International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 22-01-2022, Accepted: 07-02-2022, Published: 22-02-2022
Volume 7, Issue 2, 2022, Page No. 491-500

Important ethnomedicinal plants (of Rajasthan) with their active phytoconstituents; potent against various ailments

Saloni Soni, Aparna Pareek*
Department of Botany, University of Rajasthan, Jaipur, India

Abstract
Plants consist of numerous constituents known as phytoconstituents or bioactive components. Due to the therapeutic potential, these components are widely utilized in drug formulations. However the concept of medicinal plants as disease fighters is immemorial. In the traditional system of medicine, crude extract, paste and decoction formulations of plants were utilized to cure different ailments. But now with the availability of advanced technologies, it has become easier to use plants as medicines. Different phytochemical tests and techniques of HPLC and GCMS provide the accurate information regarding particular bioactive constituent present within the plant. This article looks at the important bioactive compounds present in different ethnomedicinal plants of Rajasthan used against various diseases like; diabetes, cancer, microbial infections, heart diseases etc.

Keywords: ethnomedicinal plants, traditional healers, phytoconstituents, ailments

Introduction

Therapeutic plants from ancient times

The awareness about natural drugs has developed from time immemorial. Plants are natural disease fighters with an accustomed history of utilization of medicinal drugs in traditional food system since decades. The ancient literatures are comprehensive source of the natural medicinal knowledge of plants. In historical text of *Ramayana*, it is stated in *Lanka-kaand* that when Lakshman fainted from Meghnad's arrow then imperial physician or vaidya Susena asked Hanuman to bring *Mrita sanjeevani*; to revive life, *Vishalyakarani* ; to remove arrows, *Sandhanakarani*; to restore damaged skin, *Suvarnyakarani*; to restore skin colour from DRONGIRI MOUNTAIN. (Yadav *et al*, 2017) [48] Many people, especially in villages still prefer plant based remedies to treat several diseases such as cold, fever, diarrhea, skin problems etc. Currently plant based drugs made a great contribution on human health during COVID19 pandemic, immunomodulatory plants such as *Tinospora cordifolia, Ocimum tenuiflorum, Piper nigrum, Allium sativum, Zingiber officinalis* were confidently used by people as effective crude drugs. Number of researches were conducted on them and many are still ongoing. The ministry of Ayush India also proposed various medicinal herbs in their guidelines for the prevention of COVID19. (Tillu *et al*., 2020) [45] Although drug discovery from plants and herbs has been going on since antiquity still there are thousands of plants on which research is yet to be done.

A note on phytoconstituents

For any medicinal property there are always some factors present within the plant system that are responsible for particular therapeutic activity, these components are non-nutritive, plant based bioactive factors known as phytochemical constituents and have diseases preventive properties. Phytochemicals are important constituents of plants used to treat variety of diseases and act as antioxidants, antiallergic, antimicrobial, antispasmodic, chemopreventive, hepatoprotective, hypolipidemic, immuno-modulator and neuroprotective agents. They fight and protect against various diseases such as diabetes, osteoporosis, cancer, and heart diseases; induce apoptosis; act as diuretic, CNS stimulant, analgesic; and protect from UVB-induced carcinogenesis, and many more (Thakur *et al*., 2020) [43]

Brief Discription on Important Bioactive Components

1. **Alkaloids:** These are nitrogen containing compounds and found in almost 25% of plants. On the basis of their chemistry, these are defined as crystalline, colorless components with bitter taste. Plant families such as; papaveraceae, ranuculaceae, solanaceae, amaryllidaceae are found with high amount of alkaloids. Some examples are; morphine from *Papaver somniferum*, nicotine from *Nicoticana tabacum* and thalfoliolosumine from *Thalictrum foliolosum.* (Swamy, 2020) [41]

2. **Flavonoids:** These bioactive compounds are responsible for coloration and aroma of flowers along with health benefits to human as well as animals. These are low molecular weight secondary metabolites with

two benzene rings. Flavonoids mainly found in families like, rutaceae, caryophyllaceae, fabaceae, asteraceae, malvaceae, amaranthaceae, acanthaceae and others. For example; quercetin mostly found in berries, possesses antioxidant properties. Apigenin is a prominent flavone generally found in caryphyllaceae family which have potent cancer chemoprotective activity (antiproliferative effects on human breast cancer cells, inhibition of cell growth by apoptosis in cervical carcinoma.(Jakimiuk *et al*., 2021) [16] plant based medicine rich in orientin have potent cure against respiratory disorders, skin disorders, common cold and mild anxiety. (Jakimiuk *et al*., 2021) [16] Orientin is commonly found in families of euphorbaiceae and lamiaceae with their prominent properties of antioxidant, anti-inflammatory, antimicrobial, vasodilation, cardioprotective and others.

3. **Saponins:** These are occur as polycyclic triterpenes and steroid with glycosides. Mainly present in families of agavaceae, alliaceae, asparagaceae, liliaceae and amarylidaceae. Centella asiatica is a medicinal herb with high amounts of triterpenoid saponins. Asiaticosides are major triterpene saponins with wound healing properties. Centelloside is sugar free saponin that present in fresh plants which can be used to treat venous hypertension.

4. **Terpenoids:** These components are present in derivatives of oxygen containing form including alcohols, aldehydes, carboxylic acids, ketones, esters and glycosides. Terpenoids that are present in volatile oil forms occur in families of ranuculaceae, oleaceae, magnoliaceae, lauraceae, aristolochiaceae, rutaceae, pinaceae, calastraceae, acanthaceae and taxaceae. (Yang *et al*., 2020) [49] It was found that terpenoids such as; perillyl alcohol, geraniol and paclitaxel possesses antitumor activities. Paeoniflorin is a monoterpene glycoside compound isolated from roots of paeonia lactiflora has anti-inflammatory activity.

5. **Tannins:** These are considered polyphenols and divided into two groups hydrolysable tannins and condensed tannins. (Fraga-Corral *et al*., 2020) [13] Hydrolysable tannins are containing a carbohydrate. The hydroxyl group of carbohydrate are esterified with phenolic groups such as gallic acid and ellagic acid. (Ash ok & Upadhyaya, 2012) [6] Condensed tannins are proanthocyanidins (a polymer with 2-50 flavonoids unit. (Ashok & Upadhyaya, 2012) [6] Chemically, tannins are classified into gallotannins, ellagitannins, complex tannins, condensed tannins and phlorotannins. (Fraga-Corral *et al*., 2020) [13] Tannins are mainly present in polygonaceae and fagaceae families. (Torawane *et al*., 2020) [46]

6. **Phenolic acid:** Phenolic acids are sub grouped into hydroxybenzoic acid and hydroxyl cinnamic acid. Hydroxybenzoic acid is derived from benzoic acid, that is found in soluble form in conjugated sugars and organic acids. Four commonly found hydroxyl benzoic acids are P- hydroxybenzoic, protocatechuic, vanillic acid and syringic acid. (Naresh Kumar & Goel, 2019) [20] Hydroxy cinnamic acid derived from cinnamic acid, present as simple esters, quinic acid or glucose. The most abundant soluble bound hydroxyl cinnamic acid present in chlorogenic acid. Common hydroxycinnamic acids are ferulic, caffeic, P- coumaric and sinapic acids.(Naresh Kumar & Goel, 2019) [20] Caffeic acid mostly present in lamiaceae and boraginaceae families.(Gonçalves *et al*., 2020) [14] Ferulic acid commonly present in commelinid plants and exhibit antioxidant, antidiabetic, antiaging, anticancer properties. (Naresh Kumar & Pruthi, 2014) [21]

Pharmacognosy and Ethnomedicinal Plants

Traditional healers are the source of ethnomedicinal knowledge of plants and herbs. Tribal communities play a key role in using ethnomedicinal practice of plants. From times, they have been using crude extract of plants for several ailments and they are well versed with each part of the plants that can be put to use for a particular disease treatment. In recent times, ethnomedicinal practice has caught the interest of researchers for natural products and they are making efforts to enhance research on drug discovery from natural plant materials and it also provides better opportunities to ethnomedicinal research area. It has been analyzed that the acceptable medicinal doses are available only for one third of the known human diseases, so phytochemical research work has effective solution to certain ailments. The Drug discovery from plant based materials is connected to the chemistry of bioactive compounds of plants such as, lipids, phytochemicals, pharmaceutics, pigments and others and separation of these medicinally active component include different extraction techniques under the pharmaceuticals.

Vegetation in Rajasthan

Rajasthan is the largest state of India with 342239 area $(km)^2$ It extends between $25^0$38' and $26^0$58'N latitude and $73^0$54'and 75^0 22'E longitude.(Sharma & Pandey, 2010) Vegetation in Rajasthan divides the state into four parts; North-Western, Aravalli Ranges, Eastern Plains and Southeastern Pathar.

1. **North-Western:** This region known as thar-desert and covers major area of state, about 2,00,000 km^2 Western sandy region have two types of zone; arid and semi-arid. Vegetation of north western is based on the stabilized and unstabilized area of sand dunes. The common shrubs present at sand dunes are; *Calligonum polygonoides, Clerodendrum phlomidis, Haloxylon salicornicum, Lycium barbarum* etc. Common trees are, *Acacia senegal, Prosopis cineraria, Salvadora oleoides* etc. Common families found in sandy western area are; fabaceae, poaceae, asteraceae, amaranthaceae, euphorbiaceae, lamiaceae,

malvaceae, cucurbitaceae, ascilepiadaceae, menispermaceae, solanaceae, apocynaceae, boraginaceae and salvedoraceae. (Charan, 2018)

2. **Aravalli Range:** Aravalli range runs across the state Haryana, Rajasthan and Gujrat. In Rajasthan this range run across the north east Khetri extends to south west Gurushikhar. On Khetri hills; the vegetation is scrubby and in degraded stage. The top of the hills are barren while on slops, some moisture accumulate and thick growth of plants are present like; *Acacia Senegal, Balanites aegyptiaca, Capparis deciduas, Euphorbia nivulia, Grewia tenax, Justicia adhatoda* etc. Important medicinal plants reported from aravalli range belongs to families of fabaceae, malvaeae, liliaceae, apiaceae, araceae, aristolochiaceae, bombacaceae, euphorbiaceae, cucurbitaceae, sterculiaceae, nymphaeaceae etc. (Katewa *et al*., 2003) [19]

3. **Eastern Plains:** This plain covers the part of Alwar, Bharatpur, Sawai madhopur, Bundi and area of Kota districts. The area of north east, east and some part of south east of aravalli range is known as eastern plains. The area is mainly consists of two plains; Basin plain and Chappan plain. Basin plain is dominating by deciduous vegetation with occurrence of *Acacia Senegal, Bauhinia racemosa, Boswellia serrata, Capparis sepiaria, Cassia fistula, Dichrostachys cinerea, Diospyros melanoxylon, Lannea coromandelica, Wrightia tinctoria* etc. The chappan plain dominating with *Tectona grandis.*

4. **Southeastern Pathar:** It consist of Hadauti plateau. River Chambal is major part of this region. The plateau is divided into two regions namely; Vindhyan scarpland and Deccan lava plateau. Dominating families present in hadauti region are; poaceae, fabaceae, asteraceae, acanthaceae, cyperaceae etc. (Choudhary & Nama, 2014) [12] Most of the species recorded are; *Acacia nilotica, Atrocarpus heterophyllus, Aegle marmelos, Azadirachta indica, Bombax ceiba, Cassia fistula, Citrus aurantifolia, Delonix regia, Delbergia sissoo, Phyllanthus emblica, Ficus religiosa* etc.(Choudhary & Nama, 2014) [12]

Table 1: Important ethnomedicinal plants of Rajasthan with their active phytoconstituents used against ailments

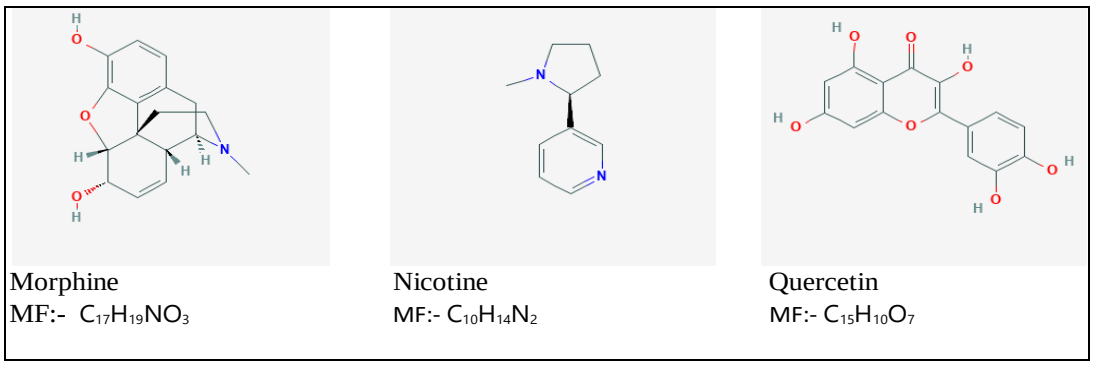
Sr. no.	Family and name of plants	Part used	Bioactive components	Ailments	description	Reference
1.	Acanthaceae *a. Andrographis paniculata* (Kalmegh)	Aerial parts	Phenols, aromatic carboxylic acid and esters	Antimicrobial activity	Chloroform extract showed significant potential to inhibit the growth of *Enterococcus faecalis, Enterococcus cloacae, pseudomonas aeruginosa and Eschertia coli.*	(Roy *et al*., 2010)
	b. *Justicia procumbens* (Kagner)	Whole plant	Justicidin B, tuberculation, procumbenoside H	Cytotoxic activity	Against human lung epithelial cells A549. The cell viability was determined by MTT assay in which ethyl acetate extract showed significant result with IC_{50} value of 66.93µg/ml	(Liu *et al*., 2018)
2.	Amaranthaceae *a. Achyranthes aspera* (Andhijaro)	Leaves	Saponin	Larvicidal activity	Ethyl acetate extract exhibited mosquito larvicidal activity against *Aedes aegypti and Culex quinquefasciatus* with IC_{50} value of 18.20 &27.84µg/ml	(Bagavan *et al*., 2008)
	b. Amaranthus virdis (Jungli-chouli)	Leaves	Chlorogenic acid, gluconic acid and kaempferol	Antioxidant activity	Methanolic extract showed DPPH radial scavenging activity (IC_{50} - 47.23±0.66µg/ml), NO radial activity(IC_{50}-33.21±3.3µg/ml), ABTS radical activity (IC_{50} – 47.61±1.31µ/ml) and metal chelating activity (IC_{50} – 32.1±1.11µg/ml)	(Nithin Kumar *et al*., 2018)
3.	Apocynaceae *a. Calotropis procera* (Aak, Madar)	Leaves	A-amyrin	Antiarthritic activity	Arthritis was induced in wistar rats by injecting 0.1ml of freund's complete adjuvant (FCA), methanolic extract of leaves showed the greater efficiency equal to standard Ibuprofen.	(Singh *et al*., 2021)
	b. Carissa carandas (Karunda)	Dried fruits	Dichloroacetic acid, 2-ethyl hexyl ester, 1-pentatria contanol, myo-inositol, 4-c-methyl and	Anti-inflammatory activity	The maximum inhibition of paw edema was found to be 76.12%	(Anupama *et al*., 2014)

			others			
4.	Aslepiadaceae *a. Leptadenia pyrotechnica* (Kheenp)	Aerial parts	Pyridine, pyrrole, pyrazine and indole	Antitumor activity	Alkaloids and alcoholic extracts showed the acute LC_{50} value of 63.09 & 11.89 ppm by brine shrimp toxicity test.	(Yousseff Moustafa *et al*., 2009)
5.	Asparagaceae *a. Asparagus racemosus* (Satawari)	Roots	Phenol,2,6-bis (1,1-dimethyle ethyl)-4-[(4-hydroxy-3,5-dimethyl phenyl)methyl], piperazine-2,5-dione, 1,4-(4-methyl phenyl)	Antioxidant activity	Observed maximum antioxidant activity were, DPPH˙ radical (49.32±0.41%), Superoxide radical (56.83±0.28%), Hydroxyl radical (77.98±0.15%) at 120 µg/ml concentration and the IC50 values were 121.65 µg/ml, 106.83 µg/ml and 75.82 µg/ml	(Saraswathi *et al*., 2020)
6.	Bignoniaceae *a. Tecomella undulate* (Rohida)	All parts	Quericitin, kaempferol, stigmasterol, sitosterol, thiazoline, phytol, pthalic acid, methyl alpha ketopalmitate	Antimicrobial activity	Leaves showed highest antimicrobial activity against *Candida albicans, Staphylococcus aureus, Escherichia coli* and *Bacillus subtilis.*	(Bhardwaj, 2018)
7.	Capparaceae *a. Cadaba fruticosa* (Dabi)	Leaves	Hydroxy urea and derivetives of imidacoles	Antimicrobial and anti-inflammatory activity	Antimicrobial activity against *Bacillus subtilis, Pseudomonas aeruginosa* and *Escherichia coli*. Anti-inflammatory activity showed 84% efficacy from ethanol extract by human red blood cells membrane stabilization method.	(Saha *et al*., 2015)
8.	Cucurbitaceae *a. Citrullus colocynthis* (Thumba)	Fruit pulp	Colocynthin	Wound healing and antioxidant properties	Methanolic extract provide wound contraction in rat. Methanolic extract showed free radical scavenging activity by DPPH assay with IC_{50} value of 196.44± 17.78 µg/ml	(Gupta *et al*., 2018)
9.	Euphorbiaceae *a. Acalypha indica* (Khokali)	Leaves	Cholestan-3-ol, 2-methylene-(3 β, 5α), squalene, stigmasterol, β-sitosterol, β-amyrin, α-amyrin	Antibacterial	Ethanolic fraction showed significant result against MDR resistant bacteria; *Acinetobacter baumannii, Klebsiella pneumoniae* and *Pseudomonas aeruginosa*	(Suresh *et al*., 2020)
	b. Baliospermum montanum (Danti)	Roots	Propiophenones	Antiallergic, anti-inflammatory and cytotoxic activities	Antiallergic & inflammatory activity showed IC_{50} value less than 6µg/ml. Ethanolic extract showed the highest cytotoxic activity against cancer cell line; HEPG2 & KKU.M156 by SRB assay.	(Pipatratanasere *et al*., 2019)
	c. Euphorbia hirta (Dudhali)	Leaves	Phytol and its derivatives; 3,7,11,15-tetramethyl-2-hexadecen-1-ol	Antituberculosis activity	Methanolic extract showed 88% inhibition of *Mycobacterium tuberculo*sis by LRP assay at concentration of 100µg/ml.	(Nirmal *et al*., 2020)
	d. Ricinus communis (Arandi)	Seeds	Stigmasterol, β-sitosterol, methyl linoleate, vitaminE and ricinoleic acid	Larvicidal activity	Methanolic extract showed best result against *Aedes aegypti and Anopheles culicifacies* with LC_{50} value(15.52 &45.24 ppm and LC_{90} (9.7 & 31.1 ppm	(Sogan *et al*., 2018)
10.	Fabaceae *a. Abrus precatorius* (Chirmi)	Leaves	3,7,11,15-tetramethyl-2-hexadecen-1-ol, n-hexadecanoic, phytol and others	Antimigraine	The binding of isolated phytochemicals against protein CGRP (calcitonin gene related peptide) using discovery studio software showed good inhibitors for migraine headache.	(V. & Ajay, 2019)
	b. Cyamopsis tetragonoloba	Seeds	3-hydroxymyristic acid, octadecanoic acid and	Anticancer,	Anticancer activity analyzed by SRB assay against human prostate	(Badr *et al*.,

	(Guar)		linolelacidic acid methyl ester	antimycoplasmal activity	carcinoma cell line (PC-3), colon carcinoma cell line (HCT_{1116})& intestinal carcinoma cell line (CACO-2) with IC_{50} value of 40.5, 41.5 and 101.0µg/ml respectively. Antimycoplasmal activity observed against *Mycoplasma bovis* with inhibition zone, 30-35mm (of 200mg/ml concentration).	2014)
	c. Pongamia pinnata (Kaling)	Bark	Protocatechuic, ellagic, ferulic, gallic, gentisic, 4-hydroxybenzoic and 4-hydroxycinnamic acid	Antioxidant activity	Maximum yield observed was 16.31% by DPPH radical scavenging activity with IC_{50} value of. 2µg/ml	(Sajid *et al*., 2012)
	d. Prosopis cineraria (Khejari)	Pod	Cloprostenal, cinecromen and dirithromycin	Against hypercholesterolemia and atherosclerosis	*In vivo* assay of test extract showed HMG-CoA inhibition activity by 78.1 % in rabbit. The reduction in the atherosclerotic plaque and improvement in lumen volume were observed in the treated groups.	(Ram, n.d.)
11.	Lamiaceae *a. Ocimum canum* (Bapchi)	Leaves	Camphor, limonene, α-pinene, naphthalene, valencene, caryophyllene, camphor and myrtenyl acetate	Cytotoxic activity	Against breast cancer cell lines (MCF-7) using MTT assay. Significant activity observed with IC_{50} value of 60 µg/ml	(Tamil Selvi *et al*., 2015)
12.	Malvaceae *a. Abutilon indicum* (Tarakanchi)	Fruit	β-sitosterol	Larvicidal activity	Petroleum ether extract of fruits showed effective larvicidal activity against *Aedes aegypti*, *Anopheles stephensi and Culex quinquefasciatus* with 11.49, 3.58 & 26,67 ppm	(Abdul Rahuman *et al*., 2008)
	b. Sida cordifolia (Kharintha)	Leaves	Methyl 2-hydroxybenzoate, 4-methylbenzaldehyde, (5R-5-methylimidazolidine-2,4-dione and others	Anticancer activity	In-silico assessment of anticancer activity of the compound were studies against BCL2 and VEGFR2	(Muthuraman *et al*., 2017)
13.	Menispermaceae *a. Cissampelos pareira (Akauadi)*	Leaves	Mome-inositol, 1,3,5-traizine-2,4,6-triamine, D-allose, 2,3-dihydro-3,5 dihydroxy-6 methyl-4H-pyran—one, 2,5-bis-aryl-3,4-dimethyl tetrahydrodrofuran, neophytadiene	Antidiabetic activity	24 days oral administration of extract to rats. The extract at doses 200 & 400 mg/kg body weight able to reduce blood sugar level.	(Asif *et al*., 2021)
	b. Tinospora cordifolia (Giloy)	Leaves	Hydroquinone, 2-hexeol, palmitic acid, 2-hexen-1-ol and phytol	Antioxidant activity	Observed radical scavenging activity by DPPH assay with IC_{50} value of 25±0.3 µg/ml.	(Naik *et al*., 2014)
14.	Mimosaceae *a. Acacia nilotica (Babool)*	Bark	13-docosenoic acid, lupeol, 9,12-octa-decadieonic acid, 6-octadecanoic acid	Antileishmanial activity	Methanolic extract showed antipromastigole and antiamastigole potential in dose dependent manner with IC50 value of 19.6± 0.9037 and 77.52± 5.167 µg/ml and its mechanism of potential drug targets of leishmania donovani	(R. Ali *et al*., 2021)
15.	Moringaceae *a. Moringa oleifera*	Leaves	6-octadecenoic acid, cis-vaccenic acid, 2-octyl-	Immunomodulatory activity	Moderate immunomodulatory potential based on humoral immune response against	(Jayanthi *et al*., 2015)

	(Sahjan)		cyclopropaneoctanol		*Salmonella typhimurium* was revealed where increase in T-lymphocytes count and induction of splenocytes proliferation.	
16.	Nyctaginaceae *a. Boerhavia diffusa* (Santhi)	Whole plant	Kaempferol, luteolin, quercetin	Antimicrobial activity	Highest activity of root against *Fusarium oxysporum*(15.33 + 1.52), *Escherichia coli*(17.33±0.58) Stems showed activity against *Candida albicans*(20.33+2.08), *Escherichia coli*(40.56±2.08), Leaves showed activity against *Candida albicans* (14.83+2.31) & *Staphylococcus aureus* (22.00±3.6)	(Bhardwaj & Sharma, 2019)
17.	Polygonaceae *a. Calligonum polygonoides* (Phog)	Leaves and barks	Taxifolin and catechin	Antioxidant activity	Radical scavenging activity by DPPH method in bark- 450.30µg/g & in leaves- 398.10µg/g	(Ahmed *et al*., 2020)
18.	Portulacaceae *a. Portulaca grandiflora* (Noniya/Lunki)	Whole plant	Oleic acid, valeric acid, methylesters of fatty acids, n-hexadecananoic acid, vanillin lactoside and gamma-sitosterol	Antioxidant activity	Methanolic extract showed significant antioxidant activity by DPPH assay.	(AO, 2019)
19.	Rutaceae *a. Aegle marmelos* (bael)	Leaves	Benzoic acid, 4-[1-oxo-2-(1-pyrrolidinyl) ethyl], amino methyl ester, dipiperdine, trimethylsilyl ester	Anticancer and antimicrobial activity	Methanol and acetone extract showed anticancer activity on tumor cells(HEP-2 and MOAMB-231) with IC_{50} value of 47.08 &79.62 µg/ml Acetone extract showed antimicrobial activity against *Serratia marcescens*	(Seemaisamy *et al*., 2019)
20.	Solanaceae *a. Solanum xanthocarpum* (Fasalkatari/Kanteli)	Leaves	2,octylcyclopropene-1-heptanol, hexadecanoic acid, 1methylene-2b hydroxymethyl-3,3-dimethyl-4b(-3methyl but-2-enyl)-c, phytol	Antibacterial and antioxidant activity	Methanolic extract showed inhibition against *Pseudomonas aeruginosa* (12±0.5mm), *Salmonella typhi*(10±0.6mm) *Staphylococcus aureus* (9±1.0mm), *Escherichia coli*(7±1.3mm) Antioxidant property observed in chloroform and methanol extract on DPPH radical scavenging activity with the lowest IC_{50} Value of 197.24 and 201.04 µg/ml)	(Nithya *et al*., 2018)
	b. Withania somnifera (Ashwagandha)	Whole plant	Oleic acid, phytol and n-hexadecanoic acid	Antibacterial activity	Against *Escherichia coli* and *Klebsiella pneumoniae* with inhibition zone of 20.5±2.40 and 8.84±0.16mm	(Mishra & Patnaik, 2020)
21.	Zygophyllaceae *a. Balanites aegyptiaca* (Hingot)	Seeds	2,6-di-tert-butyl-phenol ; 2,4-di-tert-butyl-phenol	Antiplasmodial activity	The observed IC_{50} value for the Plasmodium falciparum was 68.26µg/ml ±3.5	(Kaiser *et al*., 2011)
	b. Peganum harmala (Harmal)	Seeds	Harmaline,harmine and tetrahydroharmine	Antidepressant activity	Therapeutic benefit in the treatment of the depression with a higher efficiency at the dose of 300mg/kg & 100mg/kg were able to reduce the immobility time, adrenocorticotropic hormone rate and the defecation rate.	(Sassoui *et al*., 2015)
	c. Tribulus terrestris (Gokharu)	Thorns	2,2,4-trimethyl-3 pentanol, n-hexadecanoic acid and Z-1,6-tridecadiene	Antibacterial activity	Observed against *Escherichia coli.*	(Thorns *et al*., 2018)

Chemical Structure of Mentioned Bioactive Components



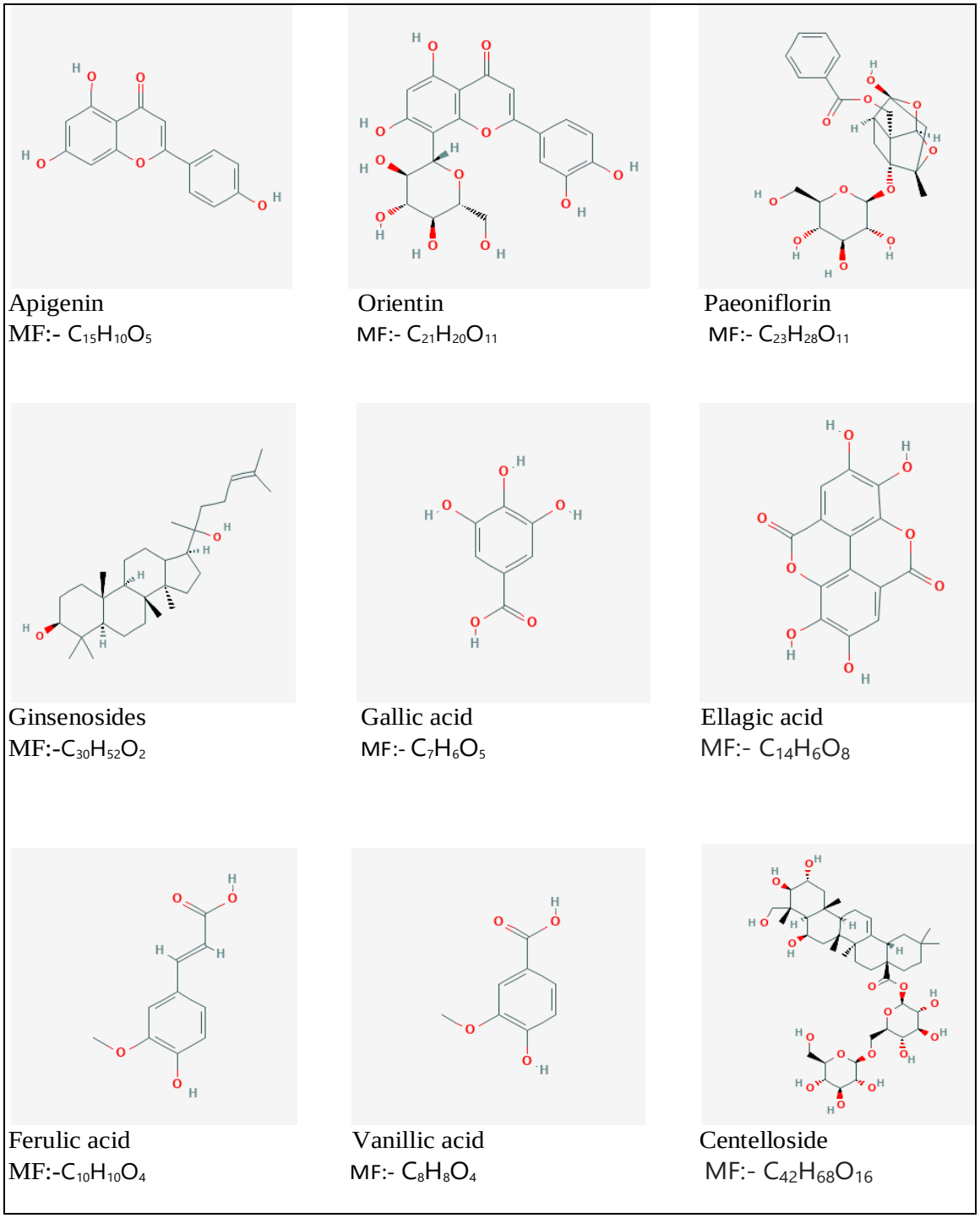


Fig 1*:* MF: Molecular formula. All chemical structures are collected from PubChem (NCBI)

References

1. Abdul Rahuman A, Gopalakrishnan G, Venkatesan P, Geetha K. Isolation and identification of mosquito larvicidal compound from Abutilon indicum (Linn.) Sweet. *Parasitology Research*,2008:102(5):981-988.
2. Ahmed H, Moawad A, Owis A, Abouzid S. Antioxidant capacity and HPLC determination of phenolic in different organs of Calligonum polygonoides subspecies comosum. *Journal of Reports in Pharmaceutical Sciences*,2020:9(2):251-255.
3. Ali R, Tabrez S, Rahman F, Alouffi AS, Alshehri BM, Alshammari FA *et al*. Antileishmanial evaluation of bark methanolic extract of acacia nilotica: In vitro and in silico studies. *ACS Omega*,2021:6:858-8560.
4. Anupama N, Madhumitha G, Rajesh KS. Role of dried fruits of carissa carandas as anti-inflammatory agents and the analysis of phytochemical constituents by GC-MS. *BioMed Research International*, 2014.
5. AO K. Investigation of Antioxidant Activity (in Vitro) and Gas Chromatography-Mass Spectrometry Profiling of Portulaca Oleracea L. and Portulaca Grandiflora Hook. Extracts. *Asian Journal of Pharmaceutical and Clinical Research*,2019:12(3):348-352.
6. Ashok PK, Upadhyaya K. Tannins are Astringent. *Journal of Pharmacognosy and Phytochemistry*,2012:1(3):45-50.
7. Asif M, Gilani SJ, Taleuzzaman M, Kala C, Godara D, Rahat I *et al*. GC-MS Analysis of Chemical Constituents of Hydroalcoholic Leaf Extract of Cissampelos Pareira and Their Anti-Diabetic Activity. *Asian Plant Research Journal*, *7*(February), 2021, 36-49.
8. Badr SEA, Abdelfattah MS, El-Sayed SH, Abd El-Aziz ASE, Sakr DM. Evaluation of anticancer, antimycoplasmal activities and chemical composition of guar (Cyamopsis tetragonoloba) seeds extract. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*,2014:5(3):413-423.
9. Bagavan, A., Rahuman, A. A., Kamaraj, C., & Geetha, K. Larvicidal activity of saponin from Achyranthes aspera against Aedes aegypti and Culex quinquefasciatus (Diptera: Culicidae). *Parasitology Research*,2008:103(1):223-229.
10. Bhardwaj R. *GC-MS analysis and antimicrobial activity of alkaloids of Tecomella undulate*,2018:6(6):68-72.
11. Bhardwaj R, Sharma RA. Flavonoids of Boerhavia diffusa- GC-MS Analysis of alkaloids and their inhibitory activity against pathogenic microorganisms. *International Journal of Pharmaceutical Sciences and Research*,2019:8(2):756-760.
12. Choudhary K, Nama KS. Phyto-diversity of Mukundara hills national park of Kota district. *Advances in Applied Science Research*,2014:*5*(1):18-23.
13. Fraga-Corral M, García-Oliveira P, Pereira AG, Lourenço-Lopes C, Jimenez-Lopez C, Prieto MA *et al*. Technological application of tannin-based extracts. *Molecules*,2020:25(3):1-27.
14. Gonçalves S, Mansinhos I, Romano A. Aromatic plants: A source of compounds with antioxidant and neuroprotective effects. *Oxidative Stress and Dietary Antioxidants in Neurological Diseases*, 2020, 155-173.
15. Gupta SC, Tripathi T, Paswan SK, Agarwal AG, Rao CV, Sidhu OP. Phytochemical investigation, antioxidant and wound healing activities of Citrullus colocynthis (bitter apple). *Asian Pacific Journal of Tropical Biomedicine*,2018:8(8):418-424.
16. Jakimiuk K, Wink M, Tomczyk M. Flavonoids of the Caryophyllaceae. *Phytochemistry Reviews*,2021:3:1-40.
17. Jayanthi M, Garg SK, Yadav P, Bhatia A, Goel A. Some newer marker phytoconstituents in methanolic extract of Moringa oleifera leaves and evaluation of its immunomodulatory and splenocytes proliferation potential in rats. *Indian Journal of Pharmacology*,2015:47(5):518-523.
18. Kaiser A, Kusch P, Deininger S, Specht S, Maniako R, Haubrich S *et al*. In vitro and *in vivo* antimalarial activity assays of seeds from balanites aegyptiaca: Compounds of the extract show growth inhibition and activity against plasmodial aminopeptidase. *Journal of Parasitology Research*, 2011, 1-9.
19. Katewa S, Chaudhary B, Jain A, Galav P. Traditional uses of plant biodiversity from Aravalli hills of Rajasthan. *Indian Journal of Traditional Knowledge (IJTK)*,2003:02(1):27-39.
20. Kumar, Naresh, Goel N. Phenolic acids: Natural versatile molecules with promising therapeutic applications. *Biotechnology Reports*,2019:24:1-10.
21. Kumar, Naresh, & Pruthi, V. Potential applications of ferulic acid from natural sources. *Biotechnology Reports*,2014:4(1):86-93.
22. Kumar, Nithin, Kanchan T, Unnikrishnan B, Thapar R, Mithra P *et al*. Characterization of Rubia cordifolia L. root extract and its evaluation of cardioprotective effect in Wistar rat model. *Indian Journal of Pharmacology*,2018:49(5), 344-347.
23. Liu B, Yang Y, Liu H, Xie Z, Li Q, Deng M *et al*. Screening for cytotoxic chemical constituents from Justicia procumbens by HPLC-DAD-ESI-MS and NMR. *Chemistry Central Journal*,2018:12(1):1-16.
24. Mishra D, Patnaik S. GC-MS analysed phyto-chemicals and antibacterial activity of Withania somnifera (L.) dunal extract in the context of treatment to liver cirrhosis. *Biomedical and Pharmacology Journal*,2020:13(1):71-78.
25. Muthuraman MS, Sinsinwar S, Vetrivel U. Anticancer activity of sida cordifolia L., – Insilico approach. *Journal of Pharmaceutical Sciences and Research*,2017:9(8):1363-1367.

26. Naik D, Dandge C, Rupanar S. Determination of Chemical Composition and Evaluation of Antioxidant Activity of Essential Oil from Tinospora cordifolia (Willd.) Leaf. *Journal of Essential Oil-Bearing Plants*,2014:17(2):228-236.
27. Nirmal CR, Ebenezer RS, Kannan P, Balasubramanian M, Thirunavukkarasu I, Mondal R *et al*. Anti-tuberculosis activity of bio-active compounds from Lantana camara L., Euphorbia hirta L., Mukia maderaspatana (L.) M. Roem, and Abutilon indicum (L.). *European Journal of Integrative Medicine*,), 2020, 1-6.
28. Nithya M, Ragavendran C, Natarajan, D. Antibacterial and free radical scavenging activity of a medicinal plant solanum xanthocarpum. *International Journal of Food Properties*,2018:21(1):313-327.
29. Pipatrattanaseree W, Itharat A, Mukkasombut N, Saesiw U. Potential in vitro anti-allergic, anti-inflammatory and cytotoxic activities of ethanolic extract of Baliospermum montanum root, its major components and a validated HPLC method. *BMC Complementary and Alternative Medicine*,2019:19(1):1-12.
30. Ram H. (n.d.). Novel Phytoconstituents of an Aqueous Pod Extract of *Prosopis Cineraria (L.)* Druce Attenuate Atherosclerotic Plaque and Hypercholesterolemia in Rabbits, 1-32.
31. Roy S, Rao K, Bhuvaneswari C, Giri A, Mangamoori LN. Phytochemical analysis of Andrographis paniculata extract and its antimicrobial activity. *World Journal of Microbiology and Biotechnology*,2010:6(1):85-91.
32. Saha H, Srikkanth A, Sikchi S, Rajeswari VD. Comparative evaluation of antimicrobial and anti-inflammatory activities of Ocimum sanctum, Phyllanthus niruri and Cadaba fruticosa: An in vitro approach with emphasis on detection of their bioactive compounds using GC-MS. *International Journal of Biological Chemistry*,2015:9(5):235-248.
33. Sajid ZI, Anwar F, Shabir G, Rasul G, Alkharfy KM, Gilani AH. Antioxidant, antimicrobial properties and phenolics of different solvent extracts from bark, leaves and seeds of Pongamia pinnata (L.) pierre. *Molecules*,2012:17(4):3917-3932.
34. Saraswathi K, Arumugam P, Sivaraj C. *Antioxidant evaluation and gas chromatography – mass spectrometry (GC – MS) profiling of aqueous dried tuberous roots of Asparagus racemosus Willd: The queen of herbs*,2020:9(3):466-476.
35. Sassoui D, Seridi R, Azin K, Usai M. Evaluation of phytochemical constituents by GC-MS and antidepressant activity of Peganum harmala L. seeds extract. *Asian Pacific Journal of Tropical Disease*,2015:5(12):971-974.
36. Seemaisamy R, Faruck LH, Gattu S, Neelamegam R, Bakshi HA, Rashan L *et al*. Anti-Microbial and Anti-Cancer Activity of Aegle Marmelos and Gas Chromatography Coupled Spectrometry Analysis of Their Chemical Constituents. *International Journal of Pharmaceutical Sciences and Research*,2019:10(1):373-380.
37. Sharma KK, Pandey AK. Phytosociological study of vegetation of some selected arid region of the Thar desert of Rajasthan, India. *Current world environment*,2010:5(1):51-58.
38. Singh VS, Dhawale SC, Shakeel F, Faiyazuddin M, Alshehri S. Antiarthritic potential of calotropis procera leaf fractions in fca-induced arthritic rats: Involvement of cellular inflammatory mediators and other biomarkers. *Agriculture (Switzerland)*,2021:11(1):1-16.
39. Sogan N, Kapoor N, Singh H, Kala S, Nayak A, Nagpal B. Larvicidal activity of Ricinus communis extract against mosquitoes. *Journal of Vector Borne Diseases*,2018:55(4):282-290.
40. Suresh, M., Alfonisan, M., Alturaiki, W., Al Aboody, M. S., Alfaiz, F. A., Premanathan, M., Vijayakumar, R., Umamagheswari, K., Ghamdi, S. Al, & Alsagaby, S. A. Investigations of Bioactivity of Acalypha indica (L.), Centella asiatica (L.) and Croton bonplandianus (Baill) against Multidrug Resistant Bacteria and Cancer Cells. *Journal of Herbal Medicine*, 2020, 1-10.
41. Swamy, M. K. Plant alkaloids: Structures and bioactive properties. *Plant derived Bioactives*: *Chemistry and Mode of Action* (Issue June), 2020, 1-589
42. Tamil Selvi M, Thirugnanasampandan R, Sundarammal S. Antioxidant and cytotoxic activities of essential oil of Ocimum canum Sims. from India. *Journal of Saudi Chemical Society*,2015:19(1):97-100.
43. Thakur M, Singh K, Khedkar R. Phytochemicals. In *Functional and Preservative Properties of Phytochemicals*, 2020, 341-361
44. Mudiganti Ram Krishna Rao, Balasubramaniam M. TLC, GC MS and Antibacterial Study of Methanol Extracts of Tribulus Terrestris Thorns and Morinaga Oleifera Flowers. *Indo American Journal of Pharmaceutical Sciences*,2018:5(5):3300-3308.
45. Tillu, G., Salvi, S., & Patwardhan, B. AYUSH for COVID-19 management. *Journal of Ayurveda and Integrative Medicine*,2020:11(2):95-96.
46. Torawane, S. D., Suryawanshi YC, Mokat DN. Controlled release of functional bioactive compounds from plants. In *Encapsulation of Active Molecules and Their Delivery System*. INC, 2020, 103-110.
47. VP, Ajay AK. Screening of potential GCMS derived antimigraine compound from the leaves of Abrus precatorius Linn to target "calcitonin gene related peptide" receptor using in silico analysis. *Food Science and Human Wellness*,2019:8(1):34-39.
48. Yadav C, Chaubey S, Kurele R, Semwal DK. Sanjeevani booti - A majestic and elusive all curing divine herb in epic Ramayana. *Journal of Conventional Knowledge and Holistic Health*,2017:1(1):1-4.

49. Yang W, Chen X, Li Y, Guo S, Wang Z, Yu X. Advances in Pharmacological Activities of Terpenoids. *Natural Product Communications*,2020:15(3):1-13.
50. Youssef Moustafa AM, Khodair AI, Saleh MA. GC-MS investigation and toxicological evaluation of alkaloids from Leptadenia pyrotechnica. *Pharmaceutical Biology*,2009:47(10):994-1003.
51. National Center for Biotechnology Information. Pub Chem Compound Summary, 2021. https://pubchem.ncbi.nlm.nih.gov/