From traditional remedy to modern medicine: Review of the genus *Euphorbia*

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Research

Abstract

Background: Plants have been used in human medicine since ancient times. Natural products continue to play a crucial role in the drug discovery process. Genus *Euphorbia* is widely known for its therapeutic properties all over the world. We aim to update traditional medicinal uses, chemical composition, pharmacological activities and clinical trial of Genus *Euphorbia*.

Methods: Data pertinent to the genus *Euphorbia* and its distinctive compounds were obtained from globally recognized scientific databases and esteemed publications via online platforms, including Web of Science, PubMed, MDPI, Springer Nature, Wiley Online Library, and Elsevier. The inquiry utilized the term "*Euphorbia*" alongside the following terms: "phenolic compounds," "flavonoids," "terpenoids," "alkaloids," "phenylpropanoids.

Results: Traditionally, the genus is used to treat skin diseases, cancer, diabetes, hypoglycemia, healing wounds, toothache. Four hundred and two compounds (402) were identified across the genus with dominant diterpenoids, triterpenoids, flavonoids and phenols. Compounds were found to be active against cancer cells, viruses, microbes and inflammation. Clinical trial show members of the genus to be effective against hemorrhoids, varicose veins, human nonmelanoma skin cancers, dengue and cracked feet.

Conclusions: The genus *Euphorbia* is a highly potential avenue of pharmacognostic research and drug discovery based on secondary metabolites. It has a vast chemical repertoire of various terpenoid compositions, which provides a good source of chemically diverse and clinically important compounds. It is also essential to conduct structure-activity relationship studies to determine the molecular characteristics that endow activity and to provide a means of rationally developing new derivatives.

Keywords: Compound, *Euphorbia*, Clinical trial, Plants

Background

Plants have been used in human medicine since ancient times, as they form most of the source of therapeutics in the entire population of the world (Dogara, 2023). In generation after generation, indigenous knowledge systems have recognized an

enormous pharmacopeia of plant species, which supposedly have healing properties, and have provided invaluable starting points in the quest of discovering a new drug (Dogara *et al.* 2024).

The genus *Euphorbia* (family Euphorbiaceae) is one of the best illustrations of a taxon with long ethnomedicinal history. It is currently among the largest and most morphologically diverse genera of flowering plants with more than 2000 species and is found in tropical, subtropical, and temperate regions (Riina *et al.* 2013). Many species of this genus have played a central role in conventional medical practices across the globe, being employed to treat a broad range of conditions such as skin conditions, wounds, gastrointestinal diseases, inflammation, and microbial infections (Jassbi, 2006; Yang *et al.* 2014). Many *Euphorbia* species secrete the characteristic milky latex, which is often the origin of any bioactivity reported, and indicates a refined knowledge of plant properties in traditional situations (Yang *et al.* 2014).

The rich history of traditional application has driven wide-ranging scientific investigation into the phytochemical basis of the action of *Euphorbia*. Studies have revealed a complex chemical composition filled with bioactive diterpenoids, triterpenoids, flavonoids and polyphenols (Anju *et al.* 2022). As a result, a considerable amount of *in vitro* and *in vivo* evidence has shown that these extracts and compounds have many pharmacological activities, including potent anticancer, anti-inflammatory, antimicrobial, and antioxidant properties (Chen *et al.* 2021; Li *et al.* 2022).

Although the biological activities of *Euphorbia* species crude extracts have been well documented in existing reviews (Amtaghri *et al.* 2022; Benjamaa *et al.* 2022; Kemboi *et al.* 2020; Shi *et al.* 2008), a direct correlation between individual phytoconstituents and their pharmacological activity has not been carried out. Moreover, there is no critical transition period between these well-defined compound activities and the application in humans that is studied. Hence, the review is the first to concentrate on biological activities of isolated compounds that are explicitly reported giving a clear mechanism of the bioactivity of the genus. Combining this compound-based methodology with a novel critical examination of human clinical trials, this study is the crucial step in filling this gap between phytochemistry, pre-clinical mechanism and clinical relevance.

Materials and Methods

Data pertinent to the genus *Euphorbia* and its distinctive compounds were obtained from globally recognized scientific databases and esteemed publications via online platforms, including Web of Science, PubMed, MDPI, Springer Nature, Wiley Online Library, and Elsevier. The inquiry utilized the term "*Euphorbia*" alongside the following terms: "phenolic compounds," "flavonoids," "terpenoids," "alkaloids," "antioxidant," "antidiabetic," "antimicrobial," "anticancer," and "anti-hyperlipidemic." The species nomenclature of *Euphorbia* was obtained from the https://www.worldfloraonline.org/ (WFO), and all pertinent literature was examined up to July 2025 to extract information concerning the biological activities and phytochemical elements of *Euphorbia* species. Articles referencing *Euphorbia* were included according to the defined criteria. Full-text papers were examined for the designated search phrases in their titles, abstracts, or whole contents. The genus *Euphorbia* encompasses a diverse array of species with documented ethnomedicinal uses, including *Euphorbia trigona* Mill, *Euphorbia lacteal* Haw, *Euphorbia canariensis* L, *Euphorbia resinifera* O.Berg, *Euphorbia milii* Des Moul, *Euphorbia tirucalli* L, *Euphorbia peplus* L, *Euphorbia helioscopia* L, *Euphorbia marginata* Pursh, *Euphorbia pulcherrima* Willd. ex Klotzsch, *Euphorbia amygdaloides* L, *Euphorbia characias* L, *Euphorbia macroclada* L, *Euphorbia craspedia* Boiss, *Euphorbia falcate* L, *Euphorbia dendroides* L, *Euphorbia wallichii* L, *Euphorbia thymifolia* L, *Euphorbia laurifolia* Lam, *Euphorbia prostrate* Aiton, *Euphorbia hirta* L, and *Euphorbia caducifolia* Haines. *Euphorbia allepica* L

Traditional Uses

The given information (Table 1) demonstrates the vast ethnobotanical importance of *Euphorbia* genus (*Euphorbia*) of which traditional uses have been reported in a wide geographical scope encompassing Europe, Asia, Africa, and the Americas. Regardless of morphological variations, the species under this genus show extraordinary convergence in their conventional applications especially in the treatment of skin related diseases and internal disorders. The latex is the most used part of the plant, a milky exudate rich and potent in phytochemical.

Table 1. Traditional uses of genus *Euphorbia*

Country	Species	Vernacular name	Parts used	Traditional uses	Methode of preparation and administration	Reference
Turkey	*Euphorbia peplus* and *E. geniculate*	Sütleğen and Ortega	roots, seeds, latex, stem wood, stem barks, leaves, and whole plants	migraine, intestinal parasites and as wart ewes	Cooked, boiled, applied directly to skin	(Özbilgin et al. 2012)
Hungary	*E. trigona*	háromélű kutyatej	aerial parts	skin disorder	Blended	(Hammadi et al. 2021)
China	*E. lactea*	guī wén jiàn, dì jǐn, lóng gǔ	leaves and stems	Digestive and respiratory disorders, inflammation, intestinal parasites, and tumors	Maceration	(Zhao et al. 2023)
Canary Islands	*E. canariensis*	Cardón	latex	skin warts	Applied directly, and used externally	(Alotaibi et al. 2024)
Morocco	*E. resinifera*	Zaggûm or Tikiu	Stems, fruits flowers, roots, leaves, stems, bark, and latex	cancer, diabetes, hypoglycemia, healing wounds, hair tonic, hair care	Poultice, Infusion, Powder, Infusion, Latex in water, decoction	(Hmidouche et al. 2023)
India	*E. milii*	Ainkona kalli (Tamil), Kanta Mukut (Bangla)	seeds, leaves and whole plant	trichiasis, hepatitis, cancer, ringworm and snake bites, and warts	Laxative, powder and whole Plant ashes are used, formulations	(Mahendiran et al. 2023)
Brazil	*E. tirucalli*	avelós	bark/latex, root, and stems	cancer, cancroids, epitheliomas, sarcomas, tumors, warts, skin diseases, and sexual impotent	Poultice, decoction, infusion	(Gupta et al. 2013)
Pakistan	*E. helioscopia*	gunda buti	leaves, seeds, stems and whole plant	skin diseases, warts, intestinal parasites, migraine, vermifuge, cholera, constipation and gonorrhea	Powder, topical (on skin), oral ingestion	(Mustafa et al. 2021)
Southern Africa	*E. marginata*		leaves and latex	astringent (leucorrhea), liniment for swelling, galactagogue (milk flow)	Infusion, chewing	(Kgosiemang et al. 2025)

Mexico	*E. pulcherrima*	Poinsettia	leaves and latex	Fevers, skin condition, and wounds	Decoction	(pulcherrima Photo et al.)
Italy	*E. amygdaloides*	Euforbia delle faggete	latex, seeds and roots	wart removal, toothache, wounds, and abscesses	Decoction, topical (sap)	(Gafforov et al. 2024)
Greece	*E. characias*	Tithymallos the Harakias	latex/sap and aerial parts	healing, anti-asthmatic, and antipyretic (fever-reducing)	Topical application, oral (purgative), applied externally	(Christodoulakis et al. 2015)
Indonesia	*E. hirta*	Daun biji kacang, Patikan kebo	leaves, roots and barks	female disorders, respiratory ailments (cough, coryza, bronchitis, and asthma), worm infestations in children, dysentery, jaundice, pimples, gonorrhea, digestive problems, and tumors	Boiled, decoction, topical or ingestion, poultice	(Kumar et al. 2010)
Iran	*E. macroclada*	Daghdaghan	Latex	wart treatment, wound healing, leukemia, asthma, skin diseases, tumors, and as an antidote to treat snake venom	Applied topically	(Rammal et al. 2013)
Lebanon	*E. craspedia*	Not available	Latex	toothache	Topically	(Paniagua-Zambrana et al. 2025), (Yeşil et al. 2021)
Algeria	*E. dendroides*	Tree spurge	Roots and latex	remove warts excising thorns, and as a fish poison	Applied directly, used internally as purgative, or as emetic (to induce vomiting)	(Ghout et al. 2018), (Benjamaa et al. 2022)
Pakistan	*E. wallichii*	Kaali Heerbi	leaves, roots and latex	treating edema, skin diseases, cutaneous anthrax, and exanthema	Fully topical, oral, decoction, infusion, poultice	(Hassan et al. 2016), (Pan et al. 2006)

India	*E. thymifolia*	laghududhika or choti-dudhi	leaves, seeds, roots and latex	blood purifier, sedative, hemostatic, aromatic, stimulant, astringent in diarrhea and dysentery, anthelminthic, demulcent, laxative, constipation, menorrhea gonorrhea, ringworm, skin diseases, and menstrual disorder	Powder, oral, decoction, infusion, poultice	(Mali et al. 2013)
Ecuador	*E. laurifolia*	Lechero tree	Latex	Skin warts	Applied topically	(Velázquez-Martí et al. 2018), (Avila et al. 2010)
Chile	*Euphorbia klotzschii*	Leche, Lecherito del campo Pastoleche, Verdulaga, Pastolechero, Lecheleche,	Latex	Wounds heal and to remove warts on the skin		(Echeverría et al. 2020)
	E. candelabrum	Mubububngu,	Stem, bark	The stem is used to expel the placenta, bark is used for skin diseases	Decoction	(Bussmann et al. 2021)
Georgia	*Euphorbia allepica*	რძიანა—Rdziana	Milky juice	Laxative		(Bussmann et al. 2024)

One of the most impressive cross-continental trends of traditional medicine is the application of *Euphorbia* latex as a means of getting rid of warts. This particular application was described independently in Canary Island (*E. canariensis*) practices (Alotaibi *et al.* 2024), Indian (*E. milii*) practices (Mahendiran *et al.* 2023), Brazil (*E. tirucalli*) practices (Gupta *et al.* 2013), Pakistan (*E. helioscopia*) practices (Mustafa *et al.* 2021), Iran (*E. macroclada*) practices (Rammal *et al.* 2013), Algeria (*E. dendroides*) practices (Ghout *et al.* 2018), and Ecuador (*E. laurifolia*) practices (Velázquez-Martí *et al.* 2018). The semiarid traditional populations resort to *E. tirucalli* to treat various diseases such as influenza, asthma, cough, intestinal parasites, earache and even skin tumors and even cancer. They make it in cataplasm form or in bottle form with the latex of the plant (da Silva Ribeiro *et al.* 2021). *Euphorbia esula* are used to treat a number of conditions; the powder is applied topically to treat tumors and is used in treating the tuberculosis and syphilis (Liu *et al.* 2020). The milky juice (latex) is applied as an external agent in the treatment of warts and calluses and the relief of leishmaniasis and scabies (Liu *et al.* 2020). The root is used as a laxative, a remedy against jaundice and heart disease (Liu *et al.* 2020).

