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Tri-spectroscopically evaluation of some selected Saudi medicinal plants for potential medical applications: UV-Visible, FTIR, and GCMS Analysis

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Abstract
The unique botanical diversity of Saudi Arabia has inspired many researchers to prospect deeply in its components. Therefore, this study was designed to identify bio molecular structure of *Senna italica*, *Cymbopogon schoenanthus*, *Artemisia Judaica*, and flowers of *Clitoria ternatea*, collected from Yanbu – Radwa Mount, in the western region of Al-Madinah Al-Munawwarah – KSA. The extraction of air parts was performed by macerating in pure ethanol and stored for further investigations. UV-Vis, FTIR, and GCMS were utilized to identify the bioactive compounds of the studied plants. In comparison between samples, it was clear that the maximum peak intensity values of phenolic groups were observed in *Artemisia Judaica.* The highest number of amine functional groups and aromatic rings were demonstrated in *Cymbopogon schoenanthus*, whereas the lowest numbers are found in the *Senna italica* and *Clitoria ternatea*, respectively. This study suggested that phenyl-amino-benzoic-acid compounds detected in extracted plants may contributed to their activity.

Keywords: KSA, Aromatic plants, bioprospecting, phenyl-amino-benzoic acid

1. Introduction
Medicinal plants have a curative value as biologically active ingredients of the primary and secondary metabolites are obtained either in pure or combined form, with little side effects and cost-effective compared to expensive synthetic medications [1]. Different phytochemicals were detected in the plant tissue, such as alkaloids, flavonoids, glycosides, vitamins, tannins, and coumarin, and have approved their efficiency against cancer and microbial cells activities [2]. Natural products are being studied as possible cytotoxic agents and have shown a promising result in preclinical research. These products are a major source of new therapeutic drugs and have motivated many creative approaches in accelerating clinical research [3].
One of the most botanically diverse nations on earth is the Kingdom of Saudi Arabia (KSA), located in the southwest of Asia. It is the largest country between Arab nations, on the mainland and in the desert, Saudi Arabia is home to a wide variety of plants, some of which have unique medical properties [4]. Most of plant species are found in the Amaranthaceae family, followed by Asteraceae, Apocynaceae, and Fabaceae. The most consumed plant parts for natural preparation in Saudi traditional medicine were the entire plant, leaves, and seeds [5].
The Cassia genus has important in the field of medicine and preventative remedies because of its diverse range of pharmacological activity and rich in phytochemical components [6]. Previous studies have been reported divers effects of the aerial parts of *Senna italica* such as anti-diabetic [7], antioxidants, anticancer, antimutagenic, antibacterial, anti-inflammatory, insecticides, larvicides activities [8-10].
Cymbopogon schoenanthus has long consumed in Asian cuisine as a flavouring component and cool drinks. It contains various phytochemical components including tannins, terpenoids, flavonoids, and volatile oils [11]. It is mainly used as an anti-infectious drug for urinary tract infections a diuretic and to avoid kidney stone formation [12], as well as in treating rheumatism, fever, gout, stomach-ache, and inflammation of the prostate [13-14]. The aromatic herb of *Artemisia Judaica* is often used in Arabic traditional medicine to alleviate ailments connected to inflammation such as atherosclerosis, arthritis, and diabetes mellitus [15].

Different species of this genera produce a wide range of chemicals, including as terpenoids, quinines, alkaloids, phenols, and flavonoids [16]. According to reports, this genus significant therapeutic promise for the treatment of gastrointestinal and inflammatory disorders, sexual dysfunction, cardiac diseases, microbial infections, and cancer [17, 18].

Recently *Clitoria ternatea* has drawn a lot of attention in medical applications. In traditional medicine, particularly Ayurvedic medicine, it is utilized as a supplement to enhance cognitive functioning and alleviate symptoms of several illnesses, including fever, inflammation, discomfort, and diabetes, to induce uterine contractions, induce menstruation, and treat intestinal and liver disorders [19]. Previous research has demonstrated that distinct sections of this specie have varying secondary metabolites such as alkaloids, flavonoids such as kaempferol and quercetin, phenols, terpenoids, glycosides, protein, ternatins, tocopherol, and phytosterol [20-21].

In despite previous studies were detected various phytoconstituents in aerial parts of each *Senna Italica* [22,23], *Cymbopogon schoenanthus* [24,25], *Artemisia judaica* [26,27], and *Clitoria ternatea* [28,29], they may differ depended on growth environment, climate conditions, soil compositions and structure, the plant's age, and the state of flowering. Spectroscopic analysis can reveal details about the molecular structures of biological components. Therefore, using non-destructive applications may demonstrate structural information of many biological systems such as plant tissues that are composed of significant biomolecules. These spectroscopic techniques can reveal deep insight into the molecular structure components.

2. Materials and Methods

2.1 Sample collection, identification and preparation

The whole fresh medicinal plant of each *Senna italica*, *Cymbopogon schoenanthus*, *Artemisia judaica*, and *Clitoria ternatea* collected in Jan 2024 from Yanbu governorate in the middle of Radwa Mountain, western region of Al-Madinah al-Munawwarah – Saudi Arabia (Figure 1). The plant taxonomy was based on anatomical description and database available in the library [30,31] and authenticated by plant taxonomist at the Department of Biology, KAU.

The fresh leaves of *Senna Italica*, *Cymbopogon schoenanthus*, *Artemisia Judaica*, and flowers of *Clitoria ternatea were* thoroughly washed with Milli Q water to stick dirt particles, then were dried under shade at room temperature for 2 weeks, then pulverized by a mechanical grinder, then kept in an airtight container in a dry place for further preparation. The extraction of all medicinal plants was performed by macerating (50 g) of soft powder in (500 ml) of 80% ethanol for 3 days at ambient temperature on digital orbital shaker, filtered through Whatman No.1 filter paper and the resulting macerate was collected in a clean conical flask and ethanol was evaporated by oven at 45 °C, then stored the obtained crude extracts at 4 °C in airtight bottles for further preparation (Figure 2) [32].

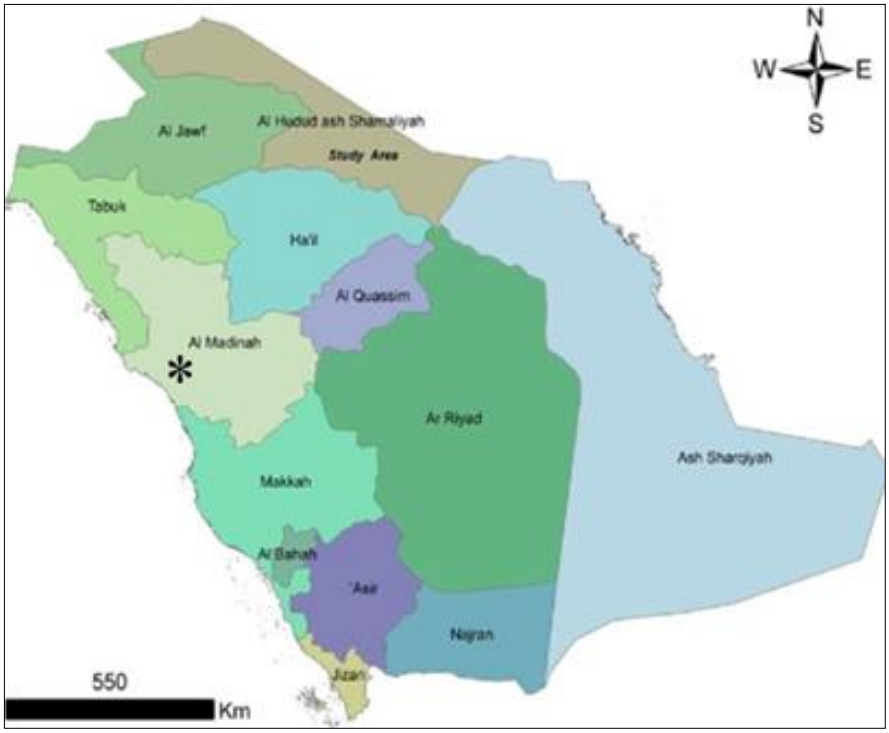

Fig 1: Location map of the KSA showing the study area of medicinal plants collection (*) [33].

