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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

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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 *Euphatoria*, 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 the 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]
	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]

Table 1. *Cont.*

Plant Species	Plant Parts	Chemical Compositions	Ref
	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″-Oacetyl-β-D-glucopyranoside) (1.8%), caffeic acid (6.7%), eupalitin (9.7%), and eupalitin 3-O-β-D-galactopyranoside (17.2%)	[71,72]
	Leaves	Euptox 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, γ-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′-hydroxytigloyloxy]-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]

Table 1. *Cont.*

Plant Species	Plant Parts	Chemical Compositions	Ref
	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-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	[84]
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-dihydroxytigloyloxy)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-*O*methyl 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 a 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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References

1. Dini, I.; Laneri, S. The new challenge of green cosmetics: Natural food ingredients for cosmetic formulations. *Molecules* **2021**, *26*, 3921. [CrossRef] [PubMed]
2. Cáceres, A.; Menéndez, H.; Méndez, E.; Cohobón, E.; Samayoa, B.E.; Jauregui, E.; Peralta, E.; Carrillo, G. Antigonorrhoeal activity of plants used in Guatemala for the treatment of sexually transmitted diseases. *J. Ethnopharmacol.* **1995**, *48*, 85–88. [CrossRef]

3. De las Heras, B.; Slowing, K.; Benedí, J.; Carretero, E.; Ortega, T.; Toledo, C.; Bermejo, P.; Iglesias, I.; Abad, M.J.; Gómez-Serranillos, P.; et al. Antiinflammatory and antioxidant activity of plants used in traditional medicine in Ecuador. *J. Ethnopharmacol.* **1998**, *61*, 161–166. [CrossRef]
4. Urzua, A.; Caroli, M.; Vasquez, L.; Mendoza, L.; Wilkens, M.; Tojo, E. Antimicrobial study of the resinous exudate and of diterpenoids isolated from Eupatorium salvia (Asteraceae). *J. Ethnopharmacol.* **1998**, *62*, 251–254. [CrossRef]
5. Abad, M.J.; Bermejo, P.; Sanchez Palomino, S.; Chiriboga, X.; Carrasco, L. Antiviral activity of some South American medicinal plants. *Phytother. Res.* **1999**, *13*, 142–146. [CrossRef]
6. Zanon, S.M.; Ceriatti, F.S.; Rovera, M.; Sabini, L.J.; Ramos, B.A. Search for antiviral activity of certain medicinal plants from Córdoba, Argentina. *Rev. Lat. Microbiol.* **1999**, *41*, 59–62.
7. Clavin, M.L.; Gorzalczany, S.; Miño, J.; Kadarian, C.; Martino, V.; Ferraro, G.; Acevedo, C. Antinociceptive effect of some Argentine medicinal species of Eupatorium. *Phytother. Res.* **2000**, *14*, 275–277. [CrossRef]
8. Muschietti, L.; Gorzalczany, S.; Ferraro, G.; Acevedo, C.; Martino, V. Phenolic compounds with anti-inflammatory activity from *Eupatorium buniifolium*. *Planta Med.* **2001**, *67*, 743–744. [CrossRef]
9. El-Seedi, H.R.; Ohara, T.; Sata, N.; Nishiyama, S. Antimicrobial diterpenoids from Eupatorium glutinosum (Asteraceae). *J. Ethnopharmacol.* **2002**, *81*, 293–296. [CrossRef]
10. Gupta, M.; Mazumder, K.; Chaudhuri, I.; Chaudhuri, R.; Bose, P.; Bhattacharya, S.; Lakshmanan, M.; Patra, S. Antimicrobial activity of *Eupatorium ayapana*. *Fitoterapia* **2002**, *73*, 168–170. [CrossRef]
11. García, C.C.; Talarico, L.; Almeida, N.; Colombres, S.; Duschatzky, C.; Damonte, E.B. Virucidal activity of essential oils from aromatic plants of San Luis, Argentina. *Phytother. Res.* **2003**, *17*, 1073–1075. [CrossRef]
