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PHYTOCHEMICAL ANALYSIS OF *EUPHORBIA* SPECIES OF GUJARAT, INDIA: A REVIEW

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ABSTRACT
In India, out of195 species of Euphorbia sub-genus, about 23 species have been recorded in the state of Gujarat, out of which phytochemical work has been done on only 12–13 species. These Euphorbia species have ethnobotanical significance and are used by indigenous communities. The research work on these species has till now displayed the presence of phytochemicals and secondary metabolites like phenolic compounds, flavonoids, tannins, terpenes, terpenoids, cardiac glycosides, etc., which are used in the treatment of skin disorders, arthritis, cancer treatment, cytotoxicity, etc. The purification of the phytochemicals revealed the exact chemical structure of the compounds present, which may help in further research and overlap with fields such as phylogenetics, cell biology, molecular biology, enzymology, etc. There is future scope for research in the investigation of phytochemicals of Euphorbia sp., like E. rosea Retz., E. orbiculate H. B. & K, on which research work has not been conducted yet.

Keywords: *Cytotoxicity, Ethnomedicinal, Euphorbia, Flavonoids,Pharmacology*

INTRODUCTION
The family Euphorbiaceae, also known as the spurge family, named in honors of Greek physician *Euphorbia*, is a diverse angiosperm family. The genus *Euphorbia* belonging to this family is the third-largest genus of Angiosperms (Olounlade *et al.*, 2017), consisting of approximately 2000 species, distributed throughout the world. In India, the species of *Euphorbia* have been part of traditional medicinal knowledge among several communities for treating various skin disorders, renal infections, snakebites, leprosy, infertility, etc. There are approximately 195 species of *Euphorbia* reported in India (Soumen, 2010), out of which, 23 species have been found in Gujarat (Shah, 1978) viz., *Euphorbia acaulis* Roxb., *Euphorbia antiquorum* L., *Euphorbia clarkeana* Hk. F., *Euphorbia dracunculoides* Lam., *Euphorbia elegans* Spr., *Euphorbia geniculata* Ort., *Euphorbia granulate* Forsk., *Euphorbia heterophylla* L., *Euphorbia hirta* L., *Euphorbia linearifolia* Roth., *Euphorbia milii* Ch. Des Moulins, *Euphorbia neriifolia* L., *Euphorbia nivulia* Buch. - Ham., *Euphorbia orbiculate* H. B. &K., *Euphorbia parviflora* L., *Euphorbia perbracteata* Gage., *Euphorbia prostrate* Ait., *Euphorbia pulcherrima*Willd. ex-Klotz., *Euphorbia pycnostegia*Boiss. var. pycnostegia, *Euphorbia pycnostegia* var. zornioides (Boiss.) Sant., *Euphorbia rosea* Retz., *Euphorbia rothiana* Spr., *Euphorbia thymifolia* L., *Euphorbia tirucalli* L. (Shah, 1978). The current review explores the distributionof *Euphorbia*, and current status of research on phytochemistry and pharmacological properties of *Euphorbia*sps.

TAXONOMY
The family of Euphorbiaceaeconsists of nearly 321 genera and about 7770 species. The genus of *Euphorbia* consists of more than 2100 species. The scientific classification of *Euphorbia*genus is given below: (Singh, 2010)

Bentham & Hooker	**Takhtajan**	**APG IV (2016)**
Divison:Angiosperm	Magnoliophyta	**Clade**- Eudicots
Class: Dicotyledons	Magnoliopsida	Superrosids
Sub class: Monochlamydeae	Dillenidae	Rosids
Series: Unisexuales	Euphorbianae	Fabids
Order: -	Euphorbiales	Malpighiales

Family: Euphorbiaceae	Euphorbiaceae	Euphorbiaceae
Genus: *Euphorbia*	*Euphorbia*	*Euphorbia*

MORPHOLOGY OF*Euphorbia:*

Euphorbia belongs to the family Euphorbiaceae with white milky latex. It comprises small trees, herbs, and shrubs. The plant body can be succulent and cactus-like; the leaves are simple, rarely palmate or trifoliate, alternate or opposite, stipulated with modified stipules that function as glands or spines; and a single female flower is surrounded by a male flower in a cup-like involucre. The rim of the involucres with or without petaloid limbs Nectary over the involucre can be seen in place of the petaloid limb. The stamens are infinite, distinct or connate; anthers might be longitudinal, transverse or poricidal in dehiscence; gynoecium shows 3 carpels, syncarpous with superior ovary; ovary is trilocular with one ovule in each locule; the styles are fused or free; placentation is apical-axile and pendulous; the type of fruit present might be capsule. (Simpson, 2015; Cooke, 1908).