This repeated application to virus-induced viral growths in independent cultures suggests a strong and effective antiviral or caustic effect in the latex of most species in this genus. In addition to warts, *Euphorbia* is commonly used in a wide variety of other dermatological concerns, such as general skin disease, wounds, abscess, and ringworm (Gafforov *et al.* 2024; Hassan *et al.* 2016; Kumar *et al.* 2010; Mahendiran *et al.* 2023; Mali *et al.* 2013; Mustafa *et al.* 2021).

The history of *Euphorbia* species usage goes well beyond the topical use. Additionally, they are traditionally used to treat parasitic and infectious diseases, especially anthelmintics against intestinal parasites in Turkey (*E. peplus, E. geniculata*) (Özbilgin *et al.* 2012), Pakistan (*E. helioscopia*) (Mustafa *et al.* 2021), and Indonesia (*E. hirta*) (Kumar *et al.* 2010). Moreover, many have been adopted in the treatment of digestive diseases (*E. thymifolia* in India against diarrhea and dysentery) (Mali *et al.* 2013) and respiratory diseases (*E. hirta* against asthma and bronchitis in Indonesia) (Kumar *et al.* 2010). Of great pharmacological value is the traditional use of some of the species in the treatment of severe systemic diseases, including cancer and tumors as recorded with *E. resinifera* in Morocco (Hmidouche *et al.* 2023), *E. milii* in India (Mahendiran *et al.* 2023), E. tirucalli in Brazil (Gupta *et al.* 2013) and *E. macroclada* in Iran (Rammal *et al.* 2013). Diabetes and hypoglycemia (*E. resinifera*) (Hmidouche *et al.* 2023), hepatitis (*E. milii*) (Mahendiran *et al.* 2023), and leukemia (*E. macroclada*) (Rammal *et al.* 2013). The extensive and converged historical utilization of these plants especially in treating contemporary diseases such as cancer, offers a solid ethnobotanical platform to expand

Botanical descriptions of the genus *Euphorbia*

Euphorbia spurge is one of the largest genera of flowering plants, consisting of more than 2000 species and widely distributed throughout the entire world, almost everywhere (Riina *et al.* 2013). Its species are very diversely shaped organisms, both in morphological terms, which do not exceed 15 cm in size, and in morphological terms, large, centennial, cactus-like succulents, referred to as evolutionary convergence (Riina *et al.* 2013). The most characteristic synapomorphy of the genus is the makeshift inflorescence known as a cyathium, a complex pseudanthium, which itself resembles a single, genuine flower (Webster, 1994).

The cyathium is composed of an involucre like cup with peripheral nectar glands that has often petals on it in search of attracting pollinators (Webster, 1994). The multiple highly reduced male flowers are crowded under the involucre on the pedicels, each bearing a single stamen (Evans *et al.* 1977). There is one, central, female flower, which has been reduced, to a single three-lobed ovary on a pedicel and grows through the middle of the cyathium (Evans *et al.* 1977). Almost all species contain a typical white or milky latex which is released on damage and is one of the most definitive key characters (Yang *et al.* 2011). This latex is generally poisonous and irritating and comprises a variety of diterpenoid esters that are a form of herbivore defense (Evans *et al.* 1977).

Vegetative morphology has been reversible; leaves typically simple and entire but leaves can be absent altogether in many succulent species where the stems are photosynthetically active. Its fruit is a unique, dehiscent, three-lobed capsule also known as a schizocarp that dries, splits and releases its seeds upon maturity. The seeds can be flexion or rectangular and have a caruncle, a fleshy projection that is used to disperse the seeds by ants (myrmecochory). In succulents, stipules become persistent spines which are the main defense mechanism, a primary difference between succulents and true cacti morphology. Phylogenetic analyses support *Euphorbia* to be a monophyletic group, and it is argued that its evolution to such a breadth of morphologies and distribution around the globe occurred due to the evolution of the cyathium and adaptive features such as succulence and latex (Althobaiti, 2023).

Chemical Composition

A thorough review of the literature summarized below reveals a total of 402 unique secondary metabolites that have been discovered over a variety of species (Table 2). The chemical composition of the *Euphorbia* genus, as described in the table, is dominated with the presence of terpenoid metabolism (diterpenoids + triterpenoids = approximately 225 compounds), which marks the chemical identity of the genus. This is accompanied by the presence of a high number of phenolic compounds (flavonoids + phenols = 72 compounds) that contribute to its antioxidant capacity (Fig. 1 and 2). The presents of other classes confirm that *Euphorbia* species are multi-faceted chemical factories with the capability to produce a broad spectrum of metabolites which clearly explains its broad spectrum of documented biological activities and ability to adapt to various ecological niches. These various compounds are always most abundant in the latex and aerial parts.

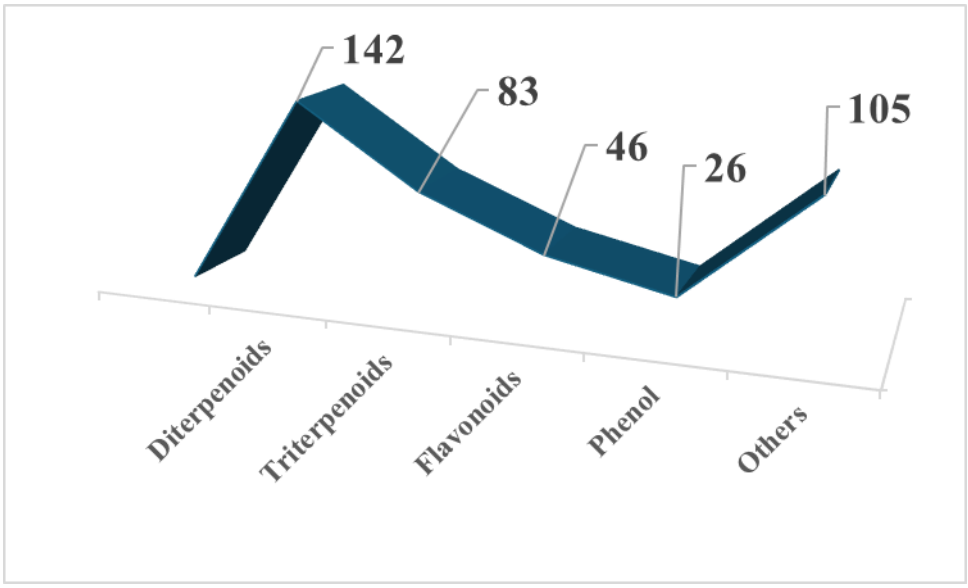
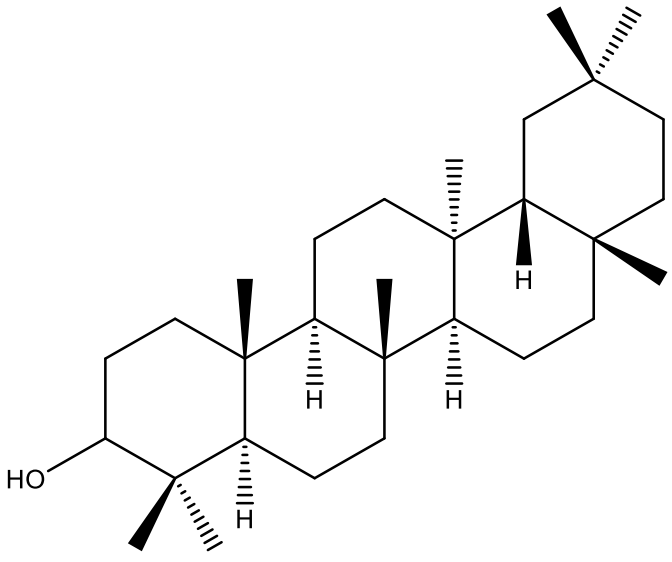


Figure. 1. Summary of major compound classes in genus *Euphorbia*: Note: The Numbers above represent the numbers of compounds in each class



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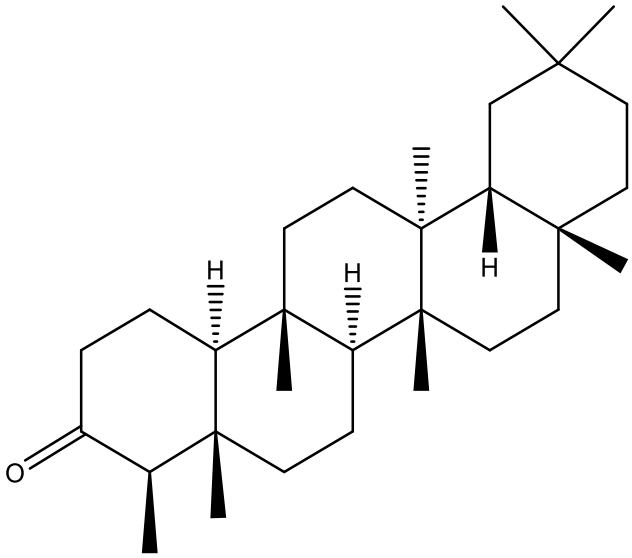

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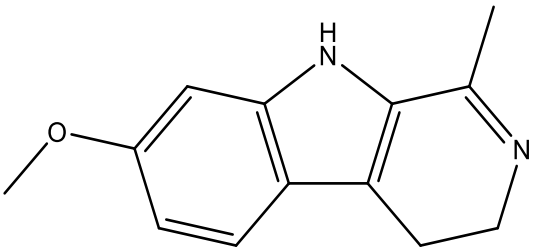

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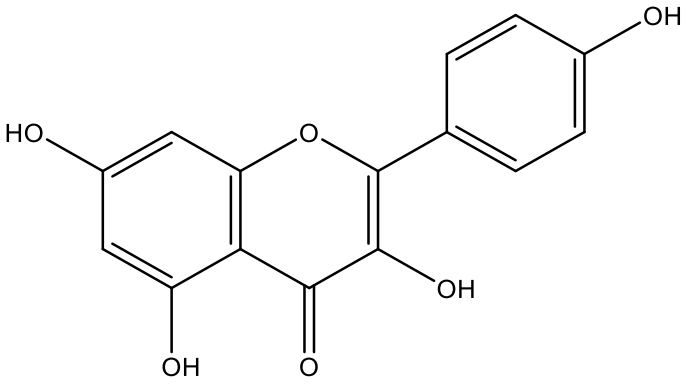

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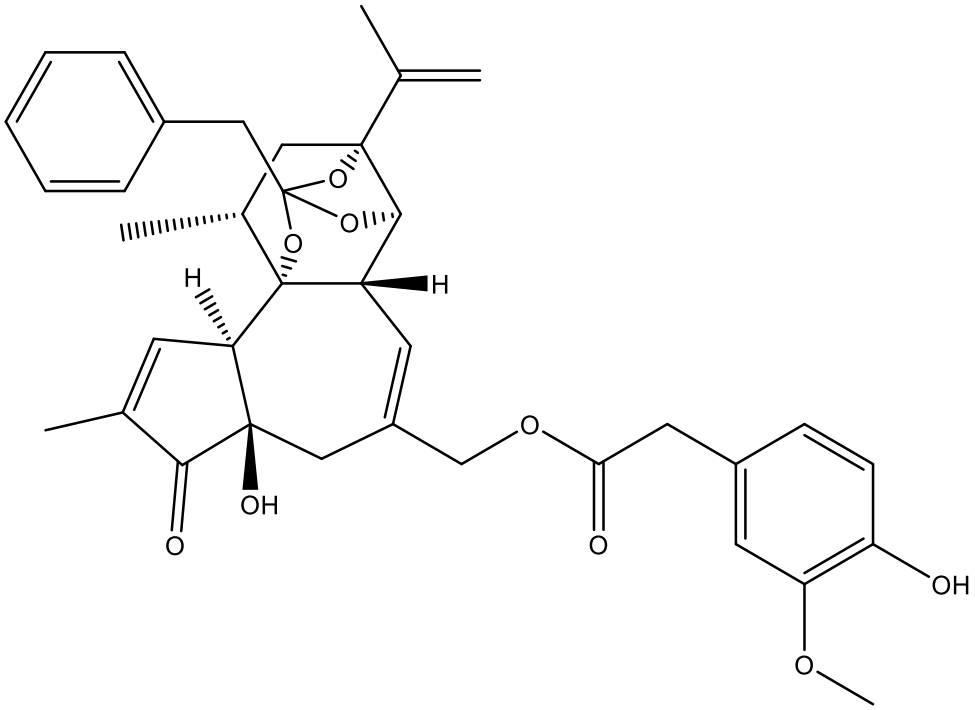

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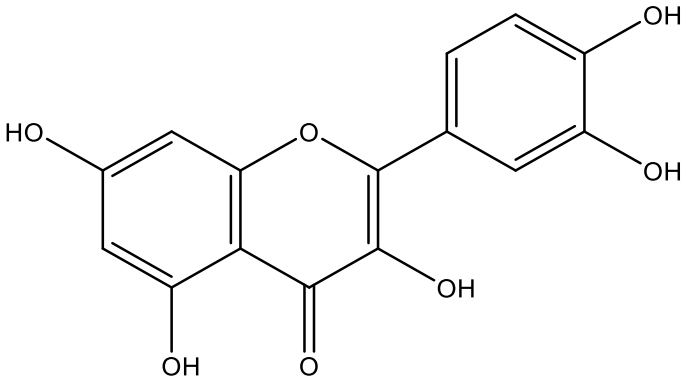

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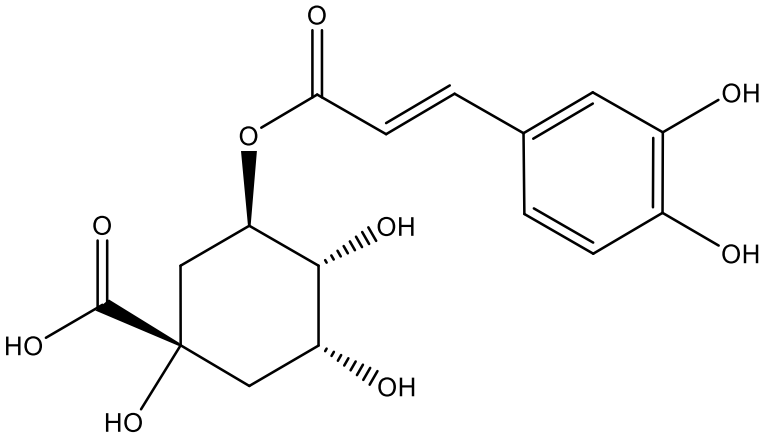

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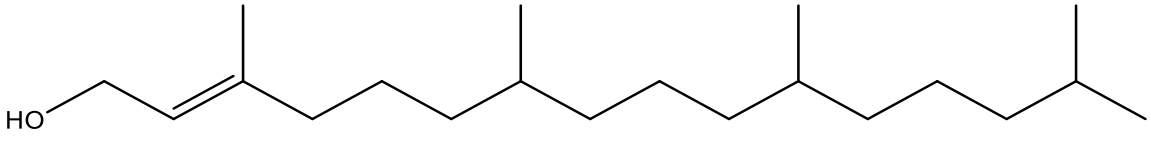

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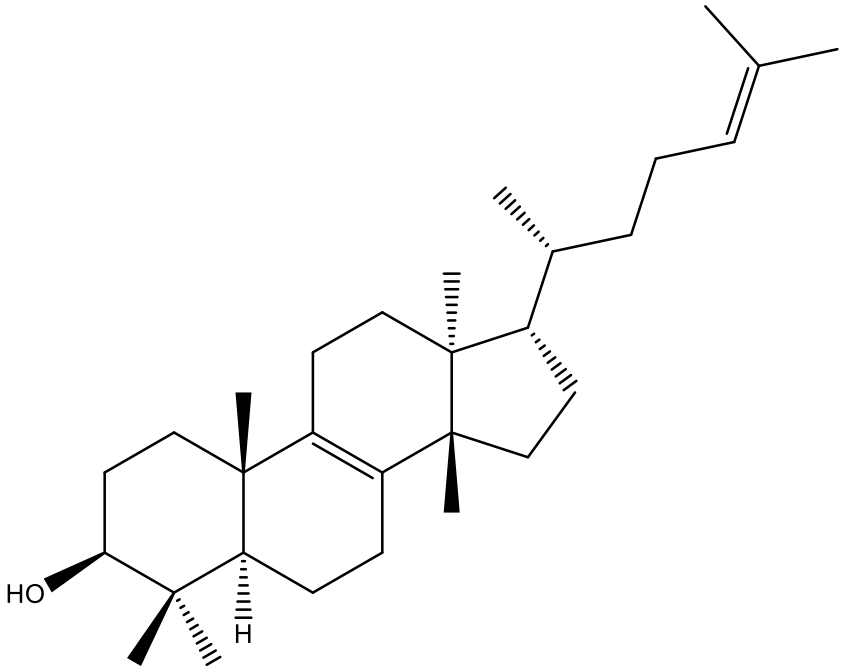

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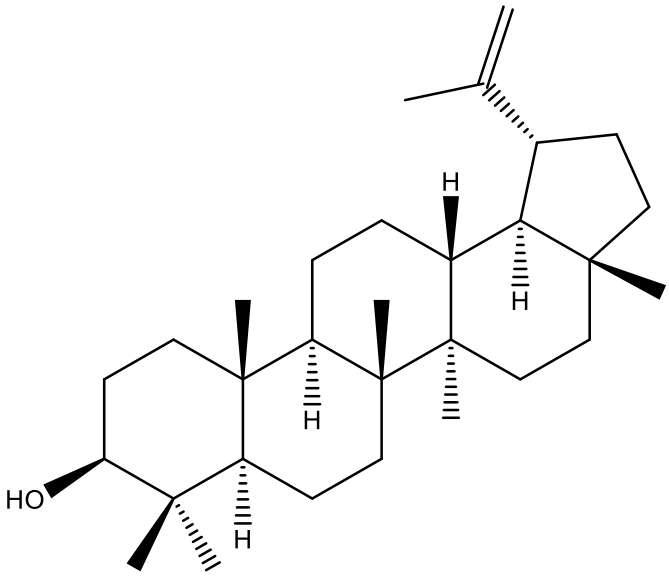

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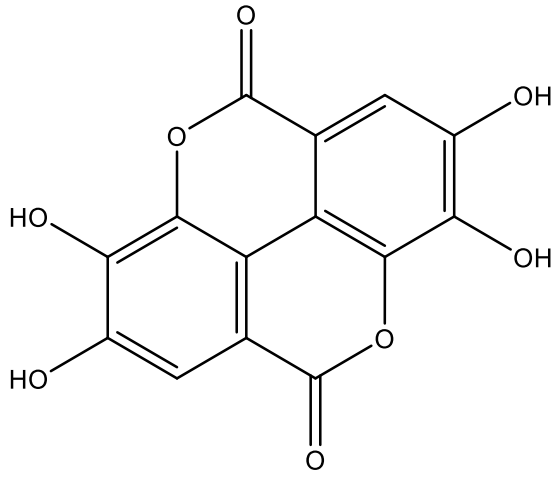

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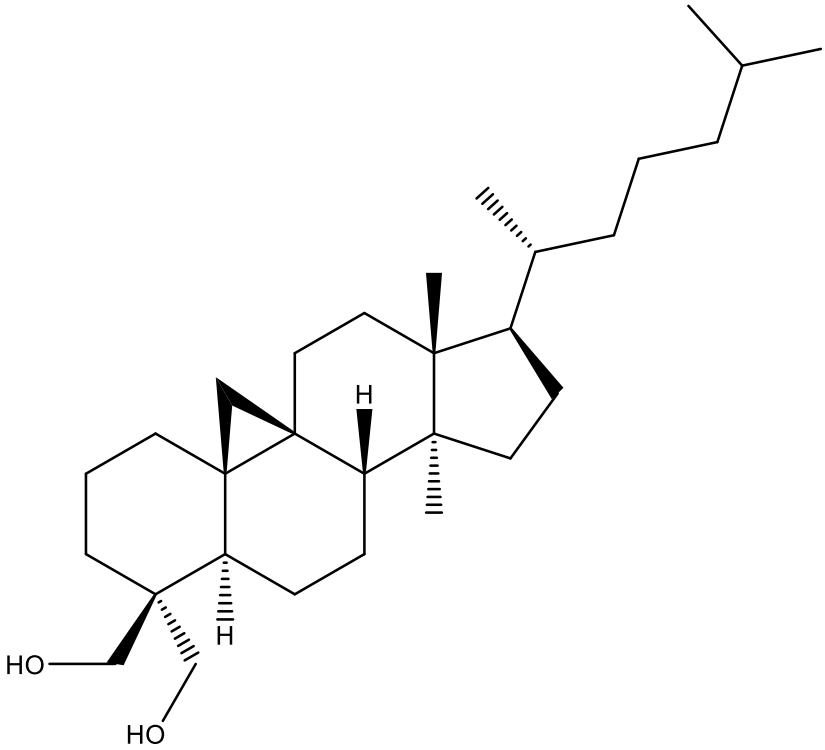

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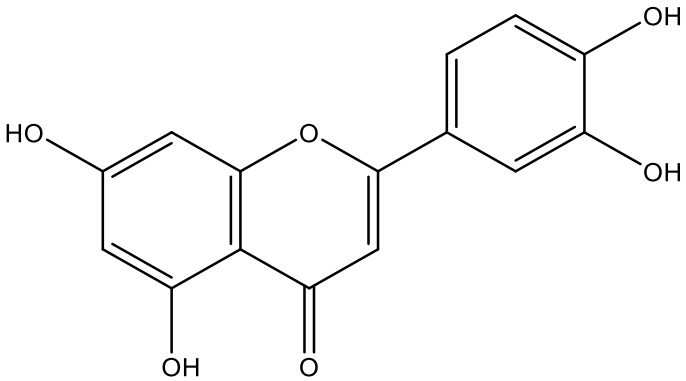

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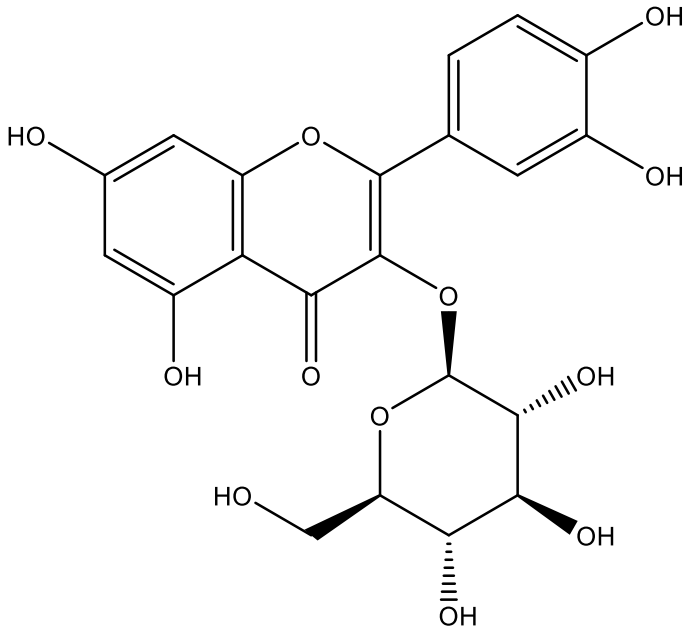

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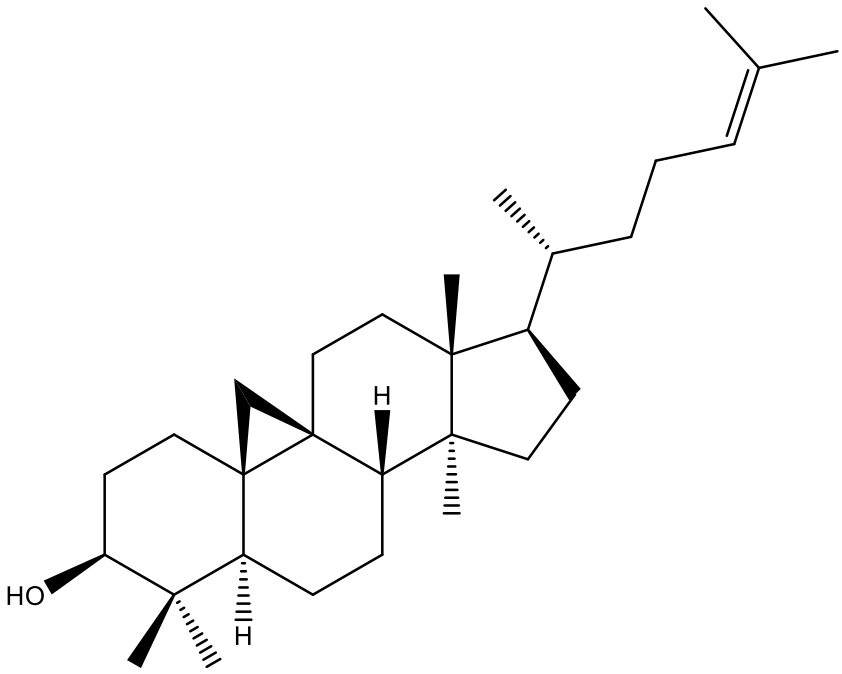

(O)

Fig.ure 2. Chemical structures of the major compounds identified from genus *Euphorbia*. (A) Taraxerol (B) Friedelin (C) Harmaline (D) Kaempferol (E) Resiniferatoxin (F) Quercetin (G) Chlorogenic acid (H) Phytol (I) Euphol (J) Lupeol (K) Ellagic acid (L) Cycloartane diols (M) Luteolin (N) Quercetin glycosides (O) Cycloartenol

Table 2. Chemical Composition of genus *Euphorbia*

Species	Parts of plant	Identification	Compound	Class	Reference
E. trigona	latex extracts	HPTLC	Epi-friedelinyl acetate, 3β-friedelinol, taraxerol, rhoiptlenone, stigmasterol and stearic acid	Triterpenoids	(Anju *et al.* 2022)
	Aerial parts	HPLC	17-0-acetyl-3-[(Z)-2-methyl-2-bu tenoyl]-20-deoxy-17-hydroxyingenol, 20-0-acetyl-3-0-(Z)-2-methyl-2 butenoyl]ingenol, 5, I 7,20-0-triacetyl-[(Z)-2-methyl-2 butenoyl]-17-hydroxyingenol, 3, 12-0-diacetyl-7-0-[(E)-2-methyl-2 butenoyl]-8,12-diepjingol	Diterpernes	(Tada *et al.* 1989)
	Aerial parts	HPLC	3,12-diacetate 7-tigliate, 8-O-methyl-ingol 3,12-diacetate 7-tigliate, 8-*O*-methyl-ingol 3,12-diacetate 7-benzoate, 3,7,12-triacetate 8-benzoate, 3,7,12-triacetate 8-tigliate, 17-acetoxyingenol 3-angelate 20-acetate, 17-acetoxyingenol 3 angelate 5,20-diacetate, 17-acetoxy-20-deoxyingenol 3-angelate, 17-acetoxy-20-deoxyingenol 5-angelate	Diterpernes	(Hammadi *et al.* 2021)
	Stem	Column Chromatography	Euphol, Cycloartenol, Cycloartanol, Lupeol, α-amyrin, β-amyrin, Betulinic acid, Taraxerol, β-sitosterol, Taraxerol acetate, Friedelin, Friedelan 3 α- and 3 βα-ols, 24-ethylene cycloartanol, Epi-friedelinyl acetate, 3β, Friedelinol, Rhoiptlenone	Triterpenoids	(Anjaneyulu *et al.* 1985; Nielsen *et al.* 1977)
E. lactea	Leaves	NMR and CG-MS	lanostan 8-24 dien, 3 b-ol	Triterpene	(Fernandez-Arche *et al.* 2010)
	Latex	TLC, NMR	3,12-di-O-acetyl-8-O tigloyl-ingol	Diterpene	(Avila *et al.* 2010)
	Latex	TLC, NMR	Friedelin, friedelan-3β-ol, taraxerol, and friedelan- 3α-ol,	Triterpenoidal	(Wongprayoon *et al.* 2022)
	Latecx (bud)	GCMS, HPLC	2,6 Octadiene,2,4-dimethyl-(1B2), 1H-Cycloprop[e]azulen-4 ol,decahydro-1,1,4,7-tetramethyl-,[1ar-(1aà,4á,4aá,7à, 7aá,7bà)]- (2B2)	Terpenoids	
			Euphlactenoid A,	Diterpenoids	(Zhao *et al.* 2023)
	Aerial	Silica gel column chromatography, ODS column chromatography, and gel LH-20 chromatography.	Euphorantin I, Jolkinolide E,	Diterpenoid	(XU *et al.* 2017)
	Aerial	Silica gel column chromatography, ODS column chromatography, and	3β-Hydroxy-25-methyloxylano-sta-8,23-diene, Inoterpene B,	Triterpenoid	(XU *et al.* 2017)

		gel LH-20 chromatography.			
	Aerial	Silica gel column chromatography, ODS column chromatography, and gel LH-20 chromatography.	3β-Hydroxystigmast-5-en-7-one	Steroid	(XU *et al.* 2017)
	Latex	TLC, NMR	3,12-di-O-acetyl-8-O-tigloyl-ingol,	Diterpene	(Ahmed *et al.* 1999)
		TLC, CC	3,12-di-O-acetylingol 8-tigliate, 3,5,16,20_tetraacetate, 16-hydroxyingenol	Diterpene	(Upadhyay *et al.* 1975)
		LC-HR/MS	2-epi-latazienone	Diterpenes	
E. canariensis	Latex	Column chromatography, TLC	2,3-diepiingol Abstract 7,12-diacetate-8-isobutyrate, ingenol-3-angelate- 17-benzoate, ingenol-3-angelate- 17-benzoate-20-acetate and 3,5,7,8,9,15-hexahydroxyjatropha-6(17),1 l-dien-14-one-5,8-bis(2- methylbutyrate)-7-(2-methylpropionate)	Diterpenes	(Miranda *et al.* 1998)
		LC-ESI-MS/MS	Triethanolamine , 1,2-aminoalcohols		(Alotaibi *et al.* 2024)
			Choline	Choline	
			Harmaline, trigonelline,	Alkaloids	
			Nicotine	Pyrrolidinylpyridines	
			4-hydroxy-3-methoxy cinnamaldehyde	Phenols	
			Kaempferol-3-O-alpha-l-rhamnoside, formononetin, (-)-riboflavin, genistein, daidzein, Acacetin-7-O-neohesperidoside, Naringenin, 3 3’ 4’ 5-tetrahydroxy-7-methoxyflavone	Flavonoids,	
			3-(4-hydroxy-3-methoxyphenyl) prop-2-enoicacid, 1-O-b-d-gluco pyranosyl sinapate	hydroxycinnamic acids	
			Scopoletin, daphnetin, 3,4-dimethoxycinnamic acid	Coumarins	
			Caffeine	Xanthines	
			Chlorogenic acid	Quinic acids	
			4-Aminohippuric acid	Hippuric acids	
			All-trans-retinoic acid	Retinoids	
			Syringaldehyde	Methoxyphenols	
			Leupeptin hemisulfate salt	Dipeptides	
	Latex	Droplet countercurrent chromatography., NMR	3-O-acetyl-16-0-benzoyl-20-0-[(Z)-2-methyl-2-butenoyl]-16-hydroxyingenol, 3-0-[(Z)-2-methyl-2-butenoyl]-16-0-benzoyl-l6-hydroxyingenol, and 3-0-acetyl-20-0-[(2)-2- methyl-2-butenoyl]ingenol	Diterpenoids	(Lin *et al.* 1983)

E. resinifera	Terpenoids	UHPLC–HRMS-	12-Deoxy-16 hydroxyphorbol 13,16-diesters	Diterpenoid	(Ezzanad *et al.* 2021)
		Column chromatography, NMR	Euphorbioside, euphorbioside-9-(3-dimethylamino-benzoate), euphorbioside-9-(4-dimethylamino-benzoate) (3), euphorbioside-9-(2-methylamino-benzoate) and euphorbioside -9-(4-methylamino-benzoate).	Diterpenoid	(Farah *et al.* 2014)
	Stem (Latex)		Euphorbioside A, Euphorbioside B	Terpenoids	(Fattorusso *et al.* 2002)
	Aerial part	HPLC	Ingenol	Terpenoids	(Girin *et al.* 1993)
	Latex	Column Chromatography	3β-hydroxy-12α-methoxylanosta-7,9(11),24-triene, 3β-hydroxy-12α-methoxy-24-methylene-lanost-7,9(11)-dien, 3,7-dioxo-lanosta-8,24-diene, and 3,7-dioxo-24-methylene-lanost-8-en	Terpenoids	(M.-M. Li *et al.* 2021)
	Latex	HPLC-DAD	Euphatexol, Euphatexol, Euphatexol, Euphatexol, Euphatexol	Terpenoids	(Li *et al.* 2022)
	Latex	HPLC-DAD, LC-MS	Euphol, Euphorbol	Terpenoids	(Mallon *et al.* 2014)
	Latex	HPLC	latazienone, 2-epi-latazienone , 15β-acetoxy-7β-nicotinoyloxy-3β,8α-di-(2-methylpropanoyloxy)-4αH,9αH,11αH-lathyra 5E,12E-dien-14-one	Diterpenes	(Durán-Peña *et al.* 2017)
	Latex		Resiniferatoxin, Proresiniferatoxin, Resiniferonol, 2-deoxy-phorbol-13-angelate 12-deoxy-phorbol-13-isobutyrate	Terpenoids	(Hergenhahn *et al.* 1975)
	Latex	Gas Chromatography, Column Chromatography	Ingenol-3-acylates, 12-deoxyphorbol-13-ester-20-acetates	Terpenoids	(Hergenhahn *et al.* 1984)
	Latex	HPLC	Cycloartan-1,24-diene-3-one, cycloartan-1,24-diene-3-ol, 3β-hydroxy-lanosta-8,24-diene-11-one, lnonotusane C, eupha-8,24-diene-3β-ol-7,11-dione, eupha-24-methylene-8-ene-3β-ol-7,11-dione, and eupha-8,24-diene-3β,11β-diol-7-one.		(Li *et al.* 2021)
	Latex	Gas chromatogram	Phorbic Acid, Glycoside, Lipid, Euphorbioside C	Terpenoids	(Nordal *et al.* 1969)
	Latex	column chromatography	Euphatexol A, Euphatexol B		(Ourhzif *et al.* 2021)
	Latex	GCMS	Ethyl linoleate, Methyl arachidonate, Methyl ester 9,11-(1,1´-bicyclopropyl)-octanoic acid	Fatty Acid Ester	(Talbaoui *et al.* 2020)
			,3,4-Trimethyl-3-cyclohexanyl-1-carboxaldehyde, 1,3,4-Trimethyl-3-cyclohexanyl-1-carboxaldehyde	Terpenoid	(Talbaoui *et al.* 2020)
			1 Heptacosane	Hydrocarbon	(Talbaoui *et al.* 2020)
			Ledane, Cis-Z-α-Bisabolene epoxide	Sesquiterpenoid	(Talbaoui *et al.* 2020)

			1,4-bis-(2′-cyclopropyl-2′-methylcyclopropyl)-but-2-en-1-one	Unsaturated Bis-Ketone	(Talbaoui *et al.* 2020)
	Latex	RP-HPLC	Euphorol A, .Euphorol B(2), Euphorol C, Euphorol D, Euphorol E, Euphorol F, Euphorol G, Euphorol H , Euphorol	Terpenoids	(Wang *et al.* 2016)
	Latex	HPLC	3*β*-hydroxy-25,26,27-trinor eupha-8-ene-24-oate, iso-maticadienediol, 25,26,27-trinorTirucall-8-ene-3*β*-ol-4-acid, dammarendiol Ⅱ (4), eupha-8,24-diene-3-ol-26-al, lnonotusane C, eupha-8,24-diene-3*β*-ol-7,11-dione, inoterpene A, inoterpene B, and eupha-24-methylene-8-ene-3*β*-ol-7,11-dione	Terpenoids	(S.-Y. Wang *et al.* 2018)
	Latex	HPLC	Euphorol K, Euphorol J, Kansuinone	Terpenoids	(Wang Huang *et al.* 2019)
	Latex	HPLC	Euphoresins A, Euphoresins B,	Diterpenes	(Wang Li *et al.* 2019)
	Latex	HPLC	Euphorblin A, Euphorblin B, Euphorblin C, Euphorblin D, Euphorblin E, Euphorblin F, Euphorblin G, Euphorblin H, Euphorblin I, Euphorblin J, Euphorblin K, Euphorblin L, Euphorblin M, Euphorblin , Euphorblin O, Euphorblin P , Euphorblin Q	Terpenoids	(Zhao *et al.* 2021)
	Latex	Column chromatography	12-deoxyphorbol-13-angelate-20-acetate, 12-deoxyphorbol-13-isobutyrate-20-acetate, 7-*p*-metoxyphenylacetate-3,8,12-triacetate ingol, resiniferatoxin, deglucosyl euphorbioside A, euphorbioside A	Terpenoids	(Ourhzif *et al.* 2022)
	Latex	Column chromatography	catechol, protocatechuic acid, 3,4 dihydroxy-phenylacetic acid	Phenolic	(Ourhzif *et al.* 2022)
	Dried latex	HPLC	Euphorblin A, euphorblin D, euphorblin L, euphorblin N, euphorblin Q		(Zhao *et al.* 2018)
	Latex	UHPLC-HRMS	2-Deoxy-16-hydroxyphorbol 13,16-diacyl derivatives, 12-Deoxy-16-hydroxyphorbol 20-acetate 13,16-diacyl derivatives, 12-Deoxyphorbol 13-acyl derivatives, 12-Deoxyphorbol 20-acetate 13-acyl derivatives, 12,20-Dideoxyphorbol 13-acyl derivatives		(Ezzanad *et al.* 2023)
	Latex		Euphatexols A, Euphatexols B	Triterpenoids	(Qi *et al.* 2019)
E. milii	Aerial and root	UHPLC-MS	Eremopetasitenin A1	Sesquiterpene	(Saleem *et al.* 2019)
	Aerial	UHPLC-MS	Lusitani coside	Phenolic	(Saleem *et al.* 2019)
		UHPLC-MS	Fraxetin	Coumarin	(Saleem *et al.* 2019)
		UHPLC-MS	Megastachine	Alkaloid	(Saleem *et al.* 2019)

	UHPLC-MS	Peruvoside	Glycoside	
Root	UHPLC-MS	dichotosinin, abruquinone B, kaempferol 3-(6''-acetylglucoside)-7-glu coside, kaempferide 5-glucoside-7-glucuronide and herbacetin 8 acetate	Flavanoids	(Saleem *et al.* 2019)
Root	UHPLC-MS	Dihydroferulic acid 4-sulfate, ellagic acid and li cochalcone A	Phenolic	(Saleem *et al.* 2019)
Aerial	LC-MS/MS	D- (+)-Malic acid, Suberic acid, Citraconic acid	Organic acid	(Hassan *et al.* 2023)
Aerial	LC-MS/MS	Chlorogenic acid, Rosmarinic	Phenol	(Hassan *et al.* 2023)
Aerial	LC-MS/MS	Aesculetin	Coumarin	(Hassan *et al.* 2023)
Aerial	LC-MS/MS	Quercetin-3-glucuronide, Kaempferol-3-glucuronide, Hesperetin-7-O-neohesperidoside, Hesperetin, Isoquercitrin, Quercetin-3-D-xyloside, (+)-Taxifolin, Quercetin, Apigenin, Isorhamnetin-3-O-glucoside, Quercetin-4'-glucoside, Phlorizin, Quercitrin, Luteolin, Naringenin		(Hassan *et al.* 2023)
Aerial	GCMS	cis-4-Methylcyclohex-3-ene-1,2-diol	Monoterpenes	(Hassan *et al.* 2023)
Aerial	GCMS	cis-Sesquisabinene hydrate, Patchoulane, (-)-Caryophyllene oxide	Sesquiterpenes	(Hassan *et al.* 2023)
Aerial	GCMS	cis-Phytol, Phytol	Diterpenes	(Hassan *et al.* 2023)
Aerial	GCMS	1-Tetradecene, (cis)-2-nonadecene, Tridecane	Alkanes	(Hassan *et al.* 2023)
Aerial	GCMS	Heneicosanoic acid, methyl ester, Linoleic acid, methyl ester, Oleic acid, methyl ester, cis-Oleic Acid	Fatty acid	(Hassan *et al.* 2023)
Aerial	GCMS	1-Tridecanol, 11-Hexadecen-1-ol, (Z), 1-Hexadecanol, E-7-Tetradecenol	Alcohols	(Hassan *et al.* 2023)
Aerial	GCMS	Oxirane, [(dodecyloxy)methyl], Z-(13,14-Epoxy)tetradec-11-en-1-ol acetate	Epoxides	(Hassan *et al.* 2023)
Aerial	GCMS	1,2-Benzenedicarboxylic acid, dibutyl ester, Octacosanoic acid, 2,4,6,8-tetramethyl-, methyl ester	Esters	(Hassan *et al.* 2023)
Aerial	GCMS	7,8-Epoxylanostan-11-ol,3-acetoxy, 9,19-Cyclolanostan-3-ol, acetate, (3á)-	Terpenoids	(Hassan *et al.* 2023)

			Glutinol, Friedelan-3-ol, Friedooleanan-3-ol, Lupenone, Lupeol acetate, Glutinyl acetate,	Triterpenoids	(Hujon *et al.* 2022)
			D:A-Friedooleanan-28-acetate, 3 beta hydroxyl, Friedooleanan-3-acetate		
			Tricosane, Octacosane, Hentriacontane, Tritriacontane, Hexacosane, Heptacosane, Tetratriacontane, Cyclotetacosane, 3-Octadecene,-Eicosene, 1-Dococene	Alkanes	
E. tirucalli	Aerial	HPLC	Ferulic acid	Phenol	(De Araújo *et al.* 2014)
	Aerial		1-O-galloyl- -D-glucoside, 1,2,3-tri-O- galloyl- -D- glu co – side, pedunculagin, 1 2,3-(S)-hexahydroxydiphenoyl- D-glucopyranosid, gallic acid, putranjivain A, 3 corilagin, casuariin, putranjivain B, 3,3 -di-O-methyl gallic acid, quercitrin, rutin, 5-desgalloylstarchyurin, 3,3 ,4-tri-O-methyl- 4 -O-rutinosyl ellagic acid	Phenol	(Lin *et al.* 2001)
	Aerial	HPLC	12-*O*-(2*E*,4*E*,6*E*,8*E*-tetradecatetraenoyl)-13-*O*-isobutyroyl-4*β*-deoxyphorbol , 13-O-acetyl-12-O-(2Z,4E-octadienoyl)-4b-deoxyphorbol, 13-O-acetyl-12-O-(2Z,4E-octadienoyl)-4a-deoxyphorbol , 4b-deoxy-phorbol-13-acetate, 4a-deoxy-phorbol-13-acetate , 3-O-(2,4,6,8-tetradecatetraenoyl) ingenol)	Diterpenoid	(Weng *et al.* 2022)
	Aerial	GC-MS, ESI-(-)-FT-ICR MS and (-)-ESI-LTQ-MS/MS.	euphol/tirucalol, lupen-3-one (B), lupeol, glutinol e friedeline	Triterpenes	(de Souza *et al.* 2023)
	Aerial	GC-MS, ESI-(-)-FT-ICR MS and (-)-ESI-LTQ-MS/MS.	Ellagic acid	Phenol	(de Souza *et al.* 2023)
	Latex	GCMS	4- (allyloxy) -2- methyl-2-pentanol	Ether Alcohol	(Stracke *et al.* 2021)
	Latex	GCMS	lanosterol and 4H-Piran-4-one,	Terpenoids	(Stracke *et al.* 2021)
	Latex	GCMS	2,3-dihydro-3,5-dihydroxy- 6-methyl	Heterocyclic Organic Compound	
	Stem	GCMS	lanosta-8,24-dien-3-ol, (3β),	Terpenoids	(Yusoff *et al.* 2017)
	Stem	GCMS	(23S)-ethylcholest-5-en-(3β)-ol	Sterol	(Yusoff *et al.* 2017)
	Stem	GCMS	Linoleic acid	Fatty acid	

	Stem	GCMS	Viminalol	Sesquiterpenoid	(Yusoff *et al.* 2017)
E. peplus	Whole plant		Euphopepluanone L,	Diterpenoid	(Min *et al.* 2021)
		HPLC	Paralianone A, paralianone B, paralianone C, paralianone D, pepluanol A, pepluanol B, pepluanol C, pepluanol D, pepluanol E, pepluanol F, pepluanol G, pepluanol H), 5,8,14-triacetoxy-3-benzoyloxy-15- hydroxy-9-oxoparapliane 5,8,9,15-tetraacetoxy-3-ben-zoyloxy-11,16-dihydroxypepluane, 5,8,11,15-tetraacetoxy-3-benzoyloxy-9,16-dihydroxypepluane , 5,8,9,11,15-pen-taacetoxy-3-benzoyloxy-16-hydroxypepluane ,7 and peplua-none	Diterpenoid	(Wan *et al.* 2016)
	Aerial	HPLC	Simiarenol, 1-hexacosanol, β-sitosterol, and β-sitosterol-3-*O*-glucoside	Terpenoids	(Amin *et al.* 2017)
	Whole plant	HPLC	11,12-didehydro-8a,14-dihydro-7-oxo-helioscopinolide A, 7a-hydroxy-8a,14- dihydro jolkinolide E, 8b-acetyl-paralianone D, helioscopinolide A, 11-hydroxy-ent-abieta-8,11,13-trien-15-one, paralianone, paralianone D	Diterpenoid	(Chen *et al.* 2021)
E. helioscopia	Whole plant	HPLC	7-,9R,14-triacetoxy-3-benzoyloxy-12-,15-epoxy-11-hydroxyjatropha-5E, 14β-acetoxy-3 β -benzoyloxy-7 β,9R,15 β -trihydroxyjatropha-5E,11E-die, 7 β,9R,14 β -triacetoxy-3 β -benzoyloxy-15 β,17-dihydroxyjatropha-5E,11E-die, 14R,15 β -diacetoxy-3 β,7 β -dibenzoyloxy-17- hydroxy-9-oxo-2 β H,13 β Hjatropha-5E,11E-diene, s: euphornin (3a), euphornin A, euphornin B (2a), euphornin G, euphohe-liosnoid A, euphoheliosnoid B, euphoheliosnoid C, euphoscopin A, euphoscopin B, euphoscopin C (4a), euphoscopin E,7 euphoscopin J, helioscopinolide A (5)	Diterpenoids	(Lu *et al.* 2008)
	Whole plant		liosnoid D, euphornin, euphornins B, euphornins C, euphoscopins A—C, euphoscopins(F and J, epieuphorscopins A and B, euphohelio-scopin A, helioscopinolide B, 2a-hydroxy helioscopinolide B, hemistepsin , y 4,5-dihydroblu-menol A, aglycone of icariside B2,	Diterpenoids	(Zhang *et al.* 2006)
	Whole plant		licochalcone A, 2,4,4-trihydroxy-chalcone , echinatia, licochalcone B, glabrone , 4,5,7-trihydroxyflavanone,	Flavonoids	(Zhang *et al.* 2006)
	Whole plant	HPLC	euphelionolide A, euphelionolide B, 3α,9,17-trihydroxyjolkinolide E, 3 β,9,17-trihydroxyjolkinolide E, euphelionolide F, 6a-hydroxyhelioscopinolide H, Euphelionolide H, Euphelionolide I, Euphelionolide J, Euphelionolide K, Euphelionolide L, Euphelionolide M, Euphelionolide N, 16-epi-18-hydroxy-abbeokutone, . Eupheliotriol A, Eupheliotriol B, 3a,9,18-trih 3a,7b-dihydroxyjolkinolide E, ent-16b,17-dihydroxyatisan-3-one, eurifoloid Q, ingenol, 20-O-acetylingenol	Diterpenoids	(Wang *et al.* 2018)

	Whole plant	HPLC	Helioscopinolides A, B and C,	Diterpenes	(Shizuri *et al.* 1983)
	Whole plant	HPLC	Euphopias A–C (1–3),	Diterpenoids	(Shi *et al.* 2020)
	Whole plant	HPLC	Euphoscopin A (1), epieuphoscopin A, euphornin G, euphohelioscopin H, euphohelionone I, euphohelioscopin J, euphohelioscopin K	Diterpenoids	(Yamamura *et al.* 1989)
	Whole plant	HPLC	Helioster-penoids A and B (1 and 2), Euphzycopin A, euphzycopin B, Euphzycopin C, euphzycopin D,		(Mai *et al.* 2017) (Qiu *et al.* 2024)
E. marginata	Seed		3-de-*O*-acetyleuphornan R, euphornans E and N	Diterpenoid	(Liu *et al.* 2023)
E. pulcherrima	Leaves	HPTLC	9,19-cycloart-23-ene-3J1,25-diol, 9,1 9-cycloart-25-ene-3JJ,24-diol	Triterpenoids	(Smith-Kielland *et al.* 1996)
	Stem bark		3,5,7-trihydroxy-2-(4-hydroxy-3-methoxyphenyl)-6-methoxy-4H-chromen-4-one (1), 2-(3,4-dihydroxy phenyl)-3,5,7-trihydroxy-6-methoxy-4H-chromen-4-one (2)		(Rauf *et al.* 2022)
	Whole plant	GCMS	3-Fluorophenyl 2-fluoro-6-(trifluoromethyl)benzoate, 1,2-Dimethyl-3-(prop-1-en-2-yl)cyclopentane, 4a,8,8a-Trimethyl-2-(prop-1-en-2-yl)-1,2,3,4,4a,5,6,8a octahydronaphthalene	Others	(Sharif *et al.* 2015)
	Whole plant	GCMS	2-(tert-Butyl)-6-methyl-4H-1,3-dioxin-4-one, 7,9-Di-tert-butyl-1-oxaspiro[4.5]deca-6,9-diene-2,8-dione, 7,9-Di-tert-butyl-1-oxaspiro[4.5]deca-6,9-diene-2,8 dione	Flavonoid	(Sharif *et al.* 2015)
	Whole plant	GCMS	4-(((Tetrahydrofuran-2-yl)methyl)amino)-1-oxaspiro[4.5]dec-3-en-2-one, O-(3-(tert-Butyl)cyclohexa-2,4-dien-1-yl) (6-methoxypyridin-2-yl)(methyl)carbamothioate, (E)-1,2-Bis(5-methylbenzo[d]oxazol-2 yl)ethene	Alkaloid	(Sharif *et al.* 2015)
	Whole plant	GCMS	Bis(4-methylheptan-3-yl) phthalate, Menthyl acetate, 2,4,4-Trimethylpentyl 2-ethylbutanoate, 2,2,6-Trimethyl-7-(prop-1-en-2-yl)cyclooctane-1,5-dione,Heptan-3-yl isobutyl phthalate, Butyl heptan-3-yl phthalate, Bromophenylheptylphthalate, , Oleamide, Bis(2-ethylhexyl) phthalate, Diisobutyl phthalate, Diisobutyl phthalate, Dibutyl phthalate, Heptan-4-yl isobutyl phthalate, Dibutyl phthalate, Diisobutyl phthalate, 5-Methyl-5-(4,8,12 trimethyltridecyl)dihydrofuran-2(3H) one, Bis(2-ethylhexyl) phthalate	Wax	
	Whole plant	GCMS	2,4-Di-tert-butylphenol	Phenol	(Sharif *et al.* 2015)
	Whole plant	GCMS	4,4,6a,6b,8a,11,11,14b-Octamethyl	Steroid	

			1,2,3,4,4a,5,6,6a,6b,7,8,8a,9,10,11,12,12a,14,14a,14b icosahydropicen-3-ol, 4,4,6a,6b,8a,11,11,14b-Octamethyl 1,2,3,4,4a,5,6,6a,6b,7,8,8a,9,10,11,12,12a,14,14a,14b icosahydropicen-3-ol, 4,4,6a,6b,8a,11,11,14b-Octamethyl 1,2,3,4,4a,5,6,6a,6b,7,8,8a,9,10,11,12b,13,14,14a,14b icosahydropicen-3-ol, (8S,9S,10R,13R,14S,17R)-17-((2R,5R)-5-Ethyl-6-methylheptan 2-yl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17 tetradecahydro-1H-cyclopenta[a]phenanthren-3-yl nonadecanoate, 2a,5a,8,8-Tetramethyl-3-(6-methylheptan-2 yl)hexadecahydrocyclopenta[a]cyclopropa[e]phenanthrene		
	Whole plant	GCMS	Lup-20(29)-en-3-ol, acetate, 4-(3-Hydroxy-3-methylpentyl)-3,4a,8,8 tetramethyldecahydronaphthalen-1-ol, 3a-(Hydroxymethyl)-5a,5b,8,8,11a-pentamethyl-1-(prop-1-en 2-yl)icosahydro-1H-cyclopenta[a]chrysen-9-ol.	Saponin	(Sharif *et al.* 2015)
			Eupulcherol A	Triterpenoid	(Yu *et al.* 2020)
E. amygdaloides	Leaves, stems,	HPLC, LC-MS-MS	(9)-8a-((benzoyloxy)methyl)-2-methoxy-4,9-dimethyltetrahydro-4H,5H-2,4a-methanobenzo[d] [1,3] dioxine-4-carboxylate (Zagrosin I), ((9)-4-hydroxy-2-methoxy-4,9-dimethyltetrahydro-4H,8aH-2,4a-methanobenzo[d] [1,3] dioxin-8a-yl) methyl benzoate (Zagrosin II), and (9)-2-methoxy-4,9-dimethyl-8a-(phenoxy methyl) tetrahydro-4H,5H-2,4a-methanobenzo[d][1,3]dioxin-4-yl 4-methylpentanoate (Zagrosin III).	Terpenoid	(Pasdaran *et al.* 2025)
E. characias	Leaves, stem		3-rhamno-side-, 3-arabinoside		(Appendino *et al.* 2000)
	Whole plant	HPLC	Gallic acid, quercetin, chlorogenic acid, caffeic acid,	Phenol	(Taib *et al.* 2022)
	Whole plant	HPLC	Kaempferol, myricetin	Flavonoid	(Taib *et al.* 2022)
E. macroclada	Whole plant	HPLC	Ellagic acid, ferulic acid, gallic acid, chlorogenic acid, caffeic acid,		(Taib *et al.* 2022)
	Whole plant	HPLC	Kaempferol, myricetin	Flavonoid	(Taib *et al.* 2022)
E. craspedia	Whole plant	HPLC	Ellagic acid, gallic acid, chlorogenic acid, caffeic acid,		(Taib *et al.* 2022)
	Whole plant	HPLC	Quercetin	Flavonoid	(Taib *et al.* 2022)
E. falcata	Whole plant	HPLC	Gallic acid, chlorogenic acid, caffeic acid, kaempferol, myricetin, quercetin	Phenol	(Taib *et al.* 2022)
E. falcata	Whole plant	HPLC	Kaempferol, myricetin, quercetin	Flavonoid	(Taib *et al.* 2022)
E. dendroides	Aerial	LC-ESI-MS/MS	Luteolin, quercetin-3-*O*-*β*-d-glucuronopyranoside, kaempferol-3-*O*-*β*-d-glucuronopyranoside, Isorhamentin-3-O-pentoside, Quercetin-3-O- hexuronide 6"-O-methyl ester, Kampferol-3-O-hexuronide 6"-O-methyl ester,	Flavonoid	(Hassan 2022)
E. dendroides	Aerial	LC-ESI-MS/MS	Vanillin, gallic acid, *trans*-caffeic acid, protocatechuic acid	Phenol	(Hassan, 2022)

		GCMS, NMR	3b-hydroxycycloart-24-ene-23-methyl ether, palmitic acid, oleic acid, lupeol, 24-methylene cycloartan-3*β* –ol, *β* -sitosterol, cycloart-23-ene-3 *β*,25-diol monoacetate, cycloart-23-ene-3 *β*,25-diol, 3 *β* -hydroxy-cycloart-23-ene-25 methyl ether, 24 R/S-3b-hydroxy-25-methylene cycloartan-24-ol	Triterpenoid	(Hassan *et al.* 2022)
	Leaves	HPLC	Luteo.6-arabinose 8-glucose, luteo.6-glucose 8-arabinose, apig.6-arabinose 8-glactose, apig.6-rhamnose 8-glucose, luteo.7-glucose, narengin, rutin, hespiridin, quercetin-3-O-glucoside, rosmarinic acid, apig.7-O-neohespiroside, kamp.3,7-dirhamnoside, apig.7-glucose, quercetrin, quercetin, naringenin, hespirtin, kampferol, rhamnetin, apegnin, acacetin.	Flavonoid	(Ali *et al.* 2025)
E. wallichii	Whole plant	HPLC	Wallkaurane A, Wallkaurane B , Wallkaurane C, Wallkaurane D , wallkaurane E, Wallatisane A, Wallatisane B, Wallatisane C, wallatisane D, ent-kaurane-16β,17,19- 172 triol-3-one , ent-kaurane-3-oxo-16α,17-diol, ent-16β-H-3-oxokauran-17-ol	Triterpenoid	(Wang *et al.* 2023)
E. thymifolia	Aerial		pseudoguaianolide, minimolide B, 4-oxo-2-ethoxy-6-tigloyloxy-pesudoguai-8,12-olide, 6-O-angeloylplenolin, 6-O-tigloyl-11,13-dihy-drohelenalin, megastigmane, dihydrophasei acid, corchoionoside C, w ent-abietane diterpene, phorbol-13-actate	Triterpenoid	(Liu *et al.* 2019)
E. laurifolia	Latex	TLC, NMR	12-Deoxyphorbol-13-acetate	Diterpenoid	(Avila *et al.* 2010)
E. prostrata	Leaves		Quercetin, isoquercitin , 2-O-galloy4, 6-S-hydroxy-diphenoyl-D-glucose, strictinin, tellimagarandin I, casuarectin, pedunculagin, corilagin, geranin, rugosin F, euphorbins G, euphorbins H	Flavonoids	(YoshidA *et al.* 1994)

Biological evaluation of the isolated compounds from genus *Euphorbia*

Anti-inflammatory activities

The molecular foundation underlying the anti-inflammatory properties of a pure compound Tyrosine kinase receptors are activated by various diseases and stressors, therefore stimulating IKKs. Furthermore, active IKKs phosphorylate the dormant IκBα-NF-κB complex. A phosphorylated variant of IκBα undergoes ubiquitylation and is ultimately degraded. The compound extract inhibits the translocation of the active form of NF-κB into the nucleus. Which facilitates the expression of genes associated with adhesion molecules, receptors, chemokines, and cytokines, all of which contribute to cell growth, proliferation, and differentiation. Arachidonic acid (**7**) can be transformed into prostaglandins by the action of Cox2; but a pure substance inhibits this process. This inflammation is induced by prostaglandins (Dogara, 2023). Lanostan 8-24 dien, 3 b-ol (0.3%), found in *E. lactea* latex, demonstrates a topical anti-inflammatory effect *in vivo*, through a mechanism associated with neutrophil migration (Fernandez-Arche *et al.* 2010). From *E. resinifera*, Euphatexol **(1-5)** exhibitted moderate anti-inflammatory activity with IC_{50} values of 22, 48, 21, 38 and 41 µM, respectively (Li *et al.* 2022). In the model of LPS-induced RAW264.7 macrophage cells, NO production was carried out, and Wallkaurane **A** from *E. wallichii* displayed an IC_{50} value of 4.21 µM (Wang *et al.* 2023). Pseudoguaianolides from *E. thymifolia* had substantial activity with IC_{50} values ranging from 0.41 to 15.32 µM and shown inhibitory effects against LPS-induced NO generation in BV-2 microglial cells (Liu *et al.* 2019). Paralianone **C,** paralianone **D,** pepluanol **G,** 15,8,14-triacetoxy-3-benzoyloxy-15- hydroxy-9-oxoparapliane**,** and 5,8,9,11,15-pentaacetoxy-3-benzoyloxy-16-hydroxypepluane from *E. peplus* revealed inhibitory activity on NO inhibition in the lipopolysaccharide (LPS)-stimulated mouse macrophage cellular model with IC_{50} values of 33.7, 38.3, 36.6, 29.9, and 37.1 µM (Wan *et al.* 2016). Euphopias A–C **(1–3)** from *E. helioscopia*, markedly inhibited lactate dehydrogenase (LDH) release (IC_{50} = 11.5, 5.4 , and 9.4 µM) and IL-1β expression (IC_{50} = 7.6, 4.1, and 10.2 µM) in comparison to the positive control MCC950, a selective NLRP3 inflammasome inhibitor (IC_{50} = 28.9 and 15 µM) (Shi *et al.* 2020). The anti-pyroptosis activity showed that Euphzycopin **C,** euphzycopin **D** from *E. helioscopia* in a dose-dependent manner, drastically lower LDH release with IC_{50} values of 8.96 µM and 7.75 µM (Qiu *et al.* 2024).

Antibacterial activities

From *E. resinifera*, euphorbioside -9-(4-methylamino-benzoate**)** exhibited the highest activities against Gram positive bacteria, *S. aureus* (31 µgm/L) and *B. subtilis* (42 mg/L), and moderate antifungal activity against *C. albicans* (74 µg/L), while euphorbioside-9-(2-methylamino-benzoate) demonstrated a moderate activity against Gram-positive microbes (37-38µg/mL). Euphorbioside-9-(3-dimethylamino-benzoate) and euphorbioside-9-(4-dimethylamino-benzoate) showed only weak and non-specific effects on all the microbes (MICs >100 µg/mL) (Farah *et al.* 2014). At concentrations of 10 µM, 50 µM, and 100 µM, 12-deoxyphorbol-13-isobutyrate-20-acetate from *E. resinifera* reduced the growth of *A. carbonarius* by 25% (Ourhzif *et al.* 2022). The compound demonstrated an impact that caused damage to DNA (Dogara, 2022). Additionally, oxidative stress is more especially, reactive oxygen species (ROS) was produced as a result of this action, disrupting the metabolic process. Furthermore, the cellular membrane was disrupted by the crude extract, which allowed cellular components to flow out.

Antiviral activities

From *E. lactea*, Euphlactenoid A, exhibited anti-HIV-1 activity with IC_{50} values of 1.17 µM (SI = 16.54) and 13.10 µM (SI = 1.93), respectively (Zhao *et al.* 2023). From *E. resinifera*, Euphorblin E exhibited the growth of yellow leaf curl virus (TYLCV), with an inhibition zone of 71.7% at a dose of 40 µg/mL (Zhao *et al.* 2021).

Enzyme Inhibitory activities

The mechanism of action is enzymatic inhibition. The identified flavonoids are dual-target inhibitors with substantial urease-inhibitory (with IC_{50} values lower than the standard thiourea) and tyrosinase-inhibitory (in one case, the activity of a compound was as potent as alpha-kojic acid) behaviors. This implies that they have the potential to interfere with the biology pathways performed by these enzymes. The results indicated that 3,5,7-trihydroxy-2-(4-hydroxy-3-methoxyphenyl)-6-methoxy-4H-chromen-4-one, and 2-(3,4-dihydroxy phenyl)-3,5,7-trihydroxy-6-methoxy-4H-chromen-4-one from *E. pulcherrima* demonstrate significant urease inhibitory activity, with IC_{50} values of 15.3 µM and 19.0 µM, respectively, whereas the positive control thiourea exhibited an IC_{50} of 21.0 µM. Likewise, these compounds were assessed for their effects on the tyrosinase enzyme; findings indicated that 3,5,7-trihydroxy-2-(4-hydroxy-3-methoxyphenyl)-6-methoxy-4H-chromen-4-one, exhibits considerable inhibitory action, as seen by its IC_{50} values of 48.7 µM, whereas 2-(3,4-dihydroxy phenyl)-3,5,7-trihydroxy-6-methoxy-4H-chromen-4-one (**2**) displayed a moderate effect with an IC_{50} value of 74.8 µM, in comparison to the standard (alpha-kojic acid, IC_{50} = 47.6 µM) (Rauf *et al.* 2022).

Anticancer activities

The cytotoxic efficacy of the compounds on keratinocytes was evaluated *in vitro*, employing ingenol mebutate as a positive control. Among the isolated compounds from *E. trigona*, two ingenane derivatives shown significantly greater cytotoxic action (IC_{50} values of 0.39 µM and 0.32 µM, respectively) on keratinocytes compared to ingenol mebutate (IC_{50} value of 0.84 µM) (Hammadi *et al.* 2021). From *E. lactea*, friedelin, friedelan-3β-ol, taraxerol, and friedelan-3α-ol demonstrated a dose-dependent cytotoxicity against HepG2, HN22, and HCT116, exhibiting a greater effect on cancer cells compared to non-transformed cells. Of the four compounds, friedelan-3β-ol demonstrated the highest potency, exhibiting the most significant inhibitory effect on HN22 and HepG2 cells (Wongprayoon *et al.* 2022). The cytotoxicity of compounds 1-10 from *E. resinifera* against the MCF-7, U937, and C6 cancer cell lines was assessed; however, none exhibited activity [32]. From *E. resinifera*, Euphorol K was the most potent against MCF-7 (5.48 mM) and C6 (6.79 µM) cells, whereas Euphorol J showed moderate activity on all the cell lines (IC_{50} around 37-47 mM) and Kansuinone showed the least activity with IC_{50} values of 46.99 and 90.21 mM against MCF-7 and U937 cells, respectively (Wang Huang *et al.* 2019). Euphoresins A showed weak activity with IC_{50} values of 85.87 µM (MCF-7), 87.36 µM (U937), and >100 µM (C6). Euphoresins B also showed weak activity with IC_{50} values of 96.89 µM (MCF-7), 94.89 µM (U937), and 8.31 µM (C6) (Wang Li *et al.* 2019). The assessment of cytotoxicity was conducted utilising Ehrlich ascites tumour cells. The IC_{50} is around 7.5 µM, and the IC_{90} is approximately 13.5 µM for 9,19-cycloart-25-ene-3,11,24-diol from *E. pulcherrima*. The 3,11,25-diol molecule exhibits a 50% reduction in activity (Smith-Kielland *et al.* 1996). In comparison to vinblastine (15.17 µM) as a positive control, quercetin-3-O-β-d-glucuronopyranoside from *E. dendroides* showed impressive inhibitory actions against OVK-18 with an IC_{50} value of 10.35 µM and MCF-7 with an IC_{50} of 6.09 µg/mL (Hassan, 2022). Against HepG2, Huh-7, KLM-1, 1321N1, and HeLa cell lines, 3b-hydroxycycloart-24-ene-23-methyl ether from *E. dendroides* showed good to weak selective cytotoxic effects, with IC_{50} values of 20.67, 16.24, 22.59, 25.9, and 40.50 µM, respectively. 3b-hydroxycycloart-24-ene-23-methyl ether (**1**), 24-methylene cycloartan-3β-ol, cycloart-23-ene-3β,25-diol monoacetate (**8**), 3β-hydroxy-cycloart-23-ene-25-methyl ether, 24 R/S-3b-hydroxy-25-methylene cycloartan-24-ol exhibited notable cytotoxic effects with IC_{50} values ranging from < 0.44 to 54.05 µM [71]. The IC_{50} of Zagrosin **I** from *E. amygdaloides* on MCF-7 cells treated for 48 hours was determined to be 1.5 µg/mL. Zagrosin **II** and **III** demonstrated cytotoxic effects on MCF-7 cells treated for 48 hours, with IC_{50} values of 14.04 and 12.50 µg/mL, respectively. The IC_{50} values for Zagrosin **I,** Zagrosin **III,** and Zagrosin **II** on human fibrosarcoma (HT1080) were 115.5 µg/mL, 16.81 µg/mL (after 48 hours of treatment), and 142.7 µg/mL (after 72 hours of therapy), respectively (Pasdaran *et al.* 2025). Various concentrations (0.001 µM, 1 µM, 10 µM, and 100 µM) of **7-**p-methoxyphenylacetate-3,8,12-triacetate ingol (**3**) from *E. resinifera* have demonstrated a substantial reduction in the viability percentage of MCF7 breast cancer cells subjected to escalating concentrations of the compound (Ourhzif *et al.* 2022). 11,12-didehydro-8a,14-dihydro-7-oxo-helioscopolide A (**1**), 7a-hydroxy-8a,14- dihydro jolkinolide E (**2**), 8b-acetyl-paralianone D (**3**), helioscopinolide A (**4**), 11-hydroxy-ent-abieta-8,11,13-trien-15-one (**5**), paralianone (**6**) and paralianone D (**7**) from *E. peplus* were tested on (Leukaemia HL-60, lung cancer A-549, liver cancer SMMC-7721, breast cancer MCF-7, and colon cancer SW480 at the concentration of 40 µM which has no activity (Chen *et al.* 2021).

Cytotoxicity: The killie-fish were susceptible to different compounds from *Euphorbia trigona*; the most potent was Wallkaurane B, (LC_{50} = 0.0023 ppm), compound **1** (LC_{50} = 0.066 ppm), compound **3** (LC_{50} = 0.076 ppm), and lastly Wallkaurane D (LC_{50} = 10 ppm) (Tada *et al.* 1989). In 178 RAW264.7 cells, Wallkaurane A, Wallkaurane B, Wallkaurane C (3), Wallkaurane D, wallkaurane E (**5**), Wallatisane A, Wallatisane B (**7**), Wallatisane C, wallatisane D, ent-kaurane-16β,17,19- 172 triol-3-one, ent-kaurane-3-oxo-16α,17-diol and ent-16β-H-3-oxokauran-17-ol from *E. wallichii* exhibited no cytotoxicity (IC_{50} > 50 µM) (Wang *et al.* 2023).

Other activities

From *E. peplus*, antileishmanial inhibition of Simiarenol and hexacosanol showed IC_{50} =20.24, β-sitosterol 34.87 and β-sitosterol-3-O-glucoside 32.05 µg/mL respectively (Amin *et al.* 2017). Eupulcherol A from *E. pulcherrima* exhibited anti-Alzheimer's disease (AD) bioactivity, potentially delaying paralysis in transgenic AD models *Caenorhabditis elegans* (Yu *et al.* 2020).

Clinical trials

Euphorbia is characterized by a wide variety and potency of bioactivity. Throughout history, an assortment of species has been involved in folk medicine systems across the world and used topically and internally as therapeutic tools to treat diverse diseases and management of some conditions. Research has confirmed traditional applications, and clinical research is beginning to unlock the therapeutic potential of *Euphorbia* extract to manage specific pathophysiological conditions (Table 3).

Table 3. Clinical trials of the genus *Euphorbia*

Species	Plant parts	Sample size	Diseases	Duration	Summary of major findings	Reference
E. prostrata	Tablet 100 mg (Sitcom)	120	Hemorrhoids	12 weeks	After two weeks, 82% (99 individuals) of the treated patients reported that their bleeding had completely stopped. Six more patients received treatment for two weeks, bringing the overall success rate to 87%. Additionally, 90% of patients reported less anal discomfort and 73% reported less itching after the treatment. No patients complained of any negative drug side effects. Three months later, at a follow-up visit, none of the patients indicated that their symptoms had returned. Nevertheless, it was shown that 46% (37 out of 79 patients) still had hemorrhoids after evaluation.	(Gupta 2011)
	Whole plant dry extract 100 mg tablets	1836	Bleeding Hemorrhoids	2 weeks	The proportion of patients who developed bleeding decreased by 85.4% (89.3% to 3.9%), pain by 88.7% (80.1% to 4.7%), swelling by 88.8% (60.4% to 6.2%) and congestion by 91.0 % (47.9% to 4.2%). As per physician determination, the total improvement was 27.7% with 63.2% being moderate. On the same note, patient judgments came out quite well with 27.5% of them reporting total improvement and 63.6% moderate improvement.	(Bakhshi *et al.* 2008)
	Sitcom tablet (100 mg), cream 1%w/w	100	Hemorrhoids During Pregnancy	8 weeks	There was a decrease in symptoms, and this was observed to be fairly even across the time period. After eight weeks, complete cessation of rectal bleeding (100% reduction) and a decrease of 77.6% pain during defecation was attained. Itching and discharge were removed completely and swelling by 84.5%. In postpartum follow-ups and two weeks later, greater than 90 % to 100 % of patients exhibited good or excellent overall improvements with no adverse events in any of the mothers or their newborns	(Porwal *et al.* 2024)

	Extract 100 mg	30	Hemorrhoids	2 weeks	The baseline value scores, which included bleeding (0.97), pain (0.60), itching (0.47), exudation (0.13), and swelling (0.43), started to decline on day four. After seven days, bleeding (0.15), pain (0.12), itching (0.15), exudation (0.15), and swelling (0.19) decreased, and by day fourteen, the symptoms of bleeding (0.0), pain (0.08), and swelling (0.08) were nearly cured, while itching (0.00) and exudation (0.00) vanished entirely.	(Ekakitie 2024)
	100 mg plus calcium dobesilate 500 mg	140	Varicose veins	12 weeks	Leg discomfort, swelling, tingling, numbness, and itching all showed substantial improvements from baseline at the 3-month follow-up (mean change: −2.9 [69%], [57%],[68%], [67%] and [74%], respectively; P = 0.0001). More than 90% of patients had good-to-excellent treatment progress at follow-up, and 58.3% of patients had fully healed ulcers.	(Porwal *et al.* 2025)
E. peplus	Sap	36	Human nonmelanoma skin cancers	3 days	A total of 48 skin cancer lesions were treated topically with 100–300 µL of *E.peplus* sap for three days, once a day.	(Ramsay *et al.* 2011)
E. hirta		125	Dengue	3 months	There was a rise in platelets in more than 70% of patients. Significant reduction in fever and flu-like symptoms after taking the extract for 24 hours	(Mir *et al.* 2012)
E. caducifolia	Oil	30	Cracked feet		In terms of symptoms like pain-related cracking ($P < 0.001$), dryness ($P < 0.001$), and itching ($P < 0.001$), the study produced statistically significant findings.	(Gupta *et al.* 2018)

The synthesized clinical trials provide data on the efficacy of various *Euphorbia* species with the primary focus on the inflammatory and vascular-related conditions hemorrhoids, varicose veins, and dermatological diseases. A significant proportion of the therapeutic effects recorded in the clinical trials can be channeled to certain groups of compounds found in *Euphorbia* species. Triterpenoids, including epi-friedelinycl acetate and taraxerol, which are present in the species like *E. trigona*, have exhibited significant anti-inflammatory and cytotoxicity activity, which is consistent to the clinical evidence of decreased hemorrhoidal swelling, pain, and bleeding. *Euphorbia* species contain flavonoids and polyphenols that are thought to defend against oxidative damage and vaso protective benefits, which may explain the observed enhancement of vascular integrity among patients with hemorrhoids and varicose veins. The observed reversal of thrombopenia in patients of dengue when subjected to *E. hirta* could also be attributed to the high concentrations of phytochemicals such as quercetin and other flavonoids that have been shown to facilitate platelet aggregation and decrease capillary fragility. The Clinical efficacy of *Euphorbia*-based therapies is a direct correlation of plentiful and heterogeneous phytochemistry. This demonstrates not only the validity of past ethnobotanical uses but also demonstrates the prospect of *Euphorbia* species as sources of standardization of herbal treatments or of new molecular structures to be used as pharmaceutical agents in the future. Future studies ought to emphasize the compounds-specific mechanism of action, standardizing extractions, and larger clinical trials to exploit the potential of this genus of medicinal plants.

Conclusion

The molecular basis of this traditional use has been identified through studies of phytochemicals. Several of the traditional claims have substantial scientific backing *in vitro* and *in vivo* research has shown that the genus has substantial anticancer, antimicrobial, anti-inflammatory, antioxidant and antiviral properties. This substantial traditional and preclinical foundation has successfully translated into clinically validated applications for specific species. Most notably, rigorous clinical trials have established *E. prostrata* extract as an effective and well-tolerated treatment for hemorrhoids, *E. peplus* sap for human nonmelanoma skin cancers, *E. hirta* for increasing platelet count in dengue patients and *E. caducifolia* oil for treating cracked feet. The genus *Euphorbia* is a highly potential avenue of pharmacognostic research and drug discovery based on secondary metabolites. It has a vast chemical repertoire of various chemical compositions, which provides a good source of chemically diverse and clinically important compounds. It is also essential to conduct structure-activity relationship studies to determine the molecular characteristics that endow activity and to provide a means of rationally developing new derivatives. Pre-clinical research in other species needs to be transferred into effective randomized controlled clinical trials to confirm traditional practices, determine safe and effective doses and eventually incorporate these potent natural resources into contemporary evidence-based therapies. This genus therefore presents an interesting potential source of lead compounds to be developed as future chemotherapeutic and chemo preventive agents.

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