12. Navarro García, V.M.; Gonzalez, A.; Fuentes, M.; Aviles, M.; Rios, M.Y.; Zepeda, G.; Rojas, M.G. Antifungal activities of nine traditional Mexican medicinal plants. *J. Ethnopharmacol.* **2003**, *87*, 85–88. [CrossRef]
13. Rios, M.Y.; Aguilar-Guadarrama, A.B.; Navarro, V. Two new benzofuranes from Eupatorium aschenbornianum and their antimicrobial activity. *Planta Med.* **2003**, *69*, 967–970. [CrossRef]
14. Sasikumar, J.M.; Doss, A.P.A.; Doss, A. Antibacterial activity of *Eupatorium glandulosum* leaves. *Fitoterapia* **2005**, *76*, 240–243. [CrossRef]
15. Lira-Salazar, G.; Marines-Montiel, E.; Torres-Monzón, J.; Hernández-Hernández, F.; Salas-Benito, J.S. Effects of homeopathic medications *Eupatorium perfoliatum* and Arsenicum album on parasitemia of Plasmodium berghei-infected mice. *Homeopathy* **2006**, *95*, 223–228. [CrossRef]
16. Liu, P.Y.; Liu, D.; Li, W.H.; Zhao, T.; Sauriol, F.; Gu, Y.C.; Shi, Q.W.; Zhang, M.L. Chemical Constituents of Plants from the Genus Eupatorium (1904–2014). *Chem. Biodivers.* **2015**, *12*, 1481–1515. [CrossRef]
17. Hnatyszyn, O.; Broussalis, A.; Herrera, G.; Muschietti, L.; Coussio, J.; Martino, V.; Ferraro, G.; Font, M.; Monge, A.; Martínez-Irujo, J.J.; et al. Argentine plant extracts active against polymerase and ribonuclease H activities of HIV-1 reverse transcriptase. *Phytother. Res.* **1999**, *13*, 206–209. [CrossRef]
18. Miño, J.; Muschietti, L.; Ferraro, G.; Martino, V.; Acevedo, C. Antinociceptive activity of Eupatorium buniifolium aqueous extract. *Fitoterapia* **2005**, *76*, 100–103. [CrossRef]
19. Sobrinho, A.C.; Morais, S.; Souza, E.; Fontenelle, R. The genus Eupatorium, L. (Asteraceae): A review of their antimicrobial activity. *J. Med. Plants Res.* **2017**, *11*, 43. [CrossRef]
20. Grigore, A.; Neagu, G.; Dobre, N.; Albulescu, A.; Ionita, L.; Ionita, C.; Albulescu, R. Evaluation of antiproliferative and protective effects of *Eupatorium cannabinum* L. extracts. *Turk. J. Biol.* **2018**, *42*, 334–344. [CrossRef]
21. Carvalho, L.H.; Brandão, M.G.; Santos-Filho, D.; Lopes, J.L.; Krettli, A.U. Antimalarial activity of crude extracts from Brazilian plants studied in vivo in *Plasmodium berghei*-infected mice and in vitro against Plasmodium falciparum in culture. *Braz. J. Med. Biol. Res.* **1991**, *24*, 1113–1123.
22. Blair, S.; Mesa, J.; Correa, A.; Carmona-Fonseca, J.; Granados, H.; Sáez, J. Antimalarial activity of neurolenin B and derivates of *Eupatorium inulaefolium* (Asteraceae). *Pharmazie* **2002**, *57*, 413–415.
23. Habtemariam, S.; Macpherson, A.M. Cytotoxicity and antibacterial activity of ethanol extract from leaves of a herbal drug, boneset (*Eupatorium perfoliatum*). *Phytother. Res.* **2000**, *14*, 575–577. [CrossRef]
24. Selvamangai, G.; Bhaskar, A. GC–MS analysis of phytocomponents in the methanolic extract of *Eupatorium triplinerve*. *Asian Pac. J. Trop. Biomed.* **2012**, *2*, S1329–S1332. [CrossRef]
25. Chen, H.; Zhou, B.; Yang, J.; Ma, X.; Deng, S.; Huang, Y.; Wen, Y.; Yuan, J.; Yang, X. Essential Oil Derived From *Eupatorium adenophorum* Spreng. Mediates Anticancer Effect by Inhibiting STAT3 and AKT Activation to Induce Apoptosis in Hepatocellular Carcinoma. *Front. Pharm.* **2018**, *9*, 483. [CrossRef]
26. Rossini, C.; Rodrigo, F.; Davyt, B.; Umpiérrez, M.L.; González, A.; Garrido, P.M.; Cuniolo, A.; Porrini, L.P.; Eguaras, M.J.; Porrini, M.P. Sub-lethal effects of the consumption of Eupatorium buniifolium essential oil in honeybees. *PLoS ONE* **2020**, *15*, e0241666. [CrossRef]
27. Sugumar, N.; Karthikeyan, S.; Gowdhami, T. Phytochemical analysis and antimicrobial activity of Eupatorium triplinerve Vahl. *Int. J. Appl. Res.* **2015**, *1*, 108–112.