ETHNOMEDICINAL USES OF*Euphorbia:*

In Gujarat, only 12-13 species have been studied for their ethnomedicinal uses. The latices (sing: latex) of *E. tirucalli* and *E. hirta* are commercial sources for rubber (Tripathi & Kumar, 2021). The root of *E. hirta*, crushed and mixed with jaggery and cumin (*Cuminum cyminum* L.) and consumed once a day, is used to treat excessive urination, as per herbal folk medicine used by tribal communities in the Sabarkantha district in the North-eastern Gujarat region (Punjani, 2010).*E. antiquorum L.* is often used in folk medicine systems to treat and prevent illnesses and infections such as asthma, bronchitis, coughing, and so on, and it has anti-inflammatory, anti-cancer, anti-bacterial, and anti-oxidant properties *(*Kumar &Saikia, 2016*)*.The latex of *E. neriifolia* is applied as a laxative, purgative, carminative and is used in treating gonorrhoea, leprosy, dyspepsia, jaundice, etc., and leaves are applied in the treatment of tumours, pains, inflammation, bronchial infections (Mali & Panchal, 2017).According to traditional medicine and contemporary medicine, the latex of several *Euphorbia* species has an important role in the treatment of wounds such as blisters, abscesses, traumas, and so on, as well as numerous skin illnesses (Olounlade*et al.,* 2017). In the traditional medicine system, *E. tirucalli* plays an important role, as it is reported to possess anti-arthritic activity, anti-cancer activity, larvicidal, anti-fungal, and anti-oxidant activity. Also, its latex is used in the treatment of intestinal parasites, and the stem is used in the treatment of diseases such as whooping cough, leprosy, syphilis, and as an emmenagogic herb, which encourages abortion, in the traditional Ayurvedic medicine system (Priya & Rao, 2011).*E. thymifolia* Linn., also known as Nahanidudheli in Gujarat, is found in semi-arid regions and has several pharmacological attributes, like anti-microbial activity, anti-helminthic activity, antioxidant activity, etc., in the traditional Ayurveda (Muthumani *et al.*, 2013).*E. prostrata*is used to treat snakebites, asthma, diabetes, and a variety of skin problems (Sharma *et al.*, 2012), and it has anti-typhoid action against the bacterium that causes typhoid, Salmonella typhi (Kengni *et al.*, 2013).*E. rothiana,* distributed in India in the states of Gujarat, Maharashtra, and Tamil Nadu, is traditionally used in Ayurveda as an anti-helminthic agent, anti-fungal agent, anti-microbial agent, and hypotensive agent (Rani *et al.*, 2009).Extracts of the decoction of *E. heterophylla* leaves are particularly efficient in the treatment of numerous respiratory illnesses in traditional medicine systems (Falodun *et al.*, 2006). *E. heterophylla* has anti-cancer, anti-HIV, and anti-tumor qualities, and it is used to cure warts, gonorrhoea, and migraines, and its latex may be used as a fish poison and pesticide (James & Friday, 2010). Plant latex from *E. nivulia* Buch. – Ham. is used in the treatment of leprosy, bronchitis, asthma, jaundice. The dry fruit ethanolic extract of *E. pulcherrima* is applicable as an anti-microbial agent against pathogenic bacteria such as *Escherichia coli, Staphylococcus aureus,* etc. (Mishra &Parida, 2020). Apart from medicinal uses, *Euphorbia* species such as *E. milii* Des. Moul., *E. tirucalli* L., and *E. pulcherrima* are also used for ornamental purposes. (Mishra &Parida, 2020).