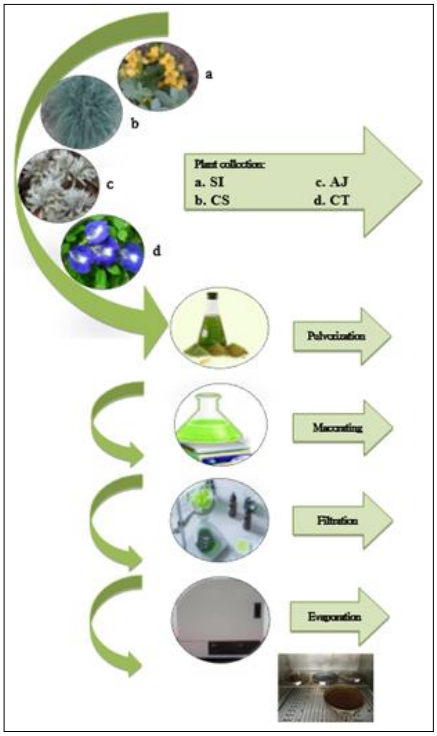

Fig 2: Schematic showing the preparation process of studied medicinal plants, *Senna italica* (SI), *Cymbopogon schoenanthus* (CS), *Artemisia judaica* (AJ), and *Clitoria ternatea* (CT)

2.2. Tri-Spectroscopical studies

2.2.1. UV-VIS spectrophotometer

Ultraviolet visible (UV-VIS) spectrophotometer (Shimadzu UV-VIS NIR spectrophotometer UV-3600, USA) conducted on the studied medicinal plant extracts using a UV-visible spectrophotometric examination. For proximate analysis, the extracts examined by visible and UV light at wavelengths between 200 and 800 nm. Using the same solvent, dilute the samples to 1:10 [34].

2.2.2 FT-IR spectroscopy

Fourier transform infrared (FTIR) spectroscopy (Thermo Scientific Nicolet iS FT-IR Spectroscopy, USA) used to identify the characteristic functional groups in the extracts. It provides information about the structure of molecules obtained from their absorption spectrum. A small quantity of

the studied plant extracts placed on sample holder then the absorbance and transparent analysis performed. The infrared spectrum obtained using Thermo Scientific Nicolet iS FT-IR Spectroscopy, USA. The sample scanned from 4000 to 500 cm^{-1} [34].

2.2.3 Gas chromatograph mass spectrometer

Thermo Scientific TRACE Ultra Multi-channel gas chromatograph mass spectrometer (GCMS), USA was used to identify the bioactive compounds of the ethanolic extract of studied medicinal plants The medicinal plant extract samples were injected using the split mode, with the injection port temperature set at 300°C, helium flowed at 1.61 ml/min, the oven temperature started at 50°C, then set to increase 10°C/min until reached 300°C, the ion source temperature was 200°C and the interface temperature set at 250°C. Scan mode was used to evaluate the samples, which had a mass range of 40–500 m/z. The mass spectrometer's ion source temperature was 240 °C, and electron impact ionization stabilized with a collision energy of 70 eV. The total run time was 32 minutes. The molecules then defined using NIST`98 mass spectral database [25].

3. Results

3.1 UV-VIS analysis

The UV-Vis spectra of the under-studied samples examined (Table 1). All the extracts have different band patterns in three clusters. Cluster I in the range of 200-280 nm can be related to the electronic transition of the double bond electrons in olefinic compounds. The most intense of the peak belongs to the *Clitoria ternatea* sample, indicating that the sample has the highest number of olefinic functional groups. Cluster II in the wavelength range of 290-350 nm attributed to the electronic transition from non-bonding electron in carbonyl (C=O) and carboxyl (O=C-OH) groups. The number of these functional groups are most in the chemical structure of the *Clitoria ternatea* sample. Finally, cluster III (380-480 nm) corresponds to the electronic transition of certain compounds, which contain extension of conjugation from the aromatic compounds. The maximum peak intensity values for aromatic rings were for *Cymbopogon schoenanthus*, *Artemisia judaica*, and *Clitoria ternatea* (Figure 3).

3.2 FT-IR analysis

FTIR spectroscopy is used to identify the functional groups of the active components present in extract based on the peak's values in the region of IR radiation. When the extract passed into the FTIR, the functional groups of the components separated based on its peak's ratio. The results of FTIR peak intensities and functional groups (Table 2). The FTIR spectra of *Senna italica*, *Cymbopogon schoenanthus*, *Artemisia judaica*, and *Clitoria ternatea* (Figure 4) gave a broad peak at around 3310-3370 cm-1 which indicated the presence of O-H stretching in phenolic and/or alcohol groups. In addition, they gave one or two peaks at about 2860 to 2940 cm-1 which indicated the presence of C-H stretching in methyl and methylene groups. The appeared peaks at about 1710-1720 cm-1 and 1610-1650 cm-1 may attributed to double bonds (C=O and C=C) stretching, and N-H bending vibrations, and the peak at around 1420-1450 cm-1 is due to C-H bending vibration in saccharide groups. The absorption peaks at about 1360-1370 cm-1 and 1220-1230 cm-1 are due to C-H bending vibration of ester and stretching vibration of C-O bonds in ester and/or glycoside functional groups. Finally, the peak in the range of 1050-1060 cm-1 indicated the presence of alcohol, acid, saccharides.

3.3 GC MS analysis

Novel medications derived from different air parts of plants. contemporary medications derived indirectly from therapeutic herbs. They have made essential contributions to combat a wide range of illnesses and ailments. Herbal formulations developed, modernized, and quality-controlled in large part by the analysis and extraction of plant material. Understanding active ingredients of medicinal plants assisting in the defines of humans against microorganism's invasion. Therefore, GCMS technique used to identify the bioactive compounds found in the ethanolic extract of studied medicinal plants with their molecular formula, retention time, and concentration (Tables 3, 4, 5 and 6, Figure 5). Some selected compounds showed different benzoic derivatives detected in the ethanolic extracts of Senna italicac (Figure 6), *Cymbopogon* schoenanthus (Figure 7), *Artemisia Judaica* (Figure 8), and *Clitoria ternatea* (Figure 9).

Table 1: UV-VIS spectra peak characterization of *S. Italica* Mill, *C. schoenanthus L.*, *A. Judaica L.*, and *C. ternatea L.* [35, 36].

Sample	Wavelength (nm)	Absorbance	Functional groups
S. Italica Mill	265	0.57	Double bonds (olefinic and aromatic compounds)
	352	0.36	Non-bonding electron in (C=O) and (O=C-OH) groups
C. schoenanthus L.	235	1.34	Double bonds (olefinic and aromatic compounds)
	294	0.4	Non-bonding electron in (C=O) and (O=C-OH) groups
	408	0.11	Aromatic compounds
A. Judaica L.	231	1.95	Double bonds (olefinic and aromatic compounds)
	275	1.14	
	331	1.06	Non-bonding electron in (C=O) and (O=C-OH) groups
	411	0.11	Aromatic compounds
C. ternatea L.	221	3.7	Double bonds (olefinic and aromatic compounds)
	266	1.95	
	302	1.21	Non-bonding electron in (C=O) and (O=C-OH) groups
	352	1.25	Aromatic compounds

Table 2: The Fourier transform infrared spectra peak characterization of *S. Italica* Mill, *C. schoenanthus L.*, *A. Judaica L.*, and *C. ternatea L* [37-44]

Sample	Wave numbers (cm^{-1})	Intensity	Bond responsible
S. Italica Mill	3340	2.71	ν:O-H (Phenolic, Alcohol)
	2940	0.91	ν:C-H (Methyl & Methylene)
	1710	0.63	ν:C=O (Ester)
	1610	0.91	ν:C=C (Aromatic rings) δ:N-H (Amine)
	1420	0.73	δ:C-H (Saccharides)