28. Garg, S.C.; Nakhare, S. Studies on the essential oil from the flower of *Eupatohum triplinerve*. *Ind. Perfum.* **1993**, *37*, 318–323.
29. Fernie, A.R.; Trethewey, R.N.; Krotzky, A.J.; Willmitzer, L. Metabolite profiling: From diagnostics to systems biology. *Nat. Rev. Mol. Cell Biol.* **2004**, *5*, 763–769. [CrossRef]

30. Kokate, C.; Verma, K.C. Pharmacological studies on the essential oil of *Eupatorium triplinerve*. *Flavour. Ind.* **1971**, *2*, 177–180.
31. Warrier, P.K. *Indian Medicinal Plants: A Compendium of 500 Species*; Orient Blackswan PVT. LTD.: Hyderabad, India, 1994; Volume 2.
32. Subash, K.; Rao, N.; Cheriyan, B.; Bhaarati, G.; Kumar, K. The anthelmintic activity of *Eupatorium triplinerve* and *Alpinia galanga* in Pheritima posthuman and Ascardia galli: A comparative study. *J. Clin. Diagn. Res.* **2012**, *6*, 947–950.
33. Wang, R.; Wang, Y.-Z. Invasion dynamics and potential spread of the invasive alien plant species *Ageratina adenophora* (Asteraceae) in China. *Divers. Distrib.* **2006**, *12*, 397–408. [CrossRef]
34. Liu, X.; Qi, C.; Wang, Z.; Li, Y.; Wang, Q.; Guo, M.; Cao, A. Effect of picloram herbicide on physiological responses of *E. adenophorum* Spreng. *Chil. J. Agric. Res.* **2014**, *74*, 438–444. [CrossRef]
35. Buccellato, L.; Byrne, M.; Witkowskki, E. Interactions between a stem gall fly and a leaf-spot pathogen in the biological control of *Ageratina adenophora*. *Biol. Control* **2012**, *61*, 222–229. [CrossRef]
36. Codilla, L.T.; Metillo, E.B. Distribution and abundance of the invasive plant species *Chromolaena odorata* L. in the Zamboanga Peninsula, Philippines. *Int. J. Environ. Sci. Dev.* **2011**, *2*, 406. [CrossRef]
37. Owoyele, V.B.; Adediji, J.O.; Soladoye, A.O. Anti-inflammatory activity of aqueous leaf extract of *Chromolaena odorata*. *Inflammopharmacology* **2005**, *13*, 479–484. [CrossRef]
38. Anyasor, G.N.; Aina, D.A.; Olushola, M.; Aniyikaye, A.F. Phytochemical constituent, proximate analysis, antioxidant, antibacterial and wound healing properties of leaf extracts of *Chromolaena odorata*. *Ann. Biol. Res.* **2011**, *2*, 441–451.
39. Vaisakh, M.N.; Anima, P. Pharmacognostic study of leaves of *Chromolaena odorata* Linn. *Int. J. Pharma Sci. Res.* **2009**, *3*, 80–83.
40. Omoregie, E.S.; Oriakhi, K.; Oikeh, E.I.; Okugbo, O.T.; Akpobire, D. Comparative study of phenolic content and antioxidant activity of leaf extracts of *Alstonia boonei* and *Eupatorium odoratum*. *Niger. J. Basic Appl. Sci.* **2014**, *22*, 91–97.
41. Flores-Fernández, J.M.; Padilla-Camberos, E.; Fernández-Flores, O.; Diaz-Martínez, N.E.; Barragán-Álvarez, C.P.; Ramírez-Rodríguez, P.B. Gastroprotective activity and pharmacological safety evaluation of *Eupatorium aschenbornianum*. *Exp. Ther. Med.* **2019**, *18*, 4467–4472.
42. Lee, J.H.; Jung, M.H.; Lee, Y.H.; Shin, Y.; Kim, H.S.; Schreiber, J.; Kim, T.J. Inhibited apoptosis of C_2C_{12} myoblasts by a *Eupatorium chinense var. simplicifolium* root extract. *Biosci. Biotechnol. Biochem.* **2013**, *77*, 2134–2136. [CrossRef]
43. Jiangsu College of New Medicine. *A Dictionary of the Traditional Chinese Medicines*; Jiangsu College of New Medicine: Zhenjiang, China, 1977.
44. Pham, T.N.; Pham, H.D.; Dang, D.K.; Duong, T.T.; Le, T.P.Q.; Nguyen, Q.D.; Nguyen Tien, D. Anticyanobacterial phenolic constituents from the aerial parts of Eupatorium fortunei Turcz. *Nat. Prod. Res.* **2019**, *33*, 1345–1348. [CrossRef]
45. Shi, J.; Yuan, M.; Yu, Y.; Shi, S.-B.; Liu, Y.-G. Chiral resolution, absolute configuration of two pairs of unusual monoterpene enantiomers from *Eupatorium fortunei*. *Tetrahedron. Lett.* **2020**, *61*, 151655. [CrossRef]
46. Nan, G.; Zhang, L.; Liu, Z.; Liu, Y.; Du, Y.; Zhao, H.; Zheng, H.; Lin, R.; Yang, G.; Zheng, S. Quantitative Determination of p-Cymene, Thymol, Neryl Acetate, and β-Caryophyllene in Different Growth Periods and Parts of *Eupatorium fortunei* Turcz. by GC-MS/MS. *J. Anal. Methods Chem.* **2021**, *2021*, 2174667. [CrossRef]
47. Tori, M.; Takeichi, Y.; Kuga, H.; Nakashima, K.; Sono, M. Seven germacranolides, eupaglehnins A, B, C, D, E, and F, and 2α-acetoxyepitulipinolide from Eupatorium glehni. *Chem. Pharm. Bull.* **2002**, *50*, 1250–1254. [CrossRef]
48. Yang, N.Y.; Qian, S.H.; Duan, J.A.; Li, P.; Tian, L.J. Cytotoxic sesquiterpene lactones from Eupatorium lindleyanum. *J. Asian Nat. Prod. Res.* **2007**, *9*, 339–345. [CrossRef]
49. Yan, G.; Ji, L.; Luo, Y.; Hu, Y. Antioxidant activities of extracts and fractions from *Eupatorium lindleyanum* DC. *Molecules* **2011**, *16*, 5998–6009. [CrossRef]
50. Yang, B.; Zhao, Y.; Lou, C.; Zhao, H. Eupalinolide O, a novel sesquiterpene lactone from *Eupatorium lindleyanum* DC., induces cell cycle arrest and apoptosis in human MDA-MB-468 breast cancer cells. *Oncol. Rep.* **2016**, *36*, 2807–2813. [CrossRef]
51. Wang, F.; Zhong, H.; Fang, S.; Zheng, Y.; Li, C.; Peng, G.; Shen, X. Potential anti-inflammatory sesquiterpene lactones from *Eupatorium lindleyanum*. *Planta Med.* **2018**, *84*, 123–128. [CrossRef]
52. Tian, S.; Chen, Y.; Yang, B.; Lou, C.; Zhu, R.; Zhao, Y.; Zhao, H. F1012-2 inhibits the growth of triple negative breast cancer through induction of cell cycle arrest, apoptosis, and autophagy. *Phytother. Res.* **2018**, *32*, 908–922. [CrossRef]
53. Yang, B.; Shen, J.W.; Zhou, D.H.; Zhao, Y.P.; Wang, W.Q.; Zhu, Y.; Zhao, H.J. Precise discovery of a STAT3 inhibitor from *Eupatorium lindleyanum* and evaluation of its activity of anti-triple-negative breast cancer. *Nat. Prod. Res.* **2019**, *33*, 477–485. [CrossRef]
54. Wu, Z.; Xu, X.; Dai, L.; Wang, Y.; Yang, B.; Zhao, H.; Lou, C. Eupalinolide J induces apoptosis, cell cycle arrest, mitochondrial membrane potential disruption and DNA damage in human prostate cancer cells. *J. Toxicol. Sci.* **2020**, *45*, 15–23. [CrossRef] [PubMed]
55. Gu, G.-J.; Eom, S.-H.; Shin, H.-J.; Paek, J.H.; Kim, S.; Lim, S.S.; Youn, H.-S. Japanese bog orchid (*Eupatorium japonicum*) extract suppresses expression of inducible nitric oxide synthase and cyclooxygenase-2 induced by toll-like receptor agonists. *Food Sci. Biotechnol.* **2013**, *22*, 811–815. [CrossRef]
56. Shin, J.-I.; Jeon, Y.-J.; Lee, S.; Lee, Y.G.; Kim, J.B.; Kwon, H.C.; Kim, S.H.; Kim, I.; Lee, K.; Han, Y.S. Apoptotic and anti-inflammatory effects of *Eupatorium japonicum* thunb. in rheumatoid arthritis fibroblast-like synoviocytes. *BioMed Res. Int.* **2018**, *2018*, 1383697. [CrossRef]
57. Zhang, Y.; Wang, Y.; Li, M.; Liu, S.; Yu, J.; Yan, Z.; Zhou, H. Traditional uses, bioactive constituents, biological functions, and safety properties of *Oviductus ranae* as functional foods in China. *Oxidative Med. Cell. Longev.* **2019**, *2019*, 4739450. [CrossRef]

58. Dai, G.; Wang, C.; Tang, W.; Liu, J.; Xue, B. A 90-Day Oral Toxicity Study of the Ethanol Extract from *Eupatorium japonicum* Thunb and *Foeniculum vulgare* in Rats. *Biomed Res. Int.* **2020**, *2020*, 6859374. [CrossRef]
59. Phan, M.G.; Do, T.T.; Nguyen, T.N.; Do, T.V.H.; Dong, N.P.; Vu, M.T. Chemical Constituents of *Eupatorium japonicum* and Anti-Inflammatory, Cytotoxic, and Apoptotic Activities of Eupatoriopicrin on Cancer Stem Cells. *Evid. Based Complement. Altern. Med.* **2021**, *2021*, 6610347. [CrossRef]
60. Liang, W.H.; Chang, T.W.; Charng, Y.C. Influence of harvest stage on the pharmacological effect of *Angelica dahurica*. *Bot. Stud.* **2018**, *59*, 14. [CrossRef]
61. Szymborska-Sandhu, I.; Przybył, J.L.; Kosakowska, O.; Bączek, K.; Węglarz, Z. Chemical Diversity of Bastard Balm (*Melittis melisophyllum* L.) as Affected by Plant Development. *Molecules* **2020**, *25*, 2421. [CrossRef]
62. Zheng, Y.L.; Feng, Y.L.; Zhang, L.K.; Callaway, R.M.; Valiente-Banuet, A.; Luo, D.Q.; Liao, Z.Y.; Lei, Y.B.; Barclay, G.F.; Silva-Pereyra, C. Integrating novel chemical weapons and evolutionarily increased competitive ability in success of a tropical invader. *New Phytol.* **2015**, *205*, 1350–1359. [CrossRef]
63. Arung, E.T.; Kuspradini, H.; Kusuma, I.W.; Shimizu, K.; Kondo, R. Validation of *Eupatorium triplinerve* Vahl leaves, a skin care herb from East Kalimantan, using a melanin biosynthesis assay. *J. Acupunct. Meridian Stud.* **2012**, *5*, 87–92. [CrossRef] [PubMed]
64. Cheriyan, B.V., Sr.; Kadhirvelu, P., Sr.; Nadipelly, J., Jr.; Shanmugasundaram, J.; Sayeli, V., Sr.; Subramanian, V., Sr. Anti-nociceptive Effect of 7-methoxy Coumarin from *Eupatorium Triplinerve vahl* (Asteraceae). *Pharm. Mag.* **2017**, *13*, 81–84. [CrossRef]
65. Biswas, A.; Bhattacharya, S.; Mahapatra, S.D.; Debnath, M.D.; Biswas, M. The Antioxidant Effects of *Eupatorium triplinerve*, *Hygrophila triflora* and *Pterocarpus marsupium*—A Comparative Study. *Eur. J. Appl. Sci.* **2012**, *4*, 136–139.
66. Ding, J.; Xuejian, Y.; Yu, W.; Ding, Z.; Chen, Z.; Hayashi, N.; Komae, H. Aromatic Components of the Essential Oils of Four Chinese Medicinal Plants (*Asarum petelotii*, *Elsholtzia souliei*, *Eupatorium adenophorum*, *Micromeria biflora*) in Yunnan. *Z. Für Nat. C* **1994**, *49*, 703–706. [CrossRef]
67. Pala-Paul, J.; Perez-Alonso, M.; Velasco-Negueruela, S. Spectrometry of the volatile components of *Ageratina adenophora* Spreng, growing in the Canary Islands. *J. Chromatogr. A* **2002**, *947*, 327–331. [CrossRef]
68. Ouyang, C.-B.; Liu, X.-M.; Liu, Q.; Bai, J.; Li, H.-Y.; Li, Y.; Wang, Q.-X.; Yan, D.-D.; Mao, L.-G.; Cao, A.; et al. Toxicity Assessment of Cadinene Sesquiterpenes from *Eupatorium adenophorum* in Mice. *Nat. Prod. Bioprospecting.* **2015**, *5*, 29–36. [CrossRef]
69. Ouyang, C.-b.; Liu, X.-m.; Yan, D.-d.; Li, Y.; Wang, Q.-x.; Cao, A.-c.; Guo, m.-x. Immunotoxicity assessment of cadinene sesquiterpenes from *Eupatorium adenophorum* in mice. *J. Integr. Agric.* **2016**, *15*, 2319–2325. [CrossRef]
70. Liu, B.; Cao, L.; Zhang, L.; Yuan, X.; Zhao, B. Preparation, Phytochemical Investigation, and Safety Evaluation of Chlorogenic Acid Products from *Eupatorium adenophorum*. *Molecules* **2017**, *22*, 67. [CrossRef]
71. Wei, Y.; Gao, Y.; Zhang, K.; Ito, Y. Isolation of caffeic acid from *Eupatorium adenophorum*-spreng by high-speed countercurrent chromatography and synthesis of caffeic acid-intercalates layered double hydroxide. *J. Liq. Chromatogr. Relat. Technol.* **2010**, *33*, 837–845. [CrossRef]
72. Wei, Y.; Zhang, K.; Zhang, G.; Ito, Y. Isolation of five bioactive components from *Eupatorium adenophorum* spreng using stepwise elution by high-speed countercurrent chromatography. *J. Liq. Chromatogr. Relat. Technol.* **2011**, *34*, 2505–2515. [CrossRef]
73. Mo, Q.; Hu, L.; Weng, J.; Zhang, Y.; Zhou, Y.; Xu, R.; Zuo, Z.; Deng, J.; Ren, Z.; Zhong, Z.; et al. Euptox A Induces G1 Arrest and Autophagy via p38 MAPK- and PI3K/Akt/mTOR-Mediated Pathways in Mouse Splenocytes. *J. Histochem. Cytochem.* **2017**, *65*, 543–558. [CrossRef]
74. Liu, Y.; Luo, S.-H.; Hua, J.; Li, D.-S.; Ling, Y.; Luo, Q.; Li, S.-H. Characterization of defensive cadinenes and a novel sesquiterpene synthase responsible for their biosynthesis from the invasive *Eupatorium adenophorum*. *New Phytol.* **2021**, *229*, 1740–1754. [CrossRef]
75. Wagner, H.; Proksch, A.; Riess-Maurer, I.; Vollmar, A.; Odenthal, S.; Stuppner, H.; Jurcic, K.; Le Turdu, M.; Heur, Y.H. Immunostimulant action of polysaccharides (heteroglycans) from higher plants. Preliminary communication. *Arzneim. Forsch.* **1984**, *34*, 659–661.
76. Gao, Y.; Zhang, Y.; Fan, Y. Eupafolin ameliorates lipopolysaccharide-induced cardiomyocyte autophagy via PI3K/AKT/mTOR signaling pathway. *Iran J. Basic Med. Sci.* **2019**, *22*, 1340–1346. [CrossRef]
77. Sanjukta, R.; Das, S.; Puro, K.; Ghatak, S.; Shakuntala, I.; Sen, A. Screening of Phytochemical and Antibacterial Property of Some Local Herbs of Meghