroform, toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, methanol, acetone, 2-propanol, petroleum ether (60-80°C), 2-butanone, dichloromethane, ethyl ether. The crude powder and dried extracts were mixed with KBr salt using mortar and pestle and compressed into a thin pellet.

RESULTS & DISCUSSION

Primary or secondary OH in-plane bend from Alcohol & hydroxy compound groups in the region of 1260–1350 cm^{-1} was present only in the *Ampelocissus latifolia* methanol extracts. O-H out-of-plane bend from Alcohol group from 590-720 cm^{-1} was present only in the *Ampelocissus latifolia* methanol extracts. O-H bond of hydrogen bonded alcohols and phenols which lies in the frequency range of 3200-3600 cm^{-1} was dominantly present in the in all samples of *Ampelocissus latifolia* leaf powder, water, chloroform, toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, methanol, acetone, 2-propanol, petroleum ether (60-80°C), 2-butanone, dichloromethane and ethyl ether extracts. Phenols protect the human body from the oxidative stress, which cause many diseases including cancer, cardiovascular problems and ageing [16]. Phenols also show antimicrobial, anthelmintic, antiapoptotic and antidiarrhoeal activities [17].

C-H bond of alkanes which lies in the frequency range of 2850-2970 cm^{-1} was present in all samples of *Ampelocissus latifolia* leaf powder, water, chloroform, toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, methanol, acetone, 2-propanol, petroleum ether (60-80°C), 2-butanone, dichloromethane and ethyl ether extracts. Another C-H bond of alkanes which lies in the frequency range of 1340-1470 cm^{-1} was present in all samples of *Ampelocissus latifolia* leaf powder, water, chloroform, toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, methanol, acetone, 2-propanol, petroleum ether (60-80°C), 2-butanone, dichloromethane and ethyl ether extracts. The alkanes protect the plant against water loss, prevent the leaching of important minerals by rain and protect against microorganisms and harmful insects [18].

C-H bond of Alkenes in the region of 675-995 cm^{-1} was present in the *Ampelocissus latifolia* water, chloroform, toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, methanol, 2-propanol, petroleum ether (60-80°C), dichloromethane & ethyl ether extracts. C=C bond of Alkenes from 1610-1680 cm^{-1} was present in the Ampelocissus latifolia water, chloroform, toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, methanol, acetone, 2-propanol, petroleum ether (60-80°C) & 2-butanone extracts. C-H bond of Alkenes in the region of 3010-3095 cm-1 was present only in the Ampelocissus latifolia toluene extract. Alkenes are important in the manufacture of plastics, e.g. polythene and as fuel and illuminant. They serve as raw materials for the manufacture of alcohols and aldehydes. Alkenes are used for artificial ripening of fruits [19].

Alkyne C-H bend from Acetylenic (Alkyne) group from the region 610-680 cm^{-1} were found to be present only in *Ampelocissus latifolia* leaf powder & ethyl acetate extracts. Alkynes are used as pharmaceuticals such as the contraceptive norethynodrel. Alkynes are highly bioactive nematocides. Alkynes possess antifungal, antitumor and antiviral properties [20].

C-N bond from CN stretch of primary amine in the range of 1020-1090 cm^{-1} was present in the *Ampelocissus latifolia* water, toluene, carbon tetrachloride, methanol, acetone, petroleum ether (60-80°C), 2-butanone & ethyl ether extracts. N-H bond of Primary amines lying in the region of 1590-1650 cm^{-1} was present only in *Ampelocissus latifolia* leaf powder. C-N bond of C-N stretch from secondary amines in the region of 1130-1190 cm^{-1} are present in the *Ampelocissus latifolia* chloroform, toluene, methanol, acetone, dichloromethane & ethyl ether extracts. Aromatic amines are used in rubber, textile and dye industries. Many amine-rich proteins are bound to DNA and some neurotransmitters are amines including epinephrine, dopamine. They are used industrially for removing carbon dioxide and hydrogen sulphide from natural gas and refinery process streams [21]. C-N bond of Amines & amides from the region of 1180-1360 cm^{-1} was present in *Ampelocissus latifolia* leaf powder, ethyl acetate & ethyl alcohol extracts only. Amines and amides are the main groups of protein synthesis [19].

C-O bond in Alcohols, ethers, carboxylic acids, esters from 1050-1300 cm^{-1} were present in *Ampelocissus latifolia* leaf powder, water, ethyl acetate, ethyl alcohol, 2-propanol, petroleum ether (60-80°C), 2-butanone and ethyl ether extracts. Carboxylic acids are biologically very important in the formation of fat in the body and act as strong antibacterial agents. They serve as main pharmaceutical products in curing ulcers, jaundice, headache, fever, pain in liver, wound in cattle, treatment of edema and rheumatic joint pains. Esters in combination with volatile oils produce the pleasant aroma of fruits [19].

C=O bond of Ketone in the region of 1705-1725 cm^{-1} was present in the *Ampelocissus latifolia* chloroform, ethyl alcohol, methanol, acetone, 2-propanol, 2-butanone & dichloromethane extracts. The trichomes of the wild tomato species *Solanum habrochaites* sub species. *glabratum* synthesize and store high levels of methylketones, primarily 2-tridecanone and 2-undecanone, that protect the plants against various herbivorous insects [22]. The ketone methadone ($C_{21}H_{27}NO$) has been used to cure addiction to opiates [23]. C=O bond of Aldehydes from the region of 1725-1740 cm^{-1} was present in the *Ampelocissus latifolia* Toluene, carbon tetrachloride, hexane, methanol, petroleum ether (60-80°C) & ethyl ether extracts. Aldehydes are found in many herbs. The aldehyde decenal is a major component of coriander leaf which is often said to be the world's most widely consumed herb [23].

C-I bond from C-I stretch of aliphatic iodo compounds in the region of 500-600 cm^{-1} was present in *Ampelocissus latifolia* leaf powder, carbon tetrachloride, hexane, ethyl alcohol, 2-propanol, petroleum ether (60-80°C) & 2-butanone extracts. C-Br bond from C-Br stretch of aliphatic bromo compounds in the region of 600–700 cm^{-1} was present only in *Ampelocissus latifolia* hexane extract. C-Cl bond of aliphatic chloro compound in 700 - 800 cm^{-1} frequency range was present only in *Ampelocissus latifolia* acetone extracts. Halogen compounds function within the plant cell to generate chlorinated tryptophan, which is then shuttled into monoterpene indole alkaloid metabolism to yield chlorinated alkaloids [24]. Chlorates play the role of disinfectants and bromide is needed by eosinophils for generating anti-parasitic brominating compounds by the action of eosinophil peroxidase [25].

S-S stretch of Aryl disulfides from 430-500 cm^{-1} was found in the *Ampelocissus latifolia* Toluene, carbon tetrachloride, ethyl acetate, hexane, ethyl alcohol, acetone & 2-butanone extracts. S-S stretch of Disulfides from 600-620 cm^{-1} was found only in the *Ampelocissus latifolia* acetone extract. S-S stretch of Polysulfides in 470-500 cm^{-1} frequency range was present only in *Ampelocissus latifolia* 2-propanol extracts. The sulfur compounds are present in the plant in three forms which are; the amino acids of proteins, volatile oils and sulfates. They are used as disinfectants and dental creams [19].

NO_2 bond from Nitro compounds found in the region of 1300-1370 cm^{-1} was present only in *Ampelocissus latifolia* leaf powder. Nitrogen containing compounds are important in plants. Examples are proteins (including enzymes), nucleotides (e.g. ATP) and nucleic acids (e.g. DNA and RNA).

A number of nitrogen containing compounds (NCC) accumulate in plants exposed to salinity stress. The most frequently accumulating NCC include amino acids, amids, imino acids, proteins, quarternary ammonium compounds (QAC) and polyamines. Osmotic adjustment, protection of cellular macromolecules, storage form of nitrogen, maintaining cellular pH, detoxification of the cells, and scavenging of free radicals are proposed functions for these compounds under stress conditions [26]. The antiviral activity of an aliphatic nitro compound (NC) isolated from *Heteropteris aphrodisiaca* O. Mach. (Malpighiaceae), a Brazilian medicinal plant was tested for its antiviral activity against poliovirus type 1 (PV-1) and bovine herpes virus type 1 (BHV-1) by plaque reduction assay in cell culture. It showed a moderate antiviral activity against PV-1 and BHV-1 in HEp-2 cells [27].

C=O bond of the Transition metal carbonyl compounds from the region of 1800-2100 cm^{-1} was present in the *Ampelocissus latifolia* water & ethyl alcohol extracts only. Chlorophyll is a porphyrin chelate in which the metal at the center of the chelate is a magnesium ion [28]. C-O-C bond of C-O stretch in cyclic ethers ranging from 1070-1140 cm^{-1} was present only in the *Ampelocissus latifolia* acetone, dichloromethane & ethyl ether extracts. Cyclic ethers like Eucalyptol is a natural organic compound is an ingredient in many brands of mouthwash and cough suppressant, as well as an inactive ingredient in body powder. Eucalyptol is used as an insecticide and insect repellent [29, 30].

C-O-O-C bond from Peroxides in the range of 820-890 cm^{-1} was present only in the *Ampelocissus latifolia* acetone extracts. Hydrogen peroxide forms a vital constituent of plant life and minute quantities of this compound is present in several fruits and vegetables, such as tomatoes, cabbage, green peppers, asparagus, apples, oranges, watercress and watermelons [31].

P-O-C stretch of Aromatic phosphates from the region of 1190-1240 cm^{-1} are present only in the *Ampelocissus latifolia* chloroform extract. P-O-C stretch of Aliphatic phosphates from the region of 990-1050 cm^{-1} are present only in the *Ampelocissus latifolia* hexane extract. Abiotic stresses like salt, osmotic and water stress, have been reported to increase acid or alkaline phosphatase activity by maintaining a certain level of inorganic phosphate in the plant cells [32]. Asymmetric / Symmetric XO_2 stretch (NO_2 & SO_2) found in

organic nitrates from 1270-1285 cm^{-1} was found only in the *Ampelocissus latifolia* carbon tetrachloride extract. In the treatment of myocardial infarction, the first-line drugs consist of nitrates, including nitroglycerin. However, their long-term use is limited by a therapeutic escape or tolerance effect, which decreases the therapeutic efficacy of the drug, compromising the patient's prognosis [33-35]. Asymmetric / Symmetric XO_2 stretch (NO_2 & SO_2) from sulphonates in the region of 1100–1200 cm^{-1} was present in the *Ampelocissus latifolia* carbon tetrachloride & hexane extracts.

Sodium tanshinone sulphonates are water-soluble derivatives of tanshinones originated from Tanshen (or Danshen, *Salvia miltiorrhiza* Bunge), a famous Traditional Chinese Medicine, which have potent biological activities, especially in the treatment of cardiovascular disorders [36]. Ø-O-H bond of aryl-O stretch in Aromatic ethers ranging from 1230-1270 cm^{-1} was present in the *Ampelocissus latifolia* Toluene, hexane & acetone extracts. Lawsone methyl ether mouthwash possesses potent antifungal activity both in vitro and in vivo [37].

Table 1: FT-IR peak values of *Ampelocissus latifolia* leaf powder

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3420.03	O-H	Hydrogen bonded Alcohols, phenols	3200-3600
2923.84	C-H	Alkanes	2850-2970
2858.41	C-H	Alkanes	2850-2970
1640.49	N-H	Primary Amine, NH bend	1590-1650
1384.80	C-H	Alkanes	1340-1470
1327.30	NO_2	Nitro compound	1300-1370
1238.22	C-N	Amines, amides	1180-1360
1059.85	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
616.30	C-H	Alkyne C-H Bend, Alkyne (Acetylenic) group	610-680
531.73	C-I	Aliphatic iodo compounds, C-I stretch	500-600

Table 2: FT-IR peak values of *Ampelocissus latifolia* water leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3446.65	O-H	Hydrogen bonded Alcohols, phenols	3200-3600
2925.82	C-H	Alkanes	2850-2970
2857.03	C-H	Alkanes	2850-2970
2064.73	C=O	Transition metal carbonyl compounds	1800-2100
1635.69	C=C	Alkenes	1610-1680
1451.64	C-H	Alkanes	1340-1470
1384.21	C-H	Alkanes	1340-1470
1231.78	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
1044.83	C-N	Primary amine, CN stretch	1020-1090
702.96	C-H	Alkenes	675-995

Table 3: FT-IR peak values of *Ampelocissus latifolia* chloroform leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3431.30	O-H	Hydrogen bonded Alcohols, phenols	3200-3600
2920.43	C-H	Alkanes	2850-2970
2853.89	C-H	Alkanes	2850-2970
1721.79	C=O	Ketone	1705-1725
1621.10	C=C	Alkenes	1610-1680
1455.12	C-H	Alkanes	1340-1470
1375.34	C-H	Alkanes	1340-1470
1227.47	P-O-C stretch	Aromatic phosphates	1190-1240
1164.93	C-N	Secondary amine, CN stretch	1130-1190
1032.95	$>CH_2$	Cyclohexane ring vibrations	1000-1055
721.91	C-H	Alkenes	675-995

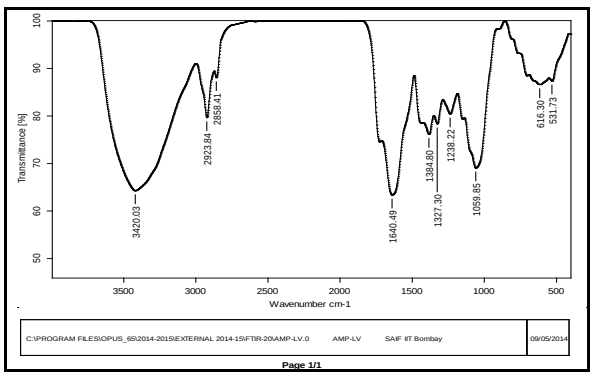

Fig. 1: FT-IR Spectrum of *Ampelocissus latifolia* powdered leaf sample (AMP-LV)

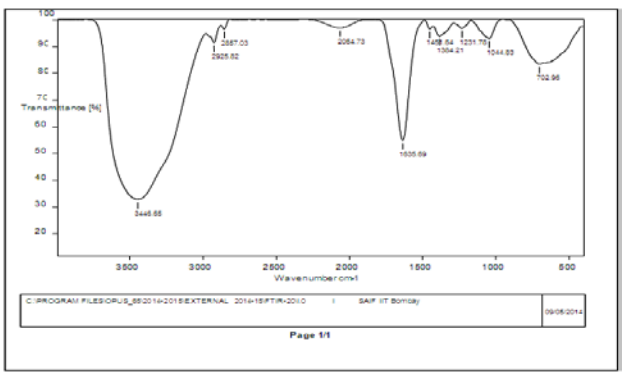

Fig. 2: FT-IR Spectrum of *Ampelocissus latifolia* Water Leaf Extract (I).

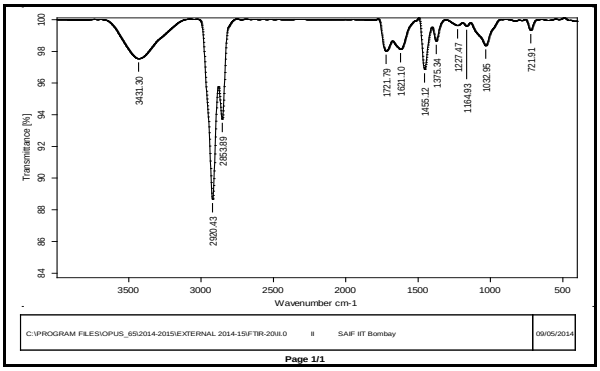

Fig. 3: FT-IR Spectrum of *Ampelocissus latifolia* Chloroform Leaf Extract (II)

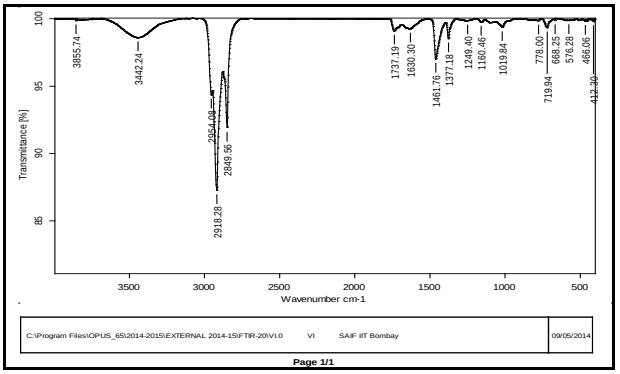

Fig. 7: FT-IR Spectrum of *Ampelocissus latifolia* Hexane Leaf Extract (VI)

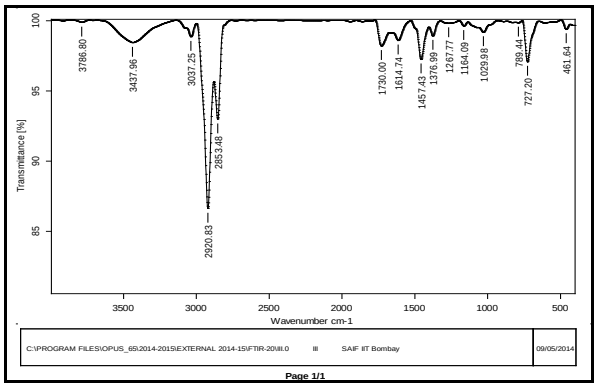

Fig. 4: FT-IR Spectrum of *Ampelocissus latifolia* Toluene Leaf Extract (III)

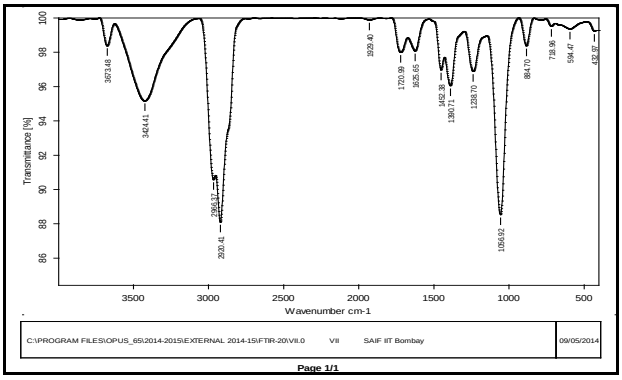

Fig. 8: FT-IR Spectrum of *Ampelocissus latifolia* Ethyl alcohol Leaf Extract (VII)

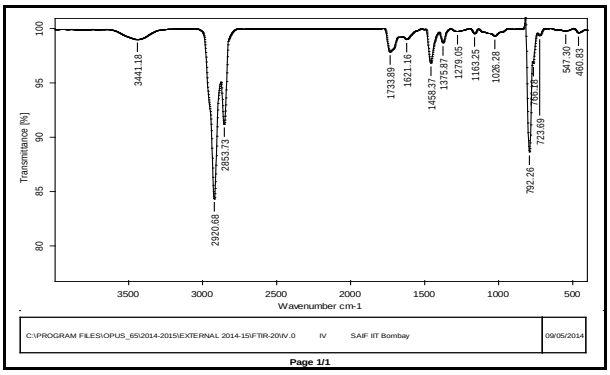

Fig. 5: FT-IR Spectrum of *Ampelocissus latifolia* Carbon tetrachloride Leaf Extract (IV)

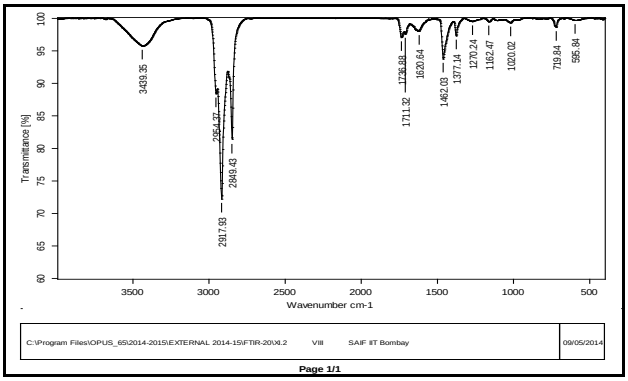

Fig. 9: FT-IR Spectrum of *Ampelocissus latifolia* Methanol Leaf Extract (VIII)

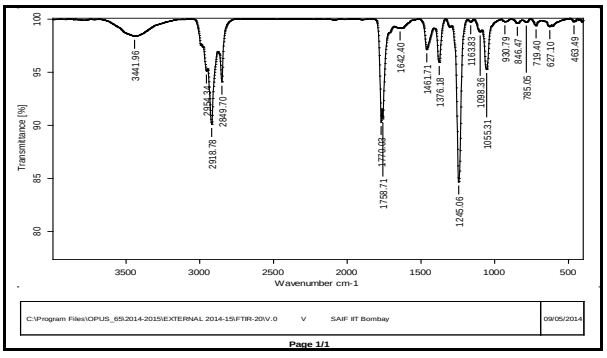

Fig. 6: FT-IR Spectrum of *Ampelocissus latifolia* Ethyl acetate Leaf Extract (V)

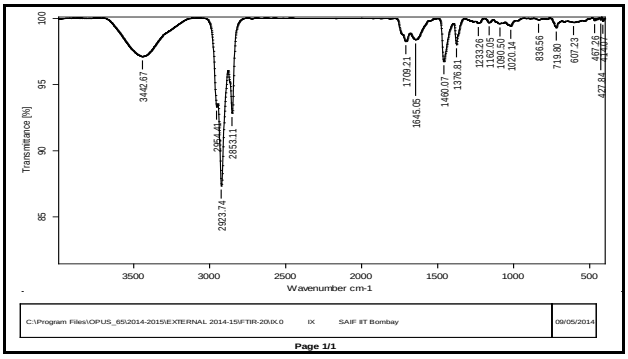

Fig. 10: FT-IR Spectrum of *Ampelocissus latifolia* Acetone Leaf Extract (IX)

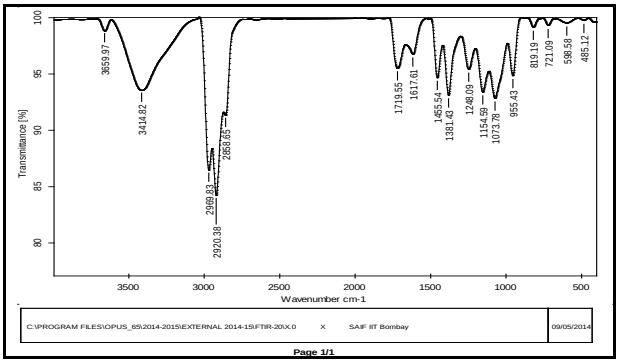

Fig. 11: FT-IR Spectrum of *Ampelocissus latifolia* 2-propanol Leaf Extract (X)

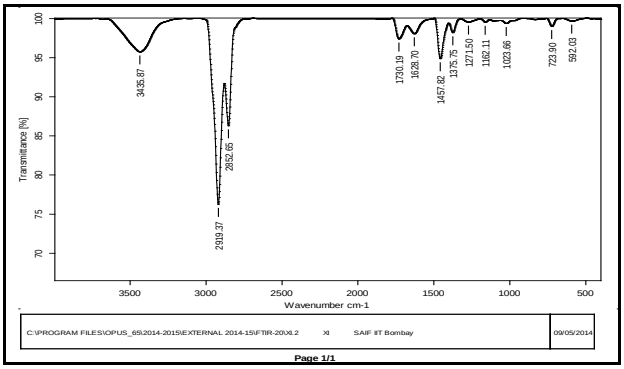

Fig. 12: FT-IR Spectrum of *Ampelocissus latifolia* Petroleum ether (60-80°C) leaf Extract (XI)

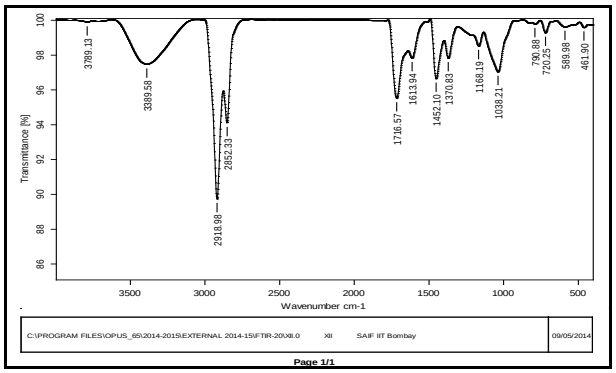

Fig. 13: FT-IR Spectrum of *Ampelocissus latifolia* 2- butanone leaf Extract (XII)

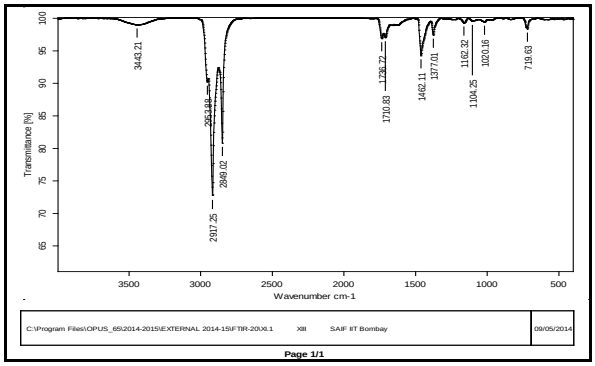

Fig. 14: FT-IR Spectrum of *Ampelocissus latifolia* Dichloromethane Leaf Extract (XIII)

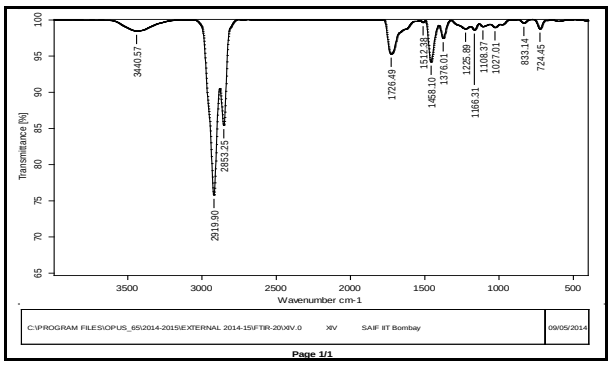

Fig. 15: FT-IR Spectrum of *Ampelocissus latifolia* Ethyl ether Leaf Extract (XIV)

Lawsone is the principal color ingredient in *Lawsonia inermis*, Henna plant [38]. >CH_2 bond from Cyclohexane ring vibrations from 1000-1055 cm^{-1} was present only in the *Ampelocissus latifolia* chloroform extract. C-H bond of Methylene (>CH_2) in the region of 2845–2865 cm^{-1} was present in the *Ampelocissus latifolia* ethyl acetate, hexane, methanol & dichloromethane extracts. C=C bond of Aromatic rings of 1500-1600 cm^{-1} frequency range was present only in *Ampelocissus latifolia* Ethyl ether extract. C=O bond in Open-chain acid anhydride ranging from 1740-1790 cm^{-1} was present only in the *Ampelocissus latifolia* ethyl acetate extracts.

The above listed infrared functional group absorptions characteristic were cited from the literature [39, 40]. FT-IR spectrum reflects objectively the panorama of chemical constituents in complex system [41]. It is a most credible method to validate, identify the mixed substance systems such as traditional herbal medicine and their extracts.

Table 4: FT-IR peak values of *Ampelocissus latifolia* toluene leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3786.80	-	Unknown	-
3437.96	O-H	Hydrogen bonded alcohols, phenols	3200-3600
3037.25	C-H	Alkenes	3010-3095
2920.83	C-H	Alkanes	2850-2970
2853.48	C-H	Alkanes	2850-2970
1730.00	C-H	Aldehyde	1725-1740
1614.74	C=C	Alkenes	1610-1680
1457.43	C-H	Alkanes	1340-1470
1376.99	C-H	Alkanes	1340-1470
1267.77	Ø-O-H	Aromatic ethers, aryl-O stretch	1230-1270
1164.09	C-N	Secondary amine, CN stretch	1130-1190
1029.98	C-N	Primary amine, CN stretch	1020-1090
789.44	C-H	Alkenes	675-995
727.20	C-H	Alkenes	675-995
461.64	S-S stretch	Aryl disulfides	430-500

Table 5: FT-IR peak values of *Ampelocissus latifolia* carbon tetrachloride leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3441.18	O-H	Hydrogen bonded Alcohols, phenols	3200-3600
2920.68	C-H	Alkanes	2850-2970
2853.73	C-H	Alkanes	2850-2970
1733.89	C=O	Aldehydes	1725-1740
1621.16	C=C	Alkenes	1610-1680
1458.37	C-H	Alkanes	1340-1470
1375.87	C-H	Alkanes	1340-1470
1279.05	Asymmetric/symmetric XO_2 stretch (NO_2 & SO_2)	Organic nitrates	1270-1285
1163.25	Asymmetric/symmetric XO_2 stretch (NO_2 & SO_2)	Sulphonates	1100-1200
1026.28	C-N	Primary amine, CN stretch	1020-1090
792.26	C-H	Alkenes	675-995
766.18	C-H	Alkenes	675-995
723.69	C-H	Alkenes	675-995
547.30	C-I	Aliphatic iodo compounds, C-I stretch	500-600
460.83	S-S stretch	Aryl disulfides	430-500

Table 6: FT-IR peak values of *Ampelocissus latifolia* ethyl acetate leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3441.96	O-H	Hydrogen bonded Alcohols, phenols	3200-3600
2954.34	C-H	Alkanes	2850-2970
2918.78	C-H	Alkanes	2850-2970
2849.70	C-H	Methylene (>CH_2)	2845-2865
1770.03	C=O	Open-chain acid anhydride	1740-1790
1758.71	C=O	Open-chain acid anhydride	1740-1790
1642.40	C=C	Alkenes	1610-1680
1461.71	C-H	Alkanes	1340-1470
1376.18	C-H	Alkanes	1340-1470
1245.06	C-N	Amines, amides	1180-1360
1163.83	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
1098.36	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
1055.31	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
930.79	C-H	Alkenes	675-995
846.47	C-H	Alkenes	675-995
785.05	C-H	Alkenes	675-995
719.40	C-H	Alkenes	675-995
627.10	C-H	Acetylenic (Alkyne) group, C-H bend	610-680
463.49	S-S stretch	Aryl disulfides	430-500

Table 7: FT-IR peak values of *Ampelocissus latifolia* hexane leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3855.74	-	Unknown	_
3442.24	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2954.08	C-H	Alkanes	2850-2970
2918.28	C-H	Alkanes	2850-2970
2849.56	C-H	Methylene >CH_2	2845-2865
1737.19	C-H	Aldehyde	1725-1740
1630.30	C=C	Alkenes	1610-1680
1461.76	C-H	Alkanes	1340-1470
1377.18	C-H	Alkanes	1340-1470
1249.40	Ø-O-H	Aromatic ethers, aryl-O stretch	1230-1270
1160.46	Asymmetric/symmetric XO_2 stretch (NO_2 & SO_2)	Sulphonates	1100-1200
1019.84	P-O-C stretch	Aliphatic phosphates	990-1050
778.00	C-H	Alkenes	675-995
719.94	C-H	Alkenes	675-995
668.25	C-Br	Aliphatic bromo compounds, C-Br stretch	600-700
576.28	C-I	Aliphatic iodo compounds, C-I stretch	500-600
466.06	S-S stretch	Aryl disulfides	430-500
412.30	-	Unknown	-

Table 8: FT-IR peak values of *Ampelocissus latifolia* ethyl alcohol leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3673.48	-	Unknown	-
3424.21	O-H	Hydrogen bonded alcohols, phenols	3200-3600
2966.37	C-H	Alkanes	2850-2970
2920.41	C-H	Alkanes	2850-2970
1929.40	C=O	Transition metal carbonyls	1800-2100
1720.99	C=O	Ketone	1705-1725

1625.65	C=C	Alkenes	1610-1680
1452.38	C-H	Alkanes	1340-1470
1390.71	C-H	Alkanes	1340-1470
1238.70	C-N	Amines, amides	1180-1360
1056.92	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
884.70	C-H	Alkenes	675-995
718.96	C-H	Alkenes	675-995
594.47	C-I	Aliphatic iodo compounds, C-I stretch	500-600
432.97	S-S stretch	Aryl disulfides	430-500

Table 9: FT-IR peak values of *Ampelocissus latifolia* methanol leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3439.35	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2954.37	C-H	Alkanes	2850-2970
2917.93	C-H	Alkanes	2850-2970
2849.43	C-H stretch	Methylene $>CH_2$	2845-2865
1736.88	C=O	Aldehyde	1725-1740
1711.32	C=O	Ketone	1705-1725
1620.64	C=C	Alkenes	1610-1680
1462.03	C-H	Alkanes	1340-1470
1377.14	C-H	Alkanes	1340-1470
1270.24	O-H, Primary or secondary, OH in-plane bend	Alcohol & Hydroxy compounds	1260-1350
1162.47	C-N	Secondary amine, CN stretch	1130-1190
1020.02	C-N	Primary amine, CN stretch	1020-1090
719.84	C-H	Alkenes	675-995
595.84	O-H	Alcohol, OH out-of-plane bend	590-720

Table 10: FT-IR peak values of *Ampelocissus latifolia* acetone leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3442.67	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2951.11	C-H	Alkanes	2850-2970
2923.74	C-H	Alkanes	2850-2970
2853.11	C-H	Alkanes	2850-2970
1709.21	C=O	Ketone	1705-1725
1645.05	C=C	Alkenes	1610-1680
1460.07	C-H	Alkanes	1340-1470
1376.81	C-H	Alkanes	1340-1470
1233.26	Ø-O-H	Aromatic ethers, aryl-O stretch	1230-1270
1162.05	C-N	Secondary amine, CN stretch	1130-1190
1090.50	C-O-C	Cyclic ethers, large rings, C-O stretch	1070-1140
1020.14	C-N	Primary amine, CN stretch	1020-1090
836.56	C-O-O-C	Peroxides	820-890
719.80	C-Cl	Aliphatic chloro compounds	700-800
607.23	S-S	Disulfides	600-620
467.26	S-S	Aryl disulfides	430-500
427.84	-	Unknown	-
414.07	-	Unknown	-

Table 11: FT-IR peak values of *Ampelocissus latifolia* 2-propanol leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3659.97	-	Unknown	-
3414.82	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2969.83	C-H	Alkanes	2850-2970
2920.38	C-H	Alkanes	2850-2970
2858.65	C-H	Alkanes	2850-2970
1719.55	C=O	Ketone	1705-1725
1617.61	C=C	Alkenes	1610-1680
1455.54	C-H	Akanes	1340-1470
1381.43	C-H	Akanes	1340-1470
1248.09	C-O	Alcohols, Ethers, Carboxlic acids, Esters	1050-1300
1154.59	C-O	Alcohols, Ethers, Carboxlic acids, Esters	1050-1300
1073.78	C-O	Alcohols, Ethers, Carboxlic acids, Esters	1050-1300
955.43	C-H	Alkenes	675-995
819.19	C-H	Alkenes	675-995
721.09	C-H	Alkenes	675-995
598.58	C-I	Aliphatic iodo compounds, C-I stretch	500-600
485.12	S-S	Polysulfides (S-S) stretch	470-500

Table 12: FT-IR peak values of *Ampelocissus latifolia* petroleum ether (60-80°c) leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3435.87	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2919.37	C-H	Alkanes	2850-2970
2852.65	C-H	Alkanes	2850-2970
1730.19	C=O	Aldehyde	1725-1740
1628.70	C=C	Alkenes	1610-1680
1457.82	C-H	Alkanes	1340-1470
1375.75	C-H	Alkanes	1340-1470
1271.50	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
1162.11	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
1023.66	C-N	Primary amine, CN stretch	1020-1090
723.90	C-H	Alkenes	675-995
592.03	C-I	Aliphatic iodo compounds, C-I stretch	500-600

Table 13: FT-IR peak values of *Ampelocissus latifolia* 2- butanone leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3789.13	-	Unknown	-
3389.58	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2918.98	C-H	Alkanes	2850-2970
2852.33	C-H	Alkanes	2850-2970
1716.57	C=O	Ketone	1705-1725
1613.94	C=C	Alkenes	1610-1680
1452.10	C-H	Alkanes	1340-1470
1370.83	C-H	Alkanes	1340-1470
1168.19	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
1038.21	C-N	Primary amine, CN stretch	1020-1090
790.88	C-Cl	Aliphatic chloro compounds	700-800
720.25	C-Cl	Aliphatic chloro compounds	700-800
589.98	C-I	Aliphatic iodo compounds, C-I stretch	500-600
461.90	S-S	Aryl disulfides	430-500

Table 14: FT-IR peak values of *Ampelocissus latifolia* dichloromethane leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3443.21	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2953.88	C-H	Alkanes	2850-2970
2917.25	C-H	Alkanes	2850-2970
2849.02	C-H stretch	Methylene ($>CH_2$)	2845-2865
1736.72	C=O	Aldehyde	1725-1740
1710.83	C=O	Ketone	1705-1725
1462.11	C-H	Alkanes	1340-1470
1377.01	C-H	Alkanes	1340-1470
1162.32	C-N	Secondary amine, CN stretch	1130-1190
1104.25	C-O-C	Cyclic ethers, large rings, C-O stretch	1070-1140
1020.16	C-N	Primary amine, CN stretch	1020-1090
719.63	C-H	Alkenes	675-995

Table 15: FT-IR peak values of *Ampelocissus latifolia* ethyl ether leaf extract

Wave number cm^{-1}	Bond	Functional Group Assignment	Group Frequency, cm^{-1}
3440.57	O-H	Hydrogen bonded Alcohols, Phenols	3200-3600
2919.90	C-H	Alkanes	2850-2970
2853.25	C-H	Alkanes	2850-2970
1726.49	C=O	Aldehyde	1725-1740
1512.38	C=C	Aromatic rings	1500-1600
1458.10	C-H	Alkanes	1340-1470
1376.01	C-H	Alkanes	1340-1470
1225.89	C-O	Alcohols, ethers, carboxlic acids, esters	1050-1300
1166.31	C-N	Secondary amine, CN stretch	1130-1190
1108.37	C-O-C	Cyclic ethers, large rings, C-O stretch	1070-1140
1027.01	C-N	Primary amine, CN stretch	1020-1090
833.14	C-H	Alkenes	675-995
724.45	C-H	Alkenes	675-995

CONCLUSION

Medicinal herbs are an important source of phytochemicals that offer traditional medicinal treatment of various ailments.

The objective of this study was to identify the functional groups present in *Ampelocissus latifolia* by Fourier transformer infra-red (FT-IR) Spectrophotometer method of analysis. Results of the FT-IR spectra of 14 different polar & nonpolar solvent extracts revealed

the presence of characteristic functional groups which are important for their medicinal usage.

CONFLICT OF INTERESTS

Declared None

ACKNOWLEDGMENTS

The authors are grateful to the authority and supporting staffs of the FT-IR Laboratory, IIT-B SAIF, Mumbai for providing the instrumental facility and the help rendered.

REFERENCES

1. Kirtikar KR, Basu BD. Indian Medicinal plants, 2nd Edn. Dehradun, India:International Book Distributor;1998:p.606.
2. Sikarwar RLS, Kaushik JP. Folk medicines of Morena district, Madhya Pradesh, India. Int J Pharmacog 1993;31:283-7.
3. Joshi MC, Patel MB and Mehta PJ. Some folk medicines of Dangs, Gujarat state. Bull Med Ethnobot Res 1980;1:8-24.
4. Singh KK, Kalakoti BS and Prakash A. Traditional phytotherapy in the health care of Gond tribals of Sonbhadra district, Uttarpradesh, India. J Bombay Nat Hist Soc 1994;91:386-90.
5. Shah GL and Gopal GV. Some folklore medicines of Vasavas, Gujarat, India. Acta Bot Indica 1986;14:48-53.
6. Saxena HO. Observations on the ethnobotany of Madhya Pradesh. Bull Bot Surv India 1986;28:149-56.
7. Jain SK and Tarafder CR. Medicinal plant-lore of the Santals (A revival of P.O.Bodding's work). Econ Bot 1970;24:241-78.
8. Shah GL, Menon AR and Gopal GV. An account of the ethnobotany of Saurashtra in Gujarat state (India). J. Econ Tax Bot 1981;2:173-82.
9. Chandra K, Pandey BN, Sinha GN and Pandey P. Medicinal plants of Rajgir, Bihar. Bull Med Ethnobot Res 1989;10:124-61.
10. Badhe PD and Pandey VK. A study of medicinal and economic plants of Amravati division, Amravati circle, Maharashtra. Bull Med Ethnobot Res 1990;11:1-39.
11. Jain SP and Puri HS. Ethnomedical plants of Jaunsar – Bawar Hills, Uttar Pradesh, India. J Ethnopharmacol 1984;12:213-22.
12. Patel JG, Patel NM, Patel AA, Patel AJ and Patel S. Comparison of Anti-inflammatory activity of *Ampelocissus latifolia* (Roxb.) root extract:Oral administration Vs. Topical application. J. Nat. Prod. Plant Resour 2013;3 (5):64-70.
13. Pednekar PA, Raman B. Estimation of variation in the elemental contents of methanolic soxhlet leaf extract of *Ampelocissus latifolia* (Roxb.) Planch. by ICP-AES technique. Int J Pharm Pharm Sci 2013;5(3):938-41.
14. Rengasamy RRK, Rajasekaran A, Perumal A. Fourier Transform Infrared Spectroscopy analysis of Seagrass polyphenols. Current Bioactive Compounds 2011;7(2):118-25.
15. Nazneen Bobby MD, Wesely EG, Johnson M. FT-IR studies on the leaves of *Albizia lebbeck* Benth. Int J Pharm Pharm Sci 2012;4(3), 293-96.
16. Robards K, Prernzler PD, Tucker G, Swatsitang P, Glover W. Phenolic compounds and their role in oxidative processes in fruits. Food Chem 1990;66:401-36.
17. Cowan MM. Plant products as antimicrobial agents. Clinical microbiology reviews 1999;12(4):564-82.
18. Baker EA. Chemistry and morphology of plant epicuticular waxes. In:Cutler DF, Alvin KL, Price CE. (Eds.). The Plant Cuticle. London:Academic Press;1982. p.139-65.
19. Pillai LS, Nair BR. Functional group analysis of *Cleome viscosa* L. and *C. burmanni* W. & A. (Cleomaceae) extracts by FT-IR. Journal of Pharmacognosy and Phytochemistry 2014;2 (6):120-4.
20. Walker S, Landovitz R, Ding WD, Ellestad GA, Kahne D. Cleavage behavior of calicheamicin gamma 1 and calicheamicin T. Proc Natl Acad Sci USA 1992;89(10):4608-12.
21. Nelson DL, Cox MM. Lehninger, Principles of Biochemistry. 3rd ed. New York:Worth Publishing;2000.
22. Yu G, Nguyen TT, Guo Y, Schauvinhold I, Auldridge ME, Bhuiyan N *et al*. Enzymatic functions of wild tomato methylketone synthases 1 and 2. Plant Physiol 2010;154(1):67-77.
23. http://www.ck12.org/book/From-Vitamins-to-Baked-Goods%253A-Real-Applications-of-Organic-Chemistry/r1/section/5.3/ (Accessed 2014-06-06).
24. Janakiraman N, Satish SS, Johnson M. UV-VIS and FT-IR spectroscopic studies on *Peristrophe bicalyculata* (Retz.) Nees. Asian J Pharm Clin Res 2011;4(4):125-9.
25. Mayeno A, Curran AJ, Roberts RL, Foote CS. Eosinophils preferentially use bromide to generate halogenating agents. The Journal of Biological Chemistry 1989;264(10):5660-68.
26. Mansour MMF. Nitrogen containing compounds and adaptation of plants to salinity stress. Biologia Plantarum 2000;43(4):491-500.
27. Melo FL, Benati FJ, Roman Junior WA, Palazzo de Mello JC, Nozawa C, Carvalho Linhares RE. The *invitro* antiviral activity of an aliphatic nitro compound from *Heteropteris aphrodisiaca*. Microbiological Research 2008; 163(2):136-9.
28. http://scifun.chem.wisc.edu/chemweek/chelates/chelates.html (Accessed 2014-06-06).
29. Klocke JA, Darlington MV, Balandrin MF. 8-Cineole (Eucalyptol), a mosquito feeding and ovipositional repellent from volatile oil of *Hemizonia fitchii* (Asteraceae)". Journal of Chemical Ecology 1987;13 (12):2131.
30. Sfara V, Zerba EN, Alzogaray RA. Fumigant Insecticidal Activity and Repellent Effect of Five Essential Oils and Seven Monoterpenes on First-Instar Nymphs of *Rhodnius prolixus*. Journal of Medical Entomology 2009;46 (3):511–5.
31. http://www.herbs2000.com/h_menu/hydrogen_peroxide.htm (Accessed 2014-06-06).
32. Olmos, E, Hellin E. Cytochemical localization of ATPase plasma membrane and acid phosphatase by cerium based in a salt-adapted cell line of *Pisum sativum*. J. Expt.Bot 1997;48:1529-35.
33. Munzel T, Daiber A, Mulsch A. Explaining the phenomenon of nitrate tolerance. Circ. Res 2005;97(7):618-28.
34. Daiber A, Gori T, Munzel T. Mechanisms and clinical significance of nitrate tolerance. Pharm Unserer Zeit 2010a;39(5):375-84.
35. Munzel T. Recent findings on nitrates:their action, bioactivation and development of tolerance. Dtsch. Med. Wochenschr 2008;133(44):2277-82.
36. Zeng L, Wu D, Wu S. A novel protocol for the preparation of sodium tanshinone sulphonates by direct ultrasound-assisted sulphonation of the crude extract of the roots of *Salvia miltiorrhiza* Bunge and following counter-current chromatography purification. Phytochem Anal 2011;22(5):424-31.
37. Sritrairat N, Nukul N, Inthasame P, Sansuk A, Prasirt J, Leewatthanakorn T *et al*. Antifungal activity of lawsone methyl ether in comparison with chlorhexidine. J Oral Pathol Med 2011;40(1):90-6.
38. Kraeling ME, Bronaugh RL, Jung CT. Absorption of lawsone through human skin. Cutan Ocul Toxicol 2007;26(1):45-56.
39. Coates J. Encyclopedia of Analytical Chemistry. In:Interpretation of Infrared Spectra, A Practical Approach. R.A. Meyers ed. Chichester:John Wiley & Sons Ltd;2000. p. 10815-37.
40. Skoog DA, Holler JF, Nieman TA. Principles of Instrumental Analysis. In:Applications of Infrared spectrometry. 5th ed. Bangalore:Thomson Brooks;2005. 404-28.
41. Liu HX, Sun SQ, Lv GH, Chan KKC. Study on *Angelica* and its different extracts by Fourier transform infrared spectroscopy and two-dimensional correlation IR spectroscopy. Spectrochimica Acta A 2006;64:321–6.