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Review

A Mini Review: The Application of Eupatorium Plants as Potential Cosmetic Ingredients

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Abstract: The Eupatorium plant has been well used in medication and as a decorative plant. Some studies have reported that this herb has biochemical compounds, such as sesquiterpenes, phenolics, polysaccharides, and pyrrolizidine alkaloids. Thus, it has pharmacological effects, including antifungal, antibacterial, cytotoxic, and antinociceptive properties, that can be utilized for cosmetic purposes. However, only a few published works have summarized the active compounds and the application of Eupatorium plants as cosmetic agents. Therefore, this article aims to review the application of Eupatorium plants as a potential cosmetic agent. The active compounds of Eupatorium are contained in the whole plant, as well as the stems, leaves, roots, and aerial parts (flower, fruit, and seeds). In terms of cosmetic applications, the activities of *Eupathorium* are antioxidant, anti-tyrosinase, anti-melanin/melanogenesis, anti-acne, and anti-inflammatory. This review aims to contribute to a better understanding for expanding the utilization of this plant for cosmetic purposes by using these active compounds.

Keywords: Eupatorium; active compound; cosmetic application; biochemical constituents

1. Introduction

The cosmetic and skincare industry needs to reconfigure itself in order to meet the new necessities and solicitations of a volatile and conscious market. The main aim is to achieve a balance between "natural" and "synthetic" cosmetics. Many customers pick "green beauty care and cosmetic products", such as herbal skin creams and makeup, trusting that the products are safe for their well-being, health, and that they have no contamination. A cosmetic product can be considered "green" if it contains dynamic, active

biochemical agents derived from plants, such as minerals or other nutrients, and if it is not practically equivalent to the synthetic chemicals created in the laboratory. It is assumed that cosmetics are manufactured in an eco-practical way if they use natural and organic ingredients in a proper and safe manner [1].

Plants belonging to the Eupatorium genera (family *Asteraceae*) contain approximately 60 species, the majority of which have been utilized in medication or as decorative plants. These plants have been explored in-depth, and several biochemical compounds with shifting impacts have been recognized. Among the different species, many have many pharmacological effects, such as antifungal, cytotoxic, antibacterial, insecticidal, virucidal, mitigating, pain relieving, anticancer, antisyphilitic, antigonorrheal, and antinociceptive properties [2–19]. For certain species such as *E. perfoliatum*, *E. arnottianum*, *E. chinense*, and *E. lindleyanum*, the different therapeutic signs correspond with certain bioactive compounds such as sesquiterpenes, phenolics, polysaccharides, and pyrrolizidine alkaloids [20].

Compounds isolated from *E. inulaefolium* and *E. squalidum* have demonstrated viability against human parasites such as *Plasmodium berghei* and *P. falciparum,* which cause malaria [21,22]. According to Lira-Salazar et al. [15], *E. perfoliatum* is used in medications treating malaria. The phytochemical compounds of *E. perfoliatum* have significant cytotoxic effects, but have weak antibacterial activities against *Staphylococcus aureus* and *Bacillus megaterium* [23]. Some members of the Asteraceae family are ornamental or decorative plants. *E. triplinerve* Vahl, or *E. ayappana*, recognized as ayappana in the Malayalam language, has a beautiful morphology with a slim herb with tight lanceolate leaves and a huge number of pedicelled bloom heads at the highest point of the branch [24]. This herb also spreads the fragrance of the aromatic compounds it contains. Several studies have extracted essential oils from the leaves, stems, and roots of *Eupatoria*, opening up opportunities for drug discovery and therapeutic benefits [25,26]. The essential oil from the plant has been found to have various restorative properties, including acting as a central nervous system (CNS) depressant, pain-relieving effects, and narcotic impacts. The ethanolic extract has an antibacterial and antifungal effect, and can be used as a disinfectant or for the treatment of different ulcers and hemorrhages [24,27–30]. The conventional utilization of the leaves of *E. triplinerve* as anthelmintics has been affirmed. The medical properties of the leaves of *E. triplinerve* are used to treat different diseases that incorporate helminthiasis. *E. triplinerve* from Kerala, India, was found to have an expansive range of anthelmintic effects when utilized on lubmricoides [31,32].

Euphatorium is a pioneering herb species. The rapid expansion of *E. adenophorum*, which was discovered in China decades ago, is unfavorably affecting biodiversity and environmental equilibrium in forests and pastures in southwestern China [33]. Physical, chemical, and biological techniques have been developed to suppress its progress [34,35]; *E. odoratum*, otherwise called *Chromolaena odorata* (L.), is a robust developing bush from the group of Asteraceae. It is one of the most widespread invasive plants, spreading from one side of the Earth to the other [36]. Despite its obvious aggravation nature as an obtrusive plant, *E. odoratum* is used for many purposes. Because of its antimicrobial properties, *E. odoratum* is used as a traditional medicine for cleaning and treating wounds. It has also been utilized as a powerful treatment against malaria, intestinal illness, fever, toothache, skin illnesses, diabetes, and diarrhea, and has been shown to have a calming effect [37–40]. Another species, *E. aschenbornianum*, has been broadly utilized in conventional Mexican medication, particularly for treating wounds, skin sores, hemorrhages, and gastric ulcers in humans. Phytochemical studies have demonstrated that hexane concentrates of *E. aschenbornianum* have antimicrobial and antifungal effects [41]. Another Eupatorium species, *E. chinense var. simplicifolium* (EUC), is broadly distributed in Korea, Japan, and China, and has anti-palsy and anti-hypertension effects. The EUC extracts have likewise been found to have an anti-tumour ability [42].

Furthermore, *E. fortunei* Turcz, one species of Eupatorium, is ordinarily involved as a fragrant in herbal medicine in China. It has been applied to treat vomiting, queasiness,

and hunger caused by clamminess. Previous research has revealed that the plant contains various bioactive agents [43–46]. In the region of Japan, *E. glehni* is found all throughout the Hokkaido, Honshu, and Shikoku Islands, particularly in the mountain, typically in the range of 1000 and 1800 m above sea level [47]. Another species, *E. lindleyanum* DC., is a Chinese medication broadly used to treat cough and tracheitis [48]. Different natural benefits from these species have been recognized, including its anti-cancer, anti-inflammatory, and antioxidant properties [49–54].

E. japonicum Thunb is broadly distributed in China, Japan, and Korea. Previous research has found that the leaves and stems have anti-inflammatory and vascular smooth muscle relaxant properties. As a result, *E. japonicum* Thunb has antibacterial, antiviral, diuretic, vermifuge, pain reliever, and carminative properties. Thus, it is used to treat nausea, vomiting, diarrhea, and indigestion symptoms [55–58]. With all of these advantages, Eupatorium plants have the potential to be applied in cosmetics. However, only a few published works have investigated the application of Eupatorium plants for cosmetic agents. Therefore, this article aims to review the application of Eupatorium plant species as a potential cosmetic agent. Accordingly, this mini review is based on an analysis of the research studies developed, using keywords such as *Eupotarium* plant, *Eupotarium* genus and species, chemicals components of *Eupotarium*, the bioactivity of *Eupotarium*, anti-acne, anti-bacterial activity, anti-melanogenesisi activity, antioxidant activity, anti-inflammatory activity, and anti-tyrosinase activity, using the search engines of www.pubmed.gov, www.researchGate.net, www.scholar.google.com, and www.google.com without limits for the year of publication. We also used software services such as Mendeley Desktop®, which allowed for the analysis of the type of publications on the topic and the visualization of the most relevant data, providing rigorous information on the application of Eupatorium plants as a potential cosmetic agent.

2. Biochemical Constituents

Various types of bioactivity have been found in *Eupatorium* species. A few sesquiterpenoids detached from the class Eupatorium have been displayed to have different degrees of anti-inflammatory, cytotoxic, antifungal, insecticidal, and antibacterial effects [16,59]. Different examinations have found items in numerous biochemical compounds in plants, which fluctuate over time; the compound yields are regularly high throughout the summer (July or August) [46,60,61]. A summary of the biochemical compounds from Eupatorium species is presented in Table 1.

Table 1. Biochemical compounds of Eupatorium plants.

Plant Species	Plant Parts	Chemical Compositions	Ref
E. odoratum	Leaves	Odoratin	[62]
E. triplinerve	Fresh plant	1-hexyl-1-nitrocyclohexane (2.09%), Bicyclo [4.1.0] heptane, 7-butyl- (2.38%), Decanoic acid, 8-methyl-, methyl ester (3.86%), 1,14-tetradecanediol (6.78%), 1-undecanol (7.82%), 2-hydroxy-3-[(9E)-9-octadecenoyloxy] propyl(9E)-9-octadecenoate (8.79%), 2,6,10-trimethyl,14-ethylene-14-pentadecne (9.84%) Hexadecenoic acid (14.65%), and Octadecanoic acid, 2-hydroxy-1,3-propanediyl ester (19.18%)	[24]
	Leaves	7-methoxycoumarin	[63,64]
	Leaves	Steroids, terpenoids, flavonoids, and glycosides	[65]
	Leaf, stem, and root	Phytochemical compounds (steroid, saponin, flavonoids, tannin, glycoside, and coumarin) and volatile oil	[27]
E. adenophorum		Volatile oils	[66,67]

Plant Species	Plant Parts	Chemical Compositions	Ref
	Leaves	Sesquiterpenes (three cadinene sesquiterpenes 2-deoxo-2-(acetyloxy)-9-oxoageraphorone (DAOA), 9-oxo-agerophorone (OA), and 9-oxo-10, and 11-dehydro-agerophorone (ODA))	[68,69]
	Whole plants	Anthemol (0.88%), thunbergene (1.09%), phytol (0.95%), thymol (0.94%), linoleic (1.43%) and palmitic (5.15%) acids, spathulenol (2.21%), carvacrol (1.86%), caryophyllene oxide (2.42%), β-cedrene (3.26%), α-bergamotene (3.56%), 8-cedren-13-ol (4.34%), β-sesquiphellandrene (4.76%), β-bisabolene (4.84%), α-curcumene (7.88%), α-bisabolol (9.12%), aristolone (11.54%), and torreyol (30.10%)	[25]
	Leaves	Neo-chlorogenic acid (3-O-caffeoylquinic acid, 3-CQA), chlorogenic acid (5-O-caffeoylquinic acid, 5-CQA), and cryptochlorogenic acid (4-O-caffeoylquinic acid, 4-CQA)	[70]
		4′-methyl quercetagetin 7-O-(6″-O-E-caffeoyl glucopyranoside) (1.8%), quercetagetin 7-O-(6″-O-acetyl-β-D-glucopyranoside) (1.8%), caffeic acid (6.7%), eupalitin (9.7%), and eupalitin 3-O-β-D-galactopyranoside (17.2%)	[71,72]
	Leaves	Eriptox A (9-oxo-10, 11-dehydroageraphorone)	[73]
	Leaves	amorpha-4,7(11)-diene, (–)-amorph-4-en-7-ol, (E)-β-Caryophyllene, (E)-β-farnesene, (E)-α-bisabolene, (E)-α-Bergamotene, (Z)-β-farnesene, Y-curcumene, germacrene D, bicyclogermacrene, β-bisabolene, β-sesquiphellandrene, (E)-α-bisabolene, α-cedrol, α-bisabolol	[74]
		β-Ecdysone, Eupatorin, Eupatilin, Quercetin, Rutin, Caffeic acid	[20]
E. perfoliatum		Acidic heteroglycans	[15,75]
		Eupafolin	[76]
E. cannabium		Acidic heteroglycans	[15,75]
	Leaves and stems	Alkaloid, flavonoids, tannin, and saponin	[77]
		Immunoactive polysaccharides essential oil, eupatoriopicrin, polyphenols, pyrrolizidine alkaloids, and terpenoids	[78]
		Eucannabinolide	[79]
E. aschembornianum	Leaves	(–)-Encecanescin	[80]
E. buniifolium	Aerial vegetative	n-tricosane, n-docosane, n-tetracosane, n-triacontane, n-tritriacontane, 9-tricosene, 7-pentacosene, 9-pentacosene, 9-heptacosene, pentacosadiene, tritriacontene, hentriacontadiene, tritriacontadiene and all methyl alkanes	[26]
E. capillifolium	Roots	Intermedine, lycopsamine,	[81]
E. chinense		Eupalinin A	[82]
E. fortunei	Leaves	*p*-cymene, thymol, neryl acetate, and *β*-caryophyllene	[46]
	Stems	*p*-cymene, thymol, neryl acetate	
	Roots	thymol	
	Whole plant	Eight germacrene-type: 14-hydroxy-8β-[4′-hydroxytigloyloxy]-costunolide, 14-acetoxy-8β-[4′-hydroxyti-gloyloxy]-costunolide, 14-acetoxy-8β-hydroxy-costunolide, 8β-[4′-hydroxytigloyloxy]-14-oxo-costunolide, 3β-acetoxy-8β-[4′,5′-dihydroxytigloyloxy]-costunolide, 2β-hydroxy-8β-[5′-hydroxy-tigloyloxy]-costunolide, prenylated ester, 8β-[4′,5′-dihydroxytigloyloxy]-costunolide, and two eudesmane-type sesquiterpene lactones (1β-hydroxy-8β-[4′-hydroxytigloyloxy]-α-cyclocostunolide and 1β-hydroxy-8β-[4′-ydroxytigloyloxy]-β-cyclocostunolide)	[83]
	Aerial part	Eupatofortunone, eupatodibenzofuran A, eupatodibenzofuran B, Eupatodithiecine, 6-Acetyl-8-methoxy-2,2-dimethylchroman-4-one, thymyl angelate, 8,9-Dehydrothymol 3-O-tiglate, 9-Angeloyloxythymol, 9-O-	[84]

Plant Species	Plant Parts	Chemical Compositions	Ref
		Angeloyl-8,10-dehydrothymol, 2-Hydroxy-4-methylacetophenone, trans-o-Coumaric acid, 6-Hydroxy-7-methoxy-2-isopropenyl-5- acetylcumaran, 2,4-Di-tert-butylphenol, 1-(2-Hydroxy-5-methoxy-4-methylphenyl)ethenone, taraxasterol, and coumarin	
E. glehni	Aerial part	2α-Acetoxyepitulipinolide and Eupaglehnin A-F	[47]
	Terrestrial part	Guaiaglehnin A, Eupasimplicin A, Hiyodorilactone B	[85]
E. lindleyanum		Eupalinode J	[54]
E. heterophyllum	Aerial part	Hydroperoxyheterophyllin A, Hydroperoxyheterophyllin B, Hydroperoxyheterophyllin C, Hydroperoxyheterophyllin D, Hydroperoxyheterophyllin E, Hydroperoxyheterophyllin F, Hydroperoxyheterophyllin G, Hydroperoxyheterophyllin H, Ketoheterophyllin A	[86]
E. japonicum	Leaves	α-amyrin and ß β-amyrin acetates, α-amyrin, β-amyrin, β-sitosterol, stigmasterol, β-sitosterol 3-*O*-β-D-glucopyranoside (daucosterol), behenic acid, stigmasterol 3-*O*-β-D-glucopyranoside, eupatoriopicrin, (2*E*)-3-[2-(β-D-glucopyranosyloxy)phenyl]-prop-2-en-oic acid, 1-hydroxy-8-(4,5-dihydroxy-tigloyloxy)eudesma-4(15),11(13)-dien-6,12-olide, caffeic acid, *p*-menth-1-ene-3,6-diol, quercetin-3-*O*-rutinoside (rutin), kaempferol 3,7,4′-trimethylether, and quercetin 3-Omethyl ether	[59]

3. Application in Cosmetics

3.1. Antioxidant Activity

Medicinal plants affect the human body as a result of various chemical compounds, and one type of influence is anti-oxidative interaction [87–94]. As energy consumption increases during pregnancy, and lactation encourages the formation of free radicals in a woman's body, investigating their antioxidant qualities is warranted [95–100]. The presence of phenols and flavonoids in plant extracts has been linked to its antioxidant activity. Phenolic compounds are antioxidants that act as free radical deactivators [40,101–103]. *E. cannabinum*, comprised of phenolic mixtures and essential oil, showed positive results in 2-Diphenyl-1-picrylhydrazyl (DPPH) examination and when using electrochemical potential sweep technique [104–106]. The methanolic concentrate of *E. triplinerve* has been found to show hepatoprotector and anti-cancer effects against carbon tetrachloride-actuated hepatotoxicity in rats, as well as anti-inflammatory and anti-septic effects in the therapy of various ulcers and hemorrhages. The matured leaf extracts have a 50.24–60.39% (petrol ether, chloroform, and methanol) anti-DPPH effect [65,107,108].

UV radiation has received particular attention because it affects medication stability and produces the greatest loss to the active structure of melatonin as a medicine [109,110]. In addition, UVA radiation may increase the risk of skin cancer [111]. Jarco et al. [112] declared that UVA radiation reduces the antioxidant interactions of all of the investigated infusions, particularly the infusion of the *E. cannabinum* L. herb, which should be protected from UVA radiation during storage. Table 2 presents the potency of the radical scavenging activity from Eupatorium species.

Table 2. The potency of the radical scavenging activity from Eupatorium species (total phenolic content (TPC) anb total flavonoid content (TFC)).

Plant Species	Plant Parts	Antioxidant Test Applied	Antioxidant Activity	References
E. odoratum	Leaf	DPPH (IC_{50})	0.07–0.042 mg/mL	[40]
		FRAP (IC_{50})	0.4–0.6 mg/mL	
		TPC	379.0–536.3 mg GAE/g of extract	
		TFC	263.33–268.75 mg QE/g of extract	
		Total flavanol	273.0–689.0 µg QE/g of extract	
E. lindleyanum		Reducing Power (IC_{50})	81.22 µg/mL	[113]
		FRAP (IC_{50})	24.72 µg/mL	
		DPPH (IC_{50})	37.13 µg/mL	
		Superoxide anion (IC_{50})	19.62 µg/mL	

3.2. Anti-Melanin/Melanogenesis Activity

Yamashita et al. [114] searched for heat sock protein 70 (HSP70) inducers in Chinese medical plants, and selected an ethanol concentrate of *E. lindleyanum*. Melanin development was found to be inhibited, as well as the tyrosinase effect and the articulation in the cells treated with *E. lindleyanum* and in the HSP70-overexpressing cells. MITF articulation was clearly stifled in the cells treated with the concentrate of *E. lindleyanum*, yet not in the HSP70-overexpressing cells. These findings imply that *E. lindleyanum* inhibits tyrosinase articulation and melanin development through both HSP70-subordinate and HSP70-autonomous pathways.

Skin hyperpigmentation diseases caused by abnormal melanin production caused by ultraviolet (UV) irradiation are both clinical and cosmetic issues. Here, the melanin production is mediated by tyrosinase, whose expression is favourably controlled by the microphthalmia-associated transcription factor (MITF) [114]. Melanin is a pigment in human and animal skin generated by tyrosinase from L-tyrosine, following the oxidation of L-DOPA to L-DOPA quinone. Skin whitening compounds have long been sought after as a treatment for skin illnesses caused by an excess of melanin on human skin, as skin darkening is one of the most significant cosmetic issues concerning humans [115].

An earlier study reported that a methanol extract of *E. triplinerve* Vahl exhibited the inhibitory activities on the melanin formation in B16 melanoma cells with IC_{50} 1780 µM and both tyrosinase enzyme activity of L-tyrosine (IC_{50} = 2360 µM) and L-DOPA (IC_{50} = 2840 µM) [63].

3.3. Anti-Acne Activity

Britto [116] tested the antimicrobial activity of *E. odoratum* against *Propionibacterium acnes* and *Staphylococcus epidermidis*, which have been identified as pus-forming bacteria triggering inflammation in acne. The antimicrobial assay revealed that *E. odoratum* exhibited potent inhibitory effects on *P. acnes*. The minimum inhibitor concentration (MIC) values for both bacterial species were 0.039 mg/mL, while the minimum bacterial concentration (MBC) values were 0.039 and 0.156 mg/mL against *P. acnes* and *S. epidermidis*, respectively. Rahman et al. [117] reposted that the MICs value of *E. odoratum* against *P. acnes* was 0.625 mg/mL. In Ramesh and Subramani's [118] research, the antimicrobial properties of *E. odoratum* leaves against *S. aureus* with a methanolic extract of a greater concentration (100 µL) performed well compared with using an aqueous extract of the same plant.

The leaf extract of *E. triplinerve* has shown considerable antibacterial activity against a wide range of microorganisms, i.e., *S. aureus*. Extracts containing phenol and triterpenes (chloroform, ethyl acetate, and methanol) were more effective regarding their antibacterial efficacy than other extracts. The present study reveals that different extracts from *E. triplinerve* leaves contain a diverse range of secondary metabolites and had an antibacterial

activity against all of the microorganisms tested. In addition, the *E. triplinerve* plant can be used to find natural products, which may lead to new pharmaceutical development [27].

3.4. Anti-Inflammatory Activity

Some Eupatorium species have exhibited a potential anti-inflammatory activity. The ethanolic extract of *E. triplinerve* had an analgesic effect in an inflammatory pain model [119]. Cheriyan et al. [64] reported that a dose-dependent antinociceptive action of 7-methoxy coumarin isolated from *E. triplinerve* was shown by the present research, which supports the traditional usage of *E. triplinerve* in pain and inflammatory disorders. Therefore, Ouyang et al. [69] focused on developing a biopesticide using *E. adenophorum*, because of its bioactive composition, which exhibited potential anti-inflammatory, insecticidal and antibacterial activities [120–123].

Garcia-Oliveira [106] collected the data that sesquiterpene lactones of *E. cannabinum* have an anti-inflammatory activity in vitro (modulation of pro-inflammatory factors) and in vivo (reduction of pro-inflammatory cytokines in mice models). The aqueous extract of *E. odoratum* leaves has shown numerous pharmacological activities, including an anti-inflammatory activity [124].

4. Conclusions

In this literature study, various extracts from whole parts of *Eupatorium* demonstrated a wide range of biochemical compounds, including steroids, saponins, flavonoids, tannins, glycosides, coumarins, and sesquiterpenes, along with their biological activities. Thus, these biochemical compounds have the potential to be used as cosmetic agents because they have antioxidant, anti-tyrosinase, anti-melanin, anti-acne, and anti-inflammatory properties. Therefore, Eupatorium plants can be used as cosmetic ingredients in the near future, but they should first be proven to be safe for human application in the cosmetic field.

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