CHEMICAL CONSTITUENTS:

Qualitative and quantitative phytochemical analysis has been conducted on many species of *Euphorbia.* The phytochemicals extracted maximum belongs to the classes of alkaloids, terpenes, saponins, terpenoids, polyphenols, flavonoids, tannins etc. *E. antiquorum* displays the presence of Diterpenes classes of compounds, such as Myrsinol, Ingol, Lathyrane, Tigliane which includes, antiquorin, isohelinol, euphol, Ingenol-3-angelate, Triterpenoids such as friedelane-3β, 30-acetoxyfriedelan-3β-ol and 30-dioldiacetate (Kumar &Saikia, 2016;Kumar & Saikia, 2016). Flavonoidssuch as quercetin-3-O-β-D-glucopyranosyl (1-4)-O-α-L-rhamnopyranosidehas been isolated from the leaves of *E. dracuncoloides* by Gautum and Mukhraya (1981). *E. thymifolia* is reported to have contained flavonoids such as 5,7,40-trihydroxy-flavone-7-glucoside, which was isolated from its leaves and stems (Noori *et al.*, 2009). The phytochemical analysis of many species of *Euphorbia* has been summarized in the following table:

Table – 1: - Phytoconstituents found in *Euphorbia* species distributed throughout Gujarat

Sr.no.	Compound groups	Compound	*Sources*	Parts	References
1	Diterpenes	Cycloartenol	*E. antiquorum*	Latex	Kumar & Saikia, 2016
			E.milli	Latex	Pancorbo & Hammaer,1972
			E.neriifolia	Whole plant	Bigoniya & Rana,2008
			E.hirta	Aerial parts	Tripathi & Kumar,2021
		Ingenol	*E. antiquorum*	Latex	Kumar & Saikia, 2016
		Antiquorin	*E. neriifolia*	Bark and root	Bigoniya & Rana,2008
		12-deoxy-4β-phorbol-13-dodecanoate-20-acetate	*E. neriifolia*	Bark and root	Bigoniya & Rana,2008
		Ingenol triacetate	*E. neriifolia*	Bark and root	Bigoniya & Rana,2008
		3,12-diacetyl-8-benzoylingol	*E. nivulia,*	Latex	Mishra & Parida,2020
		4- deoxyphorbol	*E. tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		Tirucalicine	*E. tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		12-o-(2z,4e-octadienoyl) -phorbol-13-acetate,	*E. tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		3,7,12-tri-o-acecy1-8-isovaleryl-ingol	*E. tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		Isovaleryl-ingol	*E. tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		12-o-(2,4,6,8-Tetradecatetraenoyl)	*E. tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		Phorbol-13-acetate	*E. tirucalli*	Whole plant	El-Hawary *et al.*, 2021
2	Triterpenes	Euphol 3-o-cinnamate	*E. antiquorum*	Latex	Kumar & Saikia, 2016
		Antiquol a	*E. antiquorum*	Latex	Kumar & Saikia, 2016

		Antiquol b	*E. antiquorum*	Latex	Kumar & Saikia, 2016
		Euphol	*E. antiquorum*	Latex	Kumar & Saikia, 2016
			E.milli	Latex	Pancorbo & Hammaer,1972
			E.neriifolia	Whole plant	Bigoniya & Rana,2008
		24-methylenecycloartano	*E. antiquorum*	Latex	Kumar & Saikia, 2016
		Cycloeucalenol	*E. antiquorum*	Latex	Kumar & Saikia, 2016
		(z)-9-nonacosene	*E. antiquorum*	Latex	Kumar & Saikia, 2016
		P-acetoxyphenol	*E. antiquorum*	Latex	Kumar & Saikia, 2016
		Taraxerol	*E. antiquorum*	Stem-bark	Kumar & Saikia, 2016
			E.hirta	Aerial parts	Tripathi & Kumar,2021
			E.neriifolia	Whole plant	Bigoniya & Rana,2008
			E. thymifolia	Whole plant	Shrivastava & Mishra, 2019
		Taraxerone	*E. antiquorum*	Stem-bark	Kumar & Saikia, 2016
		6,10,14-Trimethylpentadecan-2-one	*E. dracuncoloides*	Dried aerial parts	Majid *et al.*, 2015
		(e, e)-farnesyl acetone	*E. dracuncoloides*	Dried aerial parts	Majid *et al.*, 2015
		Hexadecanoic acid, methyl ester (cas)	*E. dracuncoloides*	Dried aerial parts	Majid *et al.*, 2015
		Hexadecanoic acid	*E. dracuncoloides*	Dried aerial parts	Majid *et al.*, 2015
		B-stigmasterol glucoside	*E. dracuncoloides*	Dried aerial parts	Majid *et al.*, 2015
		Stigmasterol	*E.heterophylla*	Dried aerial parts	Majid *et al.*, 2015
			E.prostrata	Whole plant	Sharma *et al.*, 2012
			E.hirta	Aerial parts	Tripathi & Kumar,2021
		A- amyrin	*E.hirta*	Aerial parts	Tripathi & Kumar,2021
		Fridelin	*E.hirta*	Aerial parts	Tripathi & Kumar,2021
		11α-oxidotaxaxerol, 12α- oxidotaraxerol	*E.hirta*	Aerial parts	Tripathi & Kumar,2021

		24-methylenecycloartanol	*E.hirta*	Aerial parts	Tripathi & Kumar,2021
		Euphorbolhexacosoate	*E.hirta*	Aerial parts	Tripathi & Kumar,2021
		Beta - Sitosterol	*E.hirta*	Aerial parts	Tripathi & Kumar,2021
			E. antiquorum	Latex	Kumar & Saikia, 2016
		Campesterol	*E.hirta*	Aerial parts	Tripathi & Kumar,2021
			E.prostrata	Whole plant	Sharma *et al.*, 2012
		Cholesterol	*E.hirta*	Aerial parts	Tripathi & Kumar,2021
			E. prostrata	Whole plant	Sharma *et al.*, 2012
		Lupeol,	*E. milli*	Latex	Pancorbo & Hammaer,1972
		B- sitosterol	*E. milli*	Latex	Pancorbo & Hammaer,1972
			E. prostrata	Whole plant	Sharma *et al.*, 2012
		B- amyrin	*E. hirta*	Aerial parts	Tripathi & Kumar,2021
			E. antiquorum	Latex	Kumar & Saikia, 2016
			E. milli	Latex	Pancorbo & Hammaer,1972
			E. neriifolia	Whole plant	Bigoniya & Rana,2008
		Nerifolione	*E. neriifolia*	Whole plant	Bigoniya & Rana,2008
		Euphorbol	*E.neriifolia*	Whole plant	Bigoniya & Rana,2008
			E. thymifolia	Whole plant	Shrivastava & Mishra, 2019
		Nerifoliene	*E.neriifolia*	Whole plant	Bigoniya & Rana,2008
		Glut-5(10)-en-1-one	*E.neriifolia*	Whole plant	Bigoniya & Rana,2008
		Glut-5-en-3β-ol	*E.neriifolia*	Whole plant	Bigoniya & Rana,2008
		Cycloart-25-en-3β-ol	*E.nivulia*	Latex	Mishra & Parida,2020
		Cyclonivulinol	*E.nivulia*	Latex	Mishra & Parida,2020
		Epitaraxerol	*E. thymifolia*	Whole plant	Shrivastava & Mishra, 2019
		4,14-dimethylergosta-8, 24(28)-dien-3β-ol	*E. thymifolia*	Whole plant	Shrivastava & Mishra, 2019
		Methylene cycloartenol	*E. thymifolia*	Whole plant	Shrivastava & Mishra, 2019
		Euphorbosterol	*E.tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		Cycloeuphordenol	*E.tirucalli*	Whole plant	El-Hawary *et al.*, 2021

		Cycloeuphornol	*E.tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		Euphorbinol	*E.tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		Euphorbiane	*E.tirucalli*	Whole plant	El-Hawary *et al.*, 2021
		Canaric acid (3,4-seco-4(23),20(30)-lupadien-3-oic acid)	*E.tirucalli*	Whole plant	El-Hawary *et al.*, 2021
3	Flavonoid	Friedelan-3β-ol	*E. antiquorum*	Stem-bark	Kumar & Saikia, 2016
		Friedelan-3α-ol	*E. antiquorum*	Stem-bark	Kumar & Saikia, 2016
		Quercetin-3-o-β-d-glucopyranosyl (1-4)-o-α-l-rhamnopyranoside	*E. dracuncoloides*	Leaves	Noori *et al.*,2015
		Quercetin	*E. heterophylla*	Whole plants	Magozwi *et al.*, 2021
			E. hirta	Leaves, Roots	Tripathi & Kumar, 2021
			E. neriifolia	Leaves	Magozwi *et al.*, 2021
			E. tirucalli	Whole plant	Magozwi *et al.*, 2021
		Quercetin 3-o-α-l-rhamnopyranoside	*E. heterophylla*	Whole plants	Magozwi *et al.*, 2021
		Quercetin 3-o-β-d-6”-malonate	*E. heterophylla*	Whole plants	Magozwi *et al.*, 2021
		Quercetin 3-o-β-d-glucopyranoside	*E. heterophylla*	Whole plants	Magozwi *et al.*, 2021
		Quercetin 3-o-β-d-galactopyranoside	*E. heterophylla*	Whole plants	Magozwi *et al.*, 2021
		Quercitrin	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
			E. tirucalli	Whole plant	Magozwi *et al.*, 2021
		Quercitol	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Rhamnose	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		quercetin-3-O-α-rhamnoside	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Chlorophenolic acid	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Rutin	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021

		Leucocyanidin	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Myricitrin	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Cyaniding 3,5-diglucoside	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Camphol	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Flavonol	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Inositol	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Tetraxerol	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Kaemferol	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		(7-o-(p-coumaroyl)-5,7,4-trihydroxy-6-(3,3-dimethylallyl)-flavonol-3-o-β- d-glucopyr-anosyl-(2” →1”’)-o-α-l-rhamnopyranoside)	*E. hirta*	Leaves, Roots	Magozwi *et al.*, 2021; Tripathi & Kumar, 2021
		Dimethoxyquercitrin	*E. hirta*	Roots	Magozwi *et al.*, 2021
		Hirtaflavonoside-b (5,7,3’,4’ –trihyroxy-6-(3,3 –dimethyl allyl)-8-9-iso-butenyl)-flavonol-3-o-β- d-glucosidase)	*E. hirta*	Roots	Magozwi *et al.*, 2021
		2-(3,4-dihydroxy-5-methoxy-phenyl)- 3,5-dihydroxy-6,7-dimethoxychromen-4-one	*E. neriifolia*	Leaves	Magozwi *et al.*, 2021
		Apigenin	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Luteolin	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Apigenin-7-glucoside	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Luteolin-7-glucoside	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Quercretingalactoside	*E. thymifolia*	Whole plant	Sisodiya & Shrivastava,2017

		4- trihydroxy flavone-7-glycoside	*E. thymifolia*	Whole plant	Shrivastava & Mishra, 2019
		Ampelopsin	*E. tirucalli*	Whole plant	Magozwi *et al.*, 2021
		Myricetin	*E. tirucalli*	Whole plant	Magozwi *et al.*, 2021
		3,5,7-trihydroxi-2-(3',4',5' trihidrox)-2,3dihidrobenzopiran-4-one	*E. tirucalli*	Whole plant	Magozwi *et al.*, 2021
		Isoquercetin	*E. tirucalli*	Whole plant	Magozwi *et al.*, 2021
		Rutin	*E. tirucalli*	Whole plant	Magozwi *et al.*, 2021
4	Steroids	Estra-1,3,5(10)-trien-17-one	*E. dracuncoloides*	Dried aerial parts	Majid *et al.*, 2015
		3à,6á-dihydroxyandrost-4-ene-17-one	*E. dracuncoloides*	Dried aerial parts	Majid *et al.*, 2015
5	Tannins	Euphorbin-a	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		Euphorbin-b	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		Euphorbin-c	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		Euphorbin-d	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		Ellagitannin dimers	*E. thymifolia*	Leaves	Shrivastava &Mishra,2019
		Euphorbin g	*E. thymifolia*	Leaves	Shrivastava &Mishra,2019
		Euphorbinh	*E. thymifolia*	Leaves	Shrivastava &Mishra,2019
		Terchebin	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		Geranin	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		1,2,3,4,6- penta-o-galloyl-β-d-glucose	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		2,3-di-o-methylellagic acid-7-o-rutinoside	*E. tirucalli*	Whole plants	El-Hawary *et al.*, 2021
		3,3,4-tri-o- methyl-4-o-Rutinosyl-ellagic acid	*E. tirucalli*	Whole plants	El-Hawary *et al.*, 2021
6	Alkaloids	Cyclobarbital	*E. milii*	Stem	Chohan *et al.*, 2020
		Mephobarbital	*E. milii*	Stem	Chohan *et al.*, 2020
7	Anthocyanin	Delphin	*E. neriifolia*	Bark and root	Bigoniya & Rana, 2008
		Tulipanin	*E. neriifolia*	Bark and root	Bigoniya & Rana, 2008

		2,4-Cyclohexadien-1-one, 2-methyl-5-(1-methylethyl)	*E. dracuncoloides,*	Dried aerial part	Majid *et al.*, 2015
		Austrobailignan-6	*E. dracuncoloides,*	Dried aerial part	Majid *et al.*, 2015
		Gallic acid	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
		Protocatechuic acid	*E. hirta*	Aerial parts	Tripathi & Kumar, 2021
8	Phenolic compounds	Apigenin	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Luteolin	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Apigenin-7-glucoside	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Luteolin-7-glucoside	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Gallic acid	*E. prostrata*	Whole plant	Sharma *et al.*, 2012
		Ellagic acid	*E. prostrata*	Whole plant	Sharma *et al.*, 2012

PHARMACOLOGICAL ACTIVITY:

Anti-inflammatory activity:

The aqueous and ethanolic extracts of *E. hirta* displayed a high percentage of anti-inflammatory properties (Ghosh *et al.*, 2019). The triterpenes found in the n-hexane extract of *E. hirta* exerted anti-inflammatory activity in mice, applying to the model of phorbol acetate-induced ear inflammation in mice (Patil *et al.*, 2009). Similarly, aqueous and alcoholic extracts of *E. antiquorum* when evaluated against acute inflammation employing carrageenan-induced rat paw oedema and chronic inflammation employing cotton pellet-induced granuloma in rats, both extracts showed a significant decrease or inhibition in chronic inflammation. It was concluded that triterpenoids present in both of the extracts may have been responsible for the anti-inflammatory property (Kumar &Saikia, 2016). In the case of *E. heterophylla* too, the anti-inflammatory property was measured by carrageenan-induced rat paw oedema, and from the research, it was established that aqueous extract of the leaves of *E. heterophylla* displayed significant activity ($p<0.001$), which was attributed to the presence of high amounts of the flavonoid quercetin (Falodun *et al.*, 2006). The ethanolic extract of *E. thymifolia* produced significant anti-inflammatory activity when applied to the carrageenan-induced rat paw oedema model *(*Garipelli *et al.,* 2012*).* The acetone extract of the latex of *E. neriifolia* displayed anti-inflammatory and anti-arthritic activity due to the presence of a novel triterpene, Nerifoline (Hasanuddin *et al.*, 2003).

Anti-cancer activity:

Hydro-ethanolic extract of *E. neriifolia* L. displays defensive property against DENA (Diethyl nitrosamine) induced abnormalities in metabolic parameters and shows improved levels of antioxidant and decreases the chances of carcinogenesis (Mali & Panchal, 2017). The methanolic and aqueous extracts of *E. tirucalli* inhibited further proliferation of pancreatic cancer cells, suggesting their future scope in the treatment of pancreatic cancer (Munro *et al.*, 2015). The terpenoids present in *E. prostrata*, and *E. milii* are responsible for anti-tumour and anti-cancer activities. *E. heterophylla* displayed anticancer activities (Qaisar *et al.*, 2012).

Antioxidant activity:

The antioxidant activity of *E. hirta* was affected by the presence of both phenolic compounds and flavonoids (Basma *et al.*, 2011). The ethyl acetate fraction of E. tirucalli constituting high amounts of polyphenol and flavonoids displayed high free radical scavenging capacity and total antioxidant capacities (Le et al., 2021). The methanolic leaf extracts of *E. antiquorum* and *E. milii* Des Moul. possessed significant antioxidant activity, which is applicable in the pharmaceutical industry for the discovery and manufacture of various drugs when chemical compounds are purified (Gapuz & Besagas, 2018).

Anti-microbial activity:
In the case of aqueous extracts of the whole plant of *E. prostrata*, they possess substances responsible for anti-bacterial activities and are employed in the treatment of typhoid and paratyphoid fevers (Kengni *et al.*, 2013). Certain phytochemicals are responsible for anti-microbial activities Flavanoids possess anti-bacterial and antifungal activities; terpenes are responsible for anti-microbial and insectifuge activities; damnacanthal, nordamnacanthal, and norindone, belonging to the class of anthraquinones, display high anti-microbial activities (Ali *et al.*, 2000). The phytochemicals such as saponin, anthraquinone, terpenoids, alkaloids, flavonoids, polyphenols, and tannins, which are responsible for anti-microbial activity, were found in all the fractions of *E. tirucalli* (Le *et al.*, 2021). The ethanolic and aqueous extracts of *E. thymifolia* were more effective than methanolic and n-hexane extracts of *E. thymifolia* against bacteria such as *E. coli*, *K. pneumoniae*, *P. mirabilis*, *S. dysentriae*, and *S. typhi* in producing large inhibition zones (Muthumani*et al.*, 2013). Ethanolic extract of the plant *E. hirta* demonstrated anti-microbial activity against pathogens such as *Staphylococcus aureus* (Gram-positive bacteria), *Salmonella typhi* (Gram-negative bacteria), and *Entamoeba histolytica* (Mishra &Parida, 2020). *E. rothiana* displayed potent anti-microbial activity against gramme negative bacteria such as *E. coli* and gramme positive bacteria such as *Staphylococcus aureus, which was* attributed to the presence of phenolic and flavonoid compounds in *E. rothiana* (Rani *et al.*, 2009).

Cytotoxic activity:
The cytotoxic activity of chloroform, ethanol, and butanol extracts of plants, *E. tirucalli* and *E. antiquorum,* was tested against two human cancer cell lines, BEL-7402 and A-549. It was discovered that chloroform extract of *E. tirucalli* displayed significant cytotoxicity against BEL-7402, having an IC_{50} value of 10.1μg/mL and high cytotoxicity against the cancer cell line, A-549, showing an IC_{50} value of 4.6 μg/mL. The ethanolic extract of *E. tirucalli* displayed potent cytotoxicity against BEL-7402, possessing an IC_{50} value of 16.9μg/mL. The chloroform extract of E. antiquorum was found to be cytotoxic to BEL-7402 and A-549, with IC50 values of 5.4 μg/mL and 1.9 μg/mL, respectively (Wang *et al.*, 2011). Evaluated against three cancer cell lines, HEPG2, MCF-7, and CACO2, it displayed potent cytotoxicity against cancer cell line CACO2, possessing an IC_{50} value of 9.8 mM (El-Hawary *et al.*, 2021). The latex of *E. neriifolia* was tested against the Brine Shrimp Lethality Test (BSLT) in a microplate bioassay, displaying a significant LC_{50} value below 100μg/mL, suggesting cytotoxic and pesticidal activities (Bigoniya& Rana, 2008).

CONCLUSION

Since ancient times, several indigenous communities in India have relied on the species of Euphorbia to treat a variety of ailments and maladies, from eczema to infertility problems, snakebites, etc. Further, there is a need to discover ethnobotanical knowledge of more species of *Euphorbia* species present in India (Soumen, 2010) and to apply it in several pharmaceutical companies. About 12 to 13 of the 23 species of *Euphorbia* prevalent in Gujarat have undergone phytochemical analysis and subsequent purification of chemical components. Triterpenoids, according to recent study, are the most varied compound group present in species of *Euphorbia.* Taraxerol, B-amyrin, euphol, stigmasterol, etc., are the most common triterpenoids. Cycloartenol and quercetin, respectively, constitute the majority of diterpenes and flavonoids discovered in species of *Euphorbia.* There is future scope in phytochemistry and ethnobotany to discover the chemical compounds and study them in the overlapping fields, such as cell biology, molecular biology, enzymology, etc., applicable in the manufacture of therapeutic drugs possessing properties of anti-inflammatory, anti-cancer, in other species of *Euphorbia*, such as *E. rosea* Retz., *E. orbiculate* H. B. & K. etc.

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