	1370	0.74	δ:C-H (Ester)
	1230	0.63	ν:C-O (Ester, glycoside)
	1050	1.38	ν:C-O(Alcohol, acid, Saccharides)
C. schoenanthus L.	3370	1.59	ν:O-H (Phenolic, Alcohol)
	2870	1.05	ν:C-H (Methyl & Methylene)
	1710	2.28	ν:C=O (Ester)
	1650	2.66	ν:C=C (Aromatic rings) δ:N-H (Amine)
	1440	1.24	δ:C-H (Saccharides)
	1370	1.82	δ:C-H (Ester)
	1220	1.24	ν:C-O (Ester, glycoside)
	1060	1.53	ν:C-O (Alcohol, acid, Saccharides)
A. Judaica L.	3380	2.93	ν:O-H (Phenolic, Alcohol)
	2970	0.94	ν:C-H (Methyl & Methylene)
	1710	1.77	ν:C=O (Ester)
	1610	2.02	ν:C=C (Aromatic rings) δ:N-H (Amine)
	1420	1.11	δ:C-H (Saccharides)
	1370	1.41	δ:C-H (Ester)
	1230	0.98	ν:C-O (Ester, glycoside)
	1050	1.50	ν:C-O (Alcohol, acid, Saccharides)
C. ternatea L.	3310	1.64	ν:O-H (Phenolic, Alcohol)
	2930	0.85	ν:C-H (Methyl & Methylene)
	1710	1.04	ν:C=O (Ester)
	1620	1.17	ν:C=C (Aromatic rings) δ:N-H (Amine)
	1420	0.93	δ:C-H (Saccharides)
	1370	1.09	δ:C-H (Ester)
	1230	0.75	ν:C-O (Ester, glycoside)
	1060	1.99	ν:C-O (Alcohol, acid, Saccharides)

N.B: (ν: stretching; δ: bending)

Table 3: GC-MS spectral analysis of ethanolic extract of *S. Italica* Mill

Peak	Compound retention time	Compound	Compound formula	Compound area	Percentages
1	6.0466	Benzo [4,5] f uro[3,2-d] pyrimidin-4-yl-(4-fluoro-phenyl)-amine	C16H10FN3O	7279833.8	66.2
2	6.9946	2-Azetidine carbothioic acid, 1-(phenylmethyl)-, S-	C17H17NOS	1932850.8	51.4
3	8.1105	4-Phenyl-2-(2-hydroxyphenyl)-5,6-dihydrobenzo[h]quinazoline	C24H18N2O	842334.3	51.1
4	9.1950	Phthalic acid, diamide, N-N'-dimethyl-N-N'-bis(phenyl)-	C22H20N2O2	6572644.1	61.1
5	9.9614	Pyrazole-3-carboxylic acid, 4-chloro-1-methyl-, 2-trifluoro- methyl-benzyli denamino ester	C13H9ClF3N3O2	4803982.1	52.9
6	10.3977	2-[(2-Chloro-4-nitro-phenyl)-hydrazono methyl]-4-nitro-phenol	C13H9ClN4O5	2595945.5	58.1
7	11.6997	Benzoic acid, 3-[(1,2-dihydro-2-oxo-4-pyrimidinyl) amino]-	C11H9N3O3	4538203.2	52.4
8	12.1865	4-(2,6-Difluoro benzoyl)-3-phenyl-5-isoxazolone	C16H9F2NO3	3564082.5	69.9
9	13.6521	1,2-Benzenediol, o-(2-methylbenzoyl)-o'-(trans-3-trifluoro methyl cinnamoyl)	C24H17F3O4	981899.3	51.4
10	15.9449	3-Chloro-2-fluoro benzoic acid, 4-nitrophenyl ester	C13H7ClFNO4	1268471.5	52.4
11	16.2367	2,6-Difluoro-3-methylbenzoic acid, 2,3,4,6-tetra chloro- phenyl ester	C14H6Cl4F2O2	1612968.8	69.9
12	16.8219	1-Benzyl-3-(p-methoxy- phenyl)-2,4-dioxo aziridino (2,3-c) pyrrolidine	C18H16N2O3	3165440.6	58.9
13	16.8313	benzenesulfonamide, N-(4-amino-1-naphthalenyl)-4-methyl	C17H16N2O2S	4078127.2	53.5
14	21.3953	1H-Pyrazole-5-carboxamide, N-(3-methoxyphenyl)-1-methyl-3-(trifluoro methyl)-	C13H12F3N3O2	930459.8	50.1
15	23.3557	Benzaldehyde,-3,4-dimethoxy,hydrazone-(4-methoxybenzoyl-)	C17H18N2O4	775557.8	52.7

Table 4: GC-MS spectral analysis of ethanolic extract of *C. schoenanthus L*

Peak	Compound retention time	Compound	Compound formula	Compound area	Percentages
1	7.8114	4-[4-[(2-Hydroxy- benzoyl) amino] anilino]-4-oxobut-2-enoic acid	C17H14N2O5	5064674.6	54.8
2	8.1201	Methanone, (3-cyclohexyl-5-trifluoro methyl-5-hydroxy-2-pyra zolin-1-yl) phenyl-	C18H21F3N2O2	850875.1	54.4
3	9.0078	1,2-Benzenediol, o-(3-fluorobenzoyl)-o'-(2-phenylacetyl)-	C21H15FO4	11550180.2	57.1
4	10.0989	1H-1,2,3,4-Tetrazole-1-propanoic acid, 2-(4-fluorophenyl)-2-oxoethyl ester	C12H11FN4O3	8161538.1	50.3
5	10.4136	2-Oxo-5-benzyl-4,6-diphenyl-1,2-dihydro pyrimidine	C23H18N2O	4538493.1	67.7
6	10.6376	2H-1,2,3,4-Tetrazole-2-acetamide, N-(2-ethylphenyl)-5-(4-pyridinyl)-	C16H16N6O	396893656.5	71.3
7	10.9832	2-Pyrrolidinone, 1-[4-[(3-phenyl-1-pyrrolidinyl) sulfonyl] phenyl]-	C20H22N2O3S	286216253.5	65.9
8	11.9918	2-(1H-Tetrazol-5-ylmethyl)-1H-benzoimidazole	C9H8N6	6404932.4	50.8
9	12.2769	1,2-Benzenediol, O-(2-furoyl)-O'-(3-phenyl propionyl)-	C20H16O5	11590045.3	54.9
10	12.4307	1,3-Benzenediol, o-(2,6-difluorobenzoyl)-o'-(4-ethylbenzoyl)	C22H16F2O4	10564613.1	71.7
11	12.4963	2,4-Difluorobenzoic acid, 4-isopropylphenyl ester	C16H14F2O2	2632391.5	52.3
12	12.5694	1,2-Benzenediol, o-(2-bromopropionyl)-o'-(4-ethylbenzoyl)-	C18H17BrO4	3923397.4	50.
13	13.8048	Dicyanoketone 2-trifluoromethylphenylhydrazone	C10H5F3N4	8009044.0	55.8
14	14.0725	Phenylalanine, 4-amino-N-t-butyloxy carbonyl-, t-butyl ester	C18H28N2O4	252016511.1	59.0
15	15.0095	1,2,4-Triazolidine-3,5-dione, 1-(bicyclo [3.2.1] oct-2-en-4-yl)-4-phenyl-	C16H17N3O2	34026565.1	51.6
16	15.4092	Propanamide, N-[3-(1H-1,3-benzimidazol-2-yl) propyl]-2-methyl-	C14H19N3O	17368391.4	51.6
17	15.9861	N-(5-amino-2-methylphenyl) furan-2-carboxamide	C15H12N2O3	3556978.8	50.8
18	16.0688	Methanone, (4-phenoxy-6-phenyl-1,2,5-dioxazinan-2-yl) phenyl	C23H21NO4	492760335.9	54.0

19	16.7260	N-[1-[(Adamantan-1-ylmethyl)-amino]-2,2,2-trifluoro-1-trifluoromethyl-ethyl]-2-methoxy-benzamide	C22H26F6N2O2	1605449.8	52.9
20	16.8150	Phenylacetic acid, 3-fluorophenyl ester	C14H11FO2	14019143.9	61.0
21	17.4247	1,1-Dimethyl ethyloxycarbonic acid 4-ethenylphenyl ester	C13H16O3	8115364.5	50.7
22	17.7591	1,2-Benzenediol, o-(4-butylbenzoyl)-o'-(2-methyl benzoyl)-	C25H24O4	11467106.9	59.1
23	18.2636	4H-1-Benzopyran-2-carboxylic acid, 6-amino-4-oxo-, ethyl ester	C12H11NO4	2847722.6	50.7
24	19.2308	1H-Imidazole-4,5-dicarboxylic acid, 4-[(4-chloro-phenyl)-amide] 5-methylamide	C12H11ClN4O2	8121715.6	57.0
25	21.7769	Pyrazolo[1,5-a] pyrimidine, 2,5,7-trimethyl-3-phenyl-	C15H15N3	588081.0	63.4
26	21.9547	1,2-Dihydro-3,6-di- phenyl-S-tetrazine	C14H12N4	6399522.8	52.5
27	22.9858	5,5'-Bis [2-(4-amino phenyl)-1H-1,3-benzimidazol]	C26H20N6	1052540.7	58.4

Table 5: GC-MS spectral analysis of ethanolic extract of *A. Judaica L*

Peak	Compound retention time	Compound	Compound formula	Compound area	percentages
1	6.0187	1H-Imidazolo[1,2-a] pyridine-6-carbonitrile, 2,3-dihydro-7-methyl-1-(3,4-dimethyl phenyl)-5-oxo-	C17H17N3O	4667275.4	62.6
2	8.1953	5-(4-Bromobenzyl)-2-t-butyl-3-methyl-4-Oxoimidazolidine-1-carboxylic acid, allyl ester	C6H14FO2P	4308913.0	57.9
3	8.6936	1,2-Benzenediol, O-(4-fluorobenzoyl)-O'-phenylacetyl	C21H15FO4	7915306.7	51.5
4	9.6401	4,6-Bis (4-ethoxy benzylthio)-5-nitropyrimidine	C22H23N3O4S2	2898864.7	64.6
5	11.3577	3-Trifluoro methylbenzoic acid, 4-nitrophenyl ester	C14H8F3NO4	12571848.6	67.7
6	11.6097	Benzamide, N-[4-(1H-1,3-benzimi dazol-2-yl)-1,2,5-oxadiazol-3-yl]-4-fluoro-	C16H10FN5O2	365327.3	53.4
7	11.8533	3-Phenyl-6-(4-nitrophenyl)-4H-(1,2,3) triazolo (1,5-d) (1,3,4) oxadiazin-4-one	C16H9N5O4	3656355.5	55.0
8	14.3598	1H-1,2,3-Triazole-4-carboxylic acid, 5-methyl-1-[4-(5-methyl-1,2,4-oxadiazol-3-yl)-1,2,5-oxadiazol-3-yl]-, ethyl ester	C11H11N7O4	549900197.0	57.3
9	14.6274	5-Nitrothiophene-2-carbox aldehyde picolinoyl- hydrazone	C11H8N4O3S	6464885.2	50.2
10	15.2212	Acetic acid, (dodeca -hydro-7-hydroxy -1,4b,8,8-tetra methyl -10-oxo-2(1H)-phenan- threny lidene)-,2-(dimethyl lamino) ethyl ester	C24H39NO4	8974744.8	61.4
11	15.7238	Benzoic acid, 4-(diphenyl phosphine oxido) methyl-, ethyl ester	C22H21O3P	5362810.0	54.5
12	16.6706	Benzamide, 3-methyl-N-(2-bromophenyl)-	C14H12BrNO	2476691.7	52.5
13	17.7274	1,3-Benzenediol, O, O'-di(cyclo propanecarbonyl)-	C14H14O4	10930669.6	55.3
14	17.7515	9-Amino-12-oxo-4-propyl-10,11-	C15H19N5O	94887605.2	55.9
15	18.4049	N'-Hydroxy-3-methyl-2,4-dioxo-1-phenyl-1,2,3,4-tetrahydro pyrimidine-5-carboxi midamide	C12H12N4O3	25550520.7	52.5
16	18.4749	2-Amino-4,6-diphenyl pyrimidine	C16H13N3	2129674.1	63.0
17	18.4832	3a,6-Epoxy-3aH-isoindole, 1,2,3,6,7,7a-hexahydro-6-methyl-2-phenyl-	C15H17NO	4979393.7	52.5
18	18.4913	4-Methoxy-N-methylphenylethylamine, pentafluorpropionyl	C13H14F5NO2	4532362.2	51.0
19	20.4748	2-Trifluoro methyl benzoic acid, 2-bromo-4-fluorophenyl ester	C14H7BrF4O2	6369042.3	50.6

Table 6: GC-MS spectral analysis of ethanolic extract of *C. ternatea L.*

Peak	Compound retention time	Compound	Compound formula	Compound area	Percentages
1	8.2089	3-(1,3-Dioxo-6-piperidin-1-yl-1H,3H-benzo[de] isoquinolin-2-yl)-propionic acid-	C20H20N2O4	1278178.3	66.8
2	8.2913	2-Methyl-4-phenoxy-5,6-diphenyl-2H-pyridazin-3-1	C23H18N2O2	264771.8	50.4
3	8.5188	(4-Methyl-piperidin-1-yl)-acetic acid, (2-oxo-2,3-dihydro-benzo [e]indol-1-ylidene)-hydrazide	C20H22N4O2	161685.7	60.2
4	11.5344	1,3-Benzenediol, o-(3-methylbut-2-enoyl)-o'-(2-fluorobenzoyl)-	C18H15FO4	1573019.0	52.7
5	16.8192	1H-Imidazole-5-carboxamide, 4-amino-1-methyl-N-(4-phenoxyphenyl)-	C17H16N4O2	821608.8	50.9
6	16.8883	Carbamic acid, [2-methoxy-4-[[(tetrahydro-2-furanyl) carbonyl] amino] phenyl]-, ethyl ester	C15H20N2O5	3600749.8	59.8
7	17.0189	Benzenemethanamine, alpha.-(2-imino-1-methyl-2-phenyl ethylidene)-N-phenyl-	C22H20N2	4708995.8	52.3
8	17.0266	2-(4-Methoxyphenyl)-8-chloro-4H-imidazo(2,1-c)(1,4)benzoxazine	C17H13ClN2O2	1442749.7	51.0
9	17.0494	1H-Benzoimidazole, 1-(4-fluoro benzyl)-2-(thiophen-2-yl)-	C18H13FN2S	2335001.3	50.3
10	18.8096	1H-Indole-3-acetamide, N-(1,3-benzodioxol-5-ylmethyl)-2-methyl-.alpha.-oxo-	C19H16N2O4	10232760.9	50.7
11	21.1829	2-Benzofurancarboxylic acid, 7-methoxy-, (3,4,4-trimethyl-1,2-dioxetan-3-yl) methyl ester	C16H18O6	2315422.1	56.0
12	25.9425	Cholesta-8,24-dien-3-ol, 4-methyl-,(3.beta.,4.alpha.)-	C28H46O	156237724.3	55.7
13	26.5341	3-Oxatricyclo [20.8.0.0 (7,16)] triaconta-1(22),7 (16),9,13,23,29-hexaene	C29H42O	91604282.8	50.3

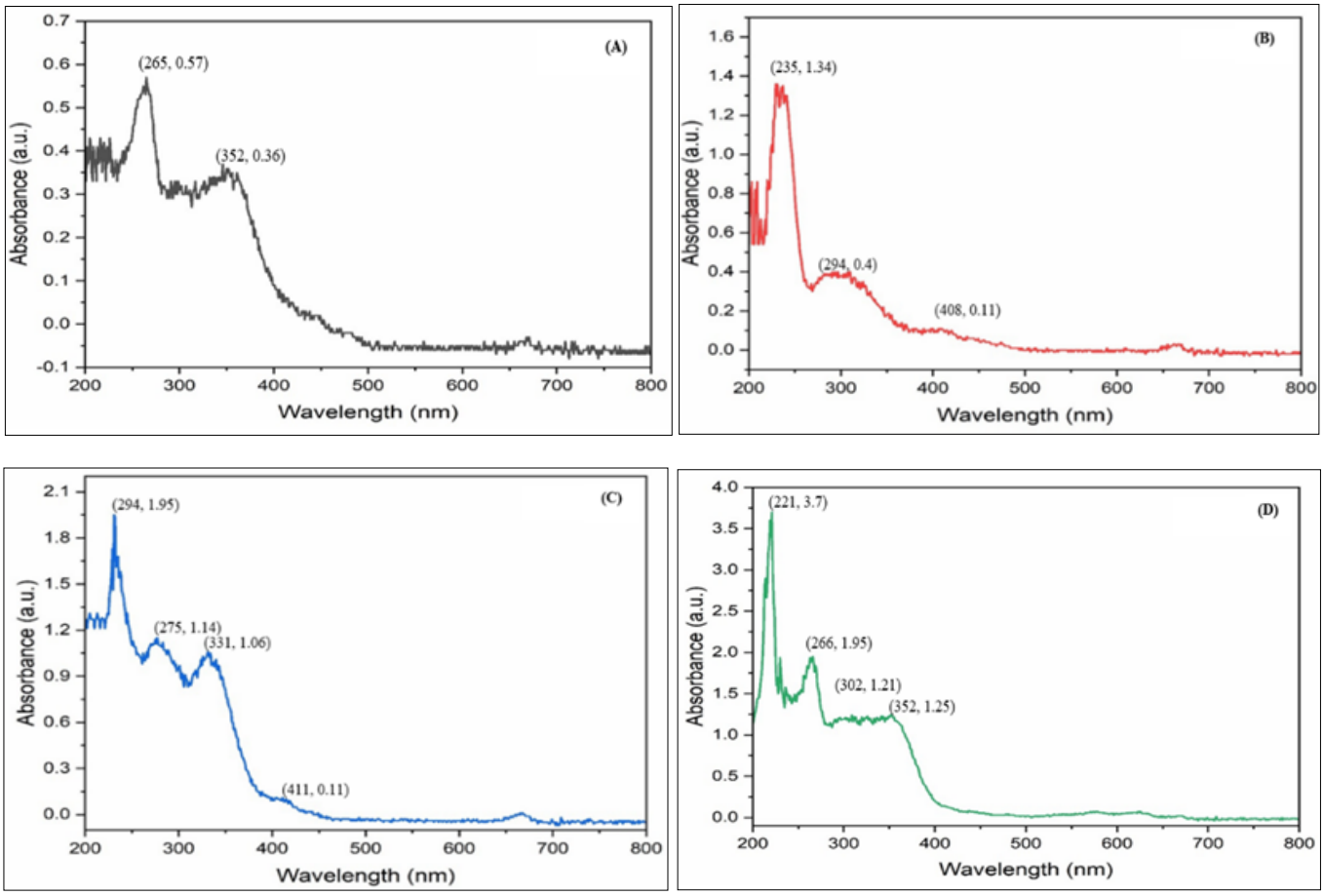

Fig 3: UV-VIS spectra of pure ethanolic extracts of: (A) *Senna Italica*, (B) *Cymbopogon schoenanthus*, (C) *Artemisia judaica*, (D) *Clitoria ternatea*

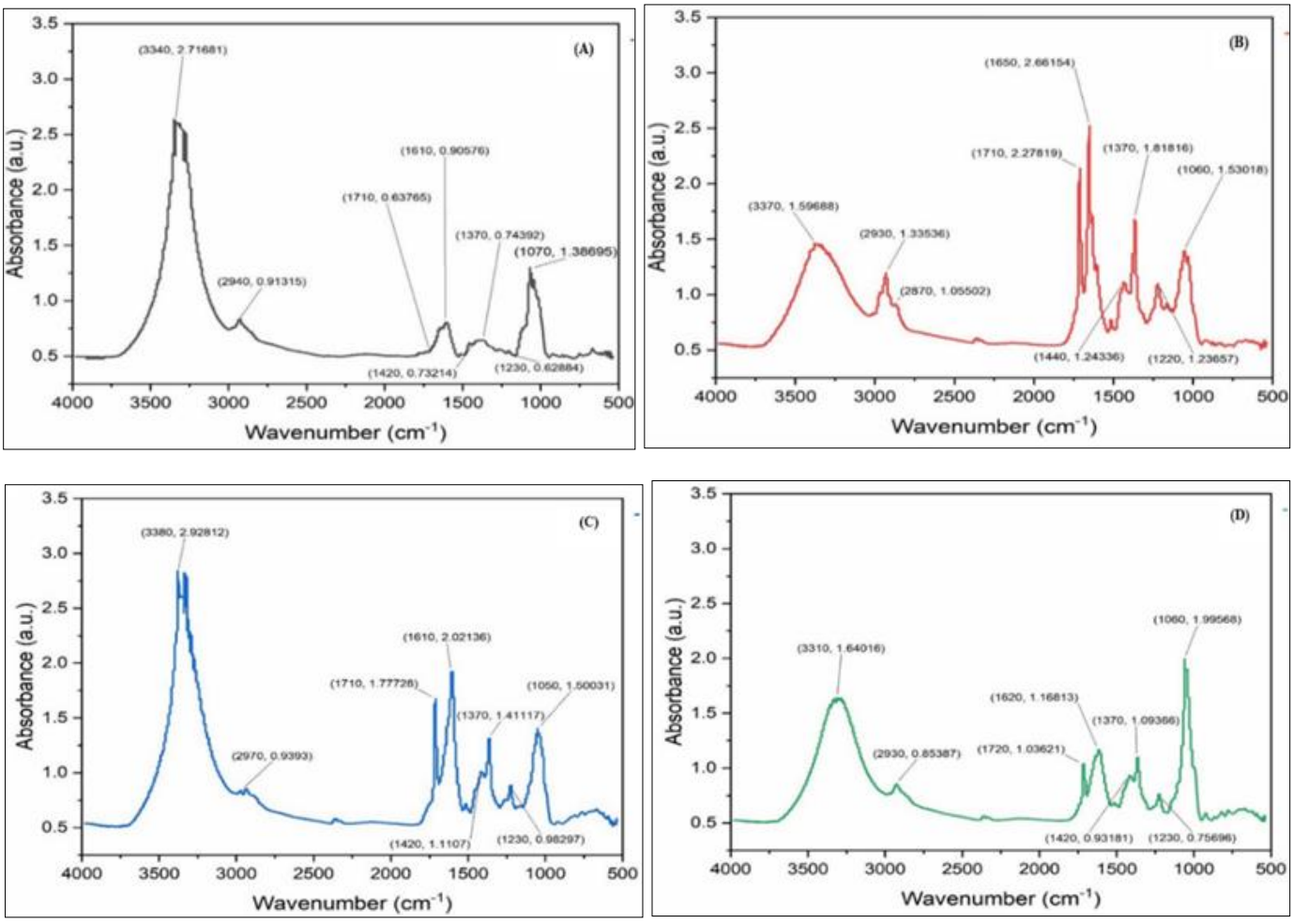

Fig 4: UV-VIS spectra of pure ethanolic extracts of: (A) *Senna italica*, (B) *Cymbopogon schoenanthus*, (C) *Artemisia judaica*, (D) *Clitoria ternatea*.

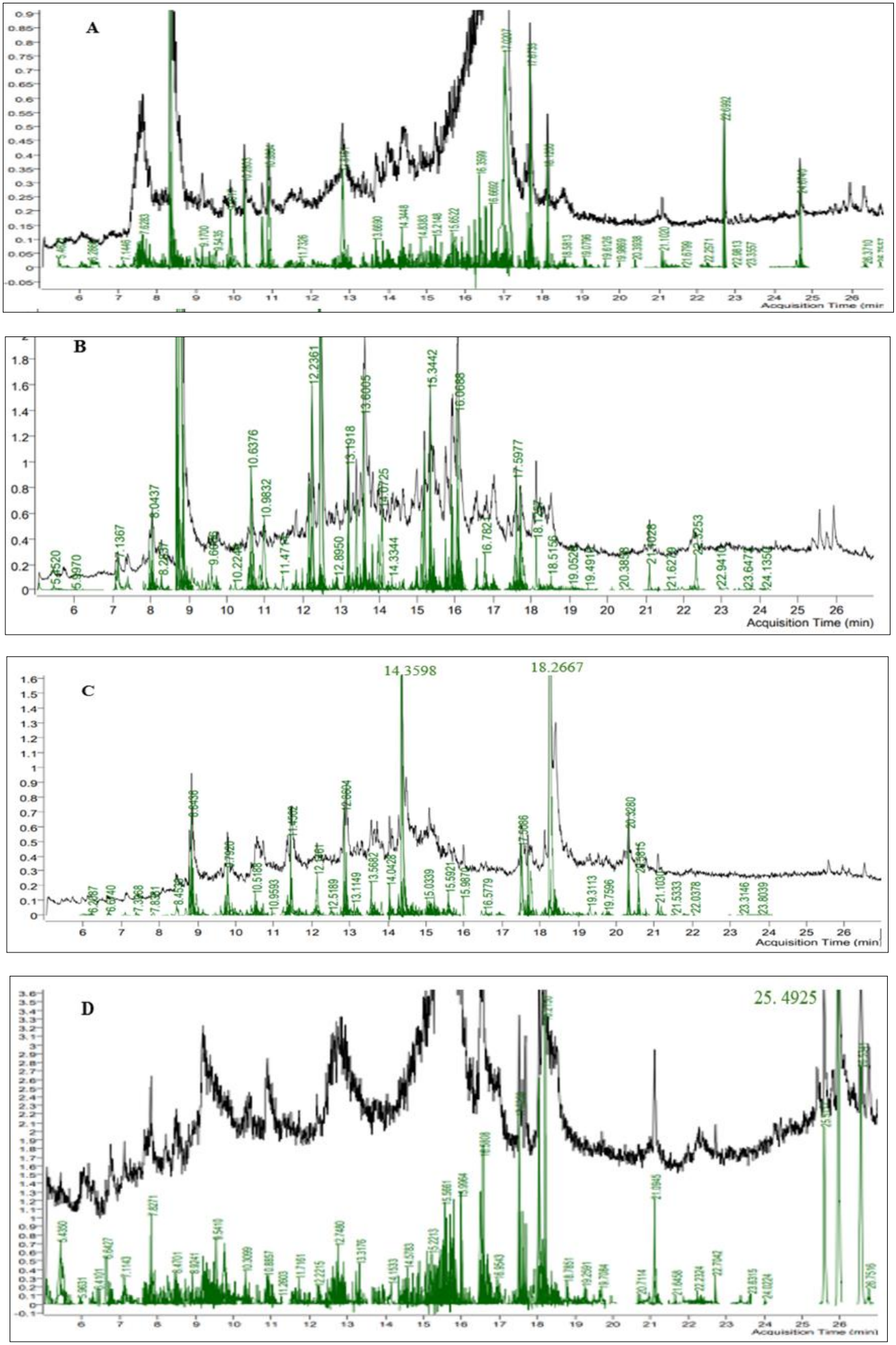

Fig 5: GCMS spectra of pure ethanolic extracts of: (A) *Senna italica*, (B) *Cymbopogon schoenanthus*, (C) *Artemisia judaica*, (D) *Clitoria ternatea*

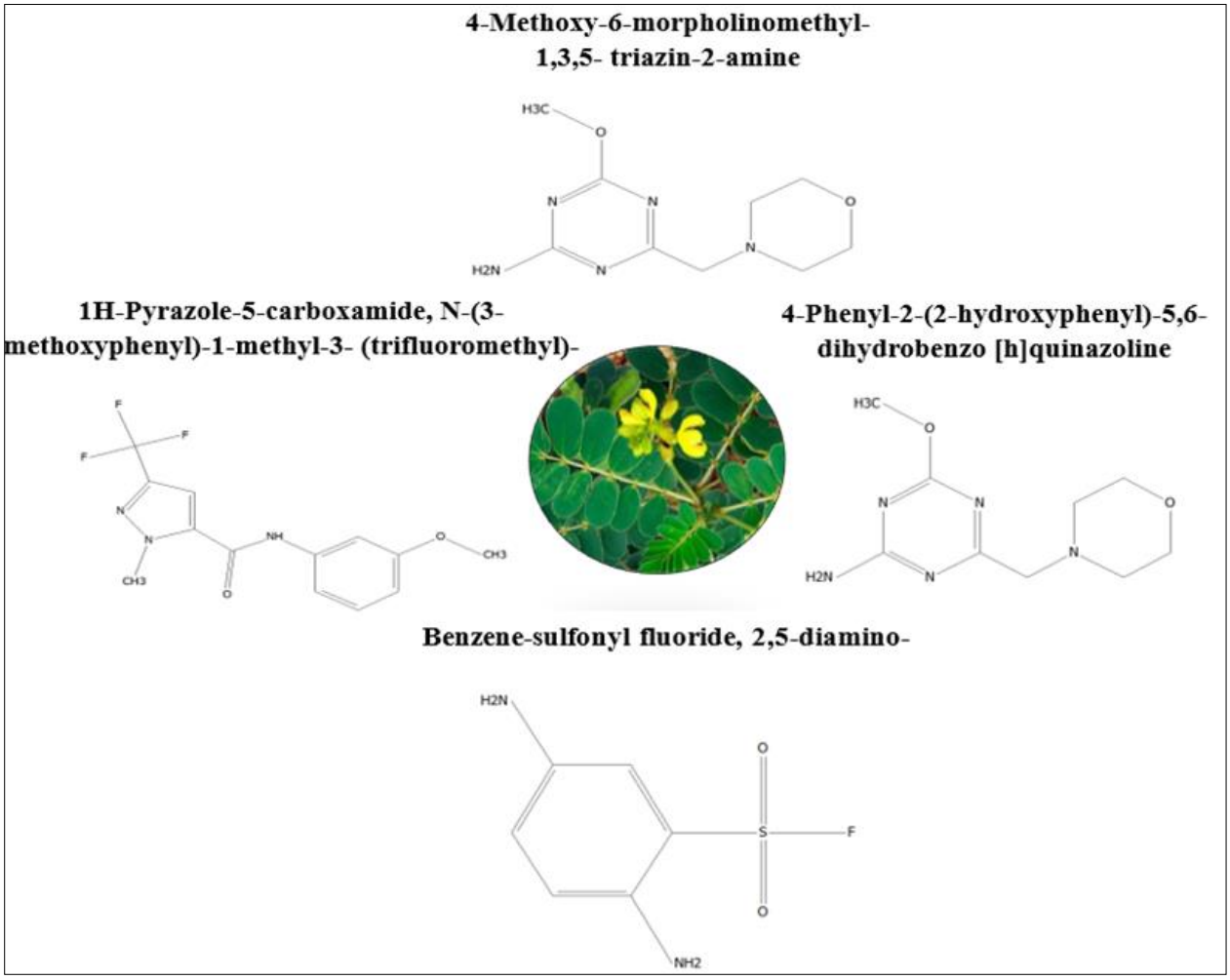

Fig 6: Chemical structures of selected compounds extracted from *Senna italica* leaves

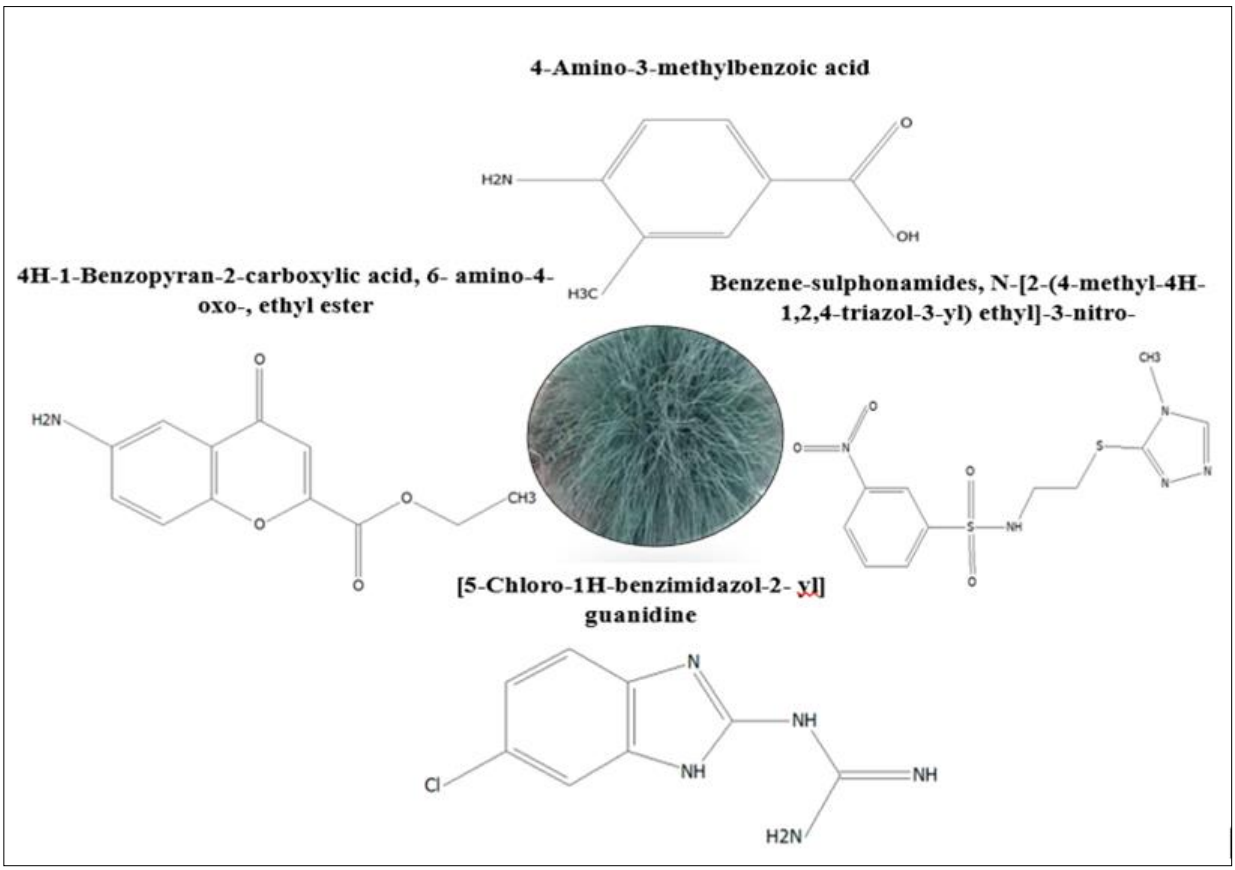

Fig 7: Chemical structures of selected compounds extracted from *Cymbopogon schoenanthus* leaves

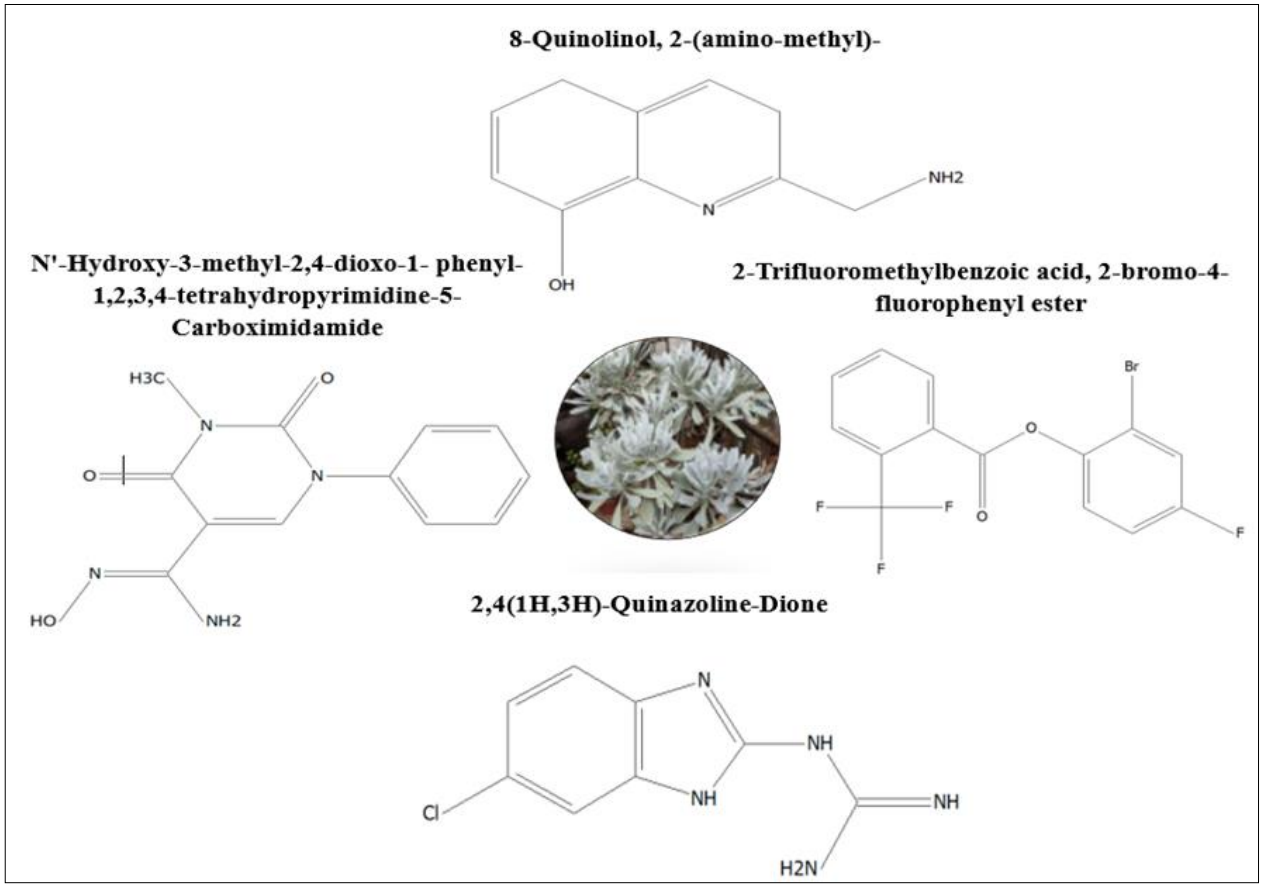

Fig 8: Chemical structures of selected compounds extracted from *Artemisia judaica* leaves

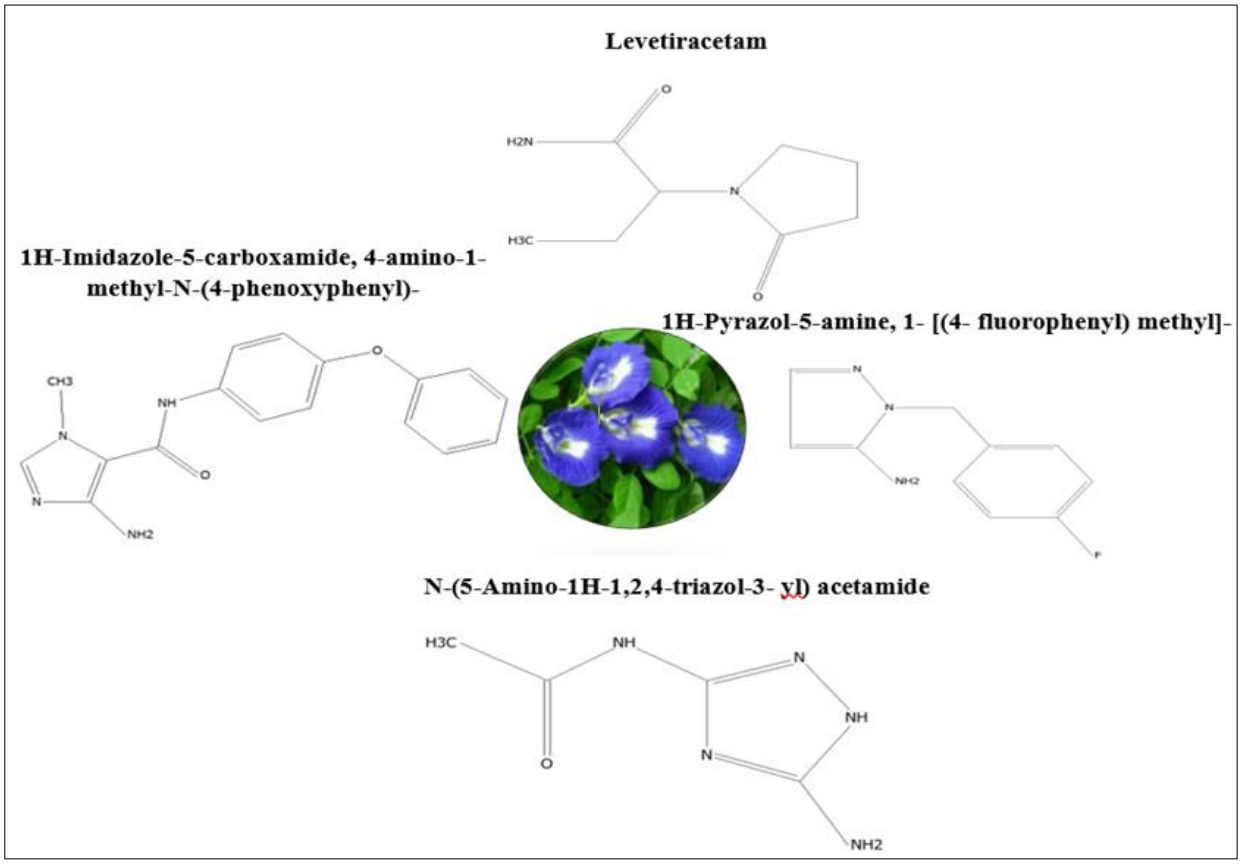

Fig 9: Chemical structures of selected compounds extracted from *Clitoria ternatea* flowers

4. Discussion

Bioprospecting analysis using spectroscopic techniques has become a widely essential approach to identify, measure, and describe bioactive components in the plant kingdom. Recently, different combined methods have been used increasingly to provide the most accurate information about active ingredients of interest in the extracted plants [45]. Tri-spectroscopical analysis using UV-visible, FTIR, and GCMS

simultaneously was helpful to isolate and characterize bioactive compounds from pure ethanolic extracts of each *Senna italica*, *Cymbopogon schoenanthus*, *Artemisia judaica*, and *Clitoria ternatea* that may have potential anticancer and antimicrobial activities different from that reported in the literature.

However, it was clear that the number of phenolic and/or alcohol (O-H) groups were the most in *Artemisia judaica* followed by *Senna italica*, *Clitoria ternatea*, *Cymbopogon schoenanthus* samples respectively. In contrast, the highest number of aromatic rings (C=C), amine (N-H) ester (C=O) and glycoside (C-O)/saccharide (C-H) functional groups, as well as methyl/methylene (aliphatic) C-H bonds, can be found in the molecular structure of *Cymbopogon schoenanthus L.* followed by *Artemisia Judaica* and *Clitoria ternatea*, respectively. The lowest number of methyl/methylene, saccharide, glycoside, and aromatic functional groups observed in the *Senna Italica*. These functional groups may function as receptor and enzyme inhibitors as well as positively regulating metabolic processes [46].

The bioactive molecules, phenolic compounds, considered the most plentiful secondary metabolites detected in plant tissue which result from the metabolism of phenylpropanoid in pentose phosphate and shikimic acid in plants. They vary in complexity from basic phenolic molecules to highly polymerized compounds and recognized by benzene rings with one or more hydroxyl groups [47,48]. Previous researchers have ascertained the importance of biological role of these compounds, as they exhibit antimicrobial, antioxidant and anti-inflammatory activities [49, 50].

Additionally, Phenolics show significant promising results as cytotoxic anti-cancer drugs that inhibit proliferation, angiogenesis, progression of cancer cells [51,52], through targeting oncogenic signaling pathways that control cell growth, differentiation and invasion which finally terminated by inducing cell cycle arrest and apoptosis [53,54].

These compounds are either linked to other groups or found as derivatives, such as ester or methyl esters. Phenolic acids, flavonoids, and tannins are one of primary dietary phenolic compounds from other phenolic components [55,56]. Earlier experimental research found that porous materials can be modified to help phenolic chemicals adsorb by adding an amine (-NH) or amino ($-NH_2$) functional group. The adsorption processes influenced by the type and distribution of ($-NH_2$) groups on these materials [57-59].

Sarawong *et al.* [60] found that content of phenolic compounds correlated positively with antioxidant activity. This may be resulted from the capacity of scavenging free radicals, donating hydrogen atoms, electrons, or chelate metal cations, depending on the number and positions of the hydroxyl groups (-OH), and the nature of substitutions on the aromatic rings (C=C) [61].

Also, the hydrogen atoms of the adjacent (-OH) groups were found in various positions of the rings, the double bonds of the benzene ring, and the double bond of the (-C=O) groups of some flavonoids. All these molecular structures provide elevated levels of antioxidant activity in these compounds [61].

However, the current studied medicinal plants showed interesting biomolecular constituents. Quinoline and quinazolinones, are one of aromatic compounds found to have broad spectrum actions against bacterial, viral, fungal, malaria, and parasitic infection, as well as consumed as cardiotonic, anti-convulsant, and analgesic agents [62, 63]. Also, it has proved potent antiproliferative and anticancer compound in several cancer cell lines such as breast, colon, lung, colorectal, and renal cancers through disruption of cancer cells migration, inhibition of angiogenesis, inducing cell cycle arrest and apoptosis [64].

Pyrazoline is heterocyclic compound have been found to exhibit considerable effects such as antibacterial, antifungal, antiamoebic, analgesic, antidepressant, and anticancer activities [65].

Compared to the other heterocyclic organic compounds, imidazole has unique characteristics that easily binding with a different enzymes, proteins, and receptors. Imidazole-based compounds have shown a wide variety of biological mechanisms including anti-microbial and anti-cancer potential activities [66]. Azabicyclo-hexan is a crucial component of natural compounds that have biological effects against bacteria, fungus, protozoan, and cancerous invasion via DNA alkylation [67,68]. Another unique organic consistent is cyclobuane ring that plays a vital role in antimicrobial, anticancer, antidiabetic, and CNS related diseases [69]. However, levetiracetam active compound demonstrated in *Clitoria ternatea* flowers extract. It is frequently used as an anticonvulsant agent, also shown neuroprotective, and antioxidant properties [70, 71].

5. Conclusion

Tri-spectroscopical analysis of pure ethanolic extract of the studied medicinal plants showing interesting differences in molecular components, particularly in *Artemisia Judaica* and *Cymbopogon schoenanthus* extracts. The of phenyl-amino-benzoic-acid compounds may have a considerable influence on solubility, hydrophobicity, and the binding of compounds to certain target proteins in the cancer and microbic cells.

6. Conflicts of interest

Future experiments are needed to confirm the obtained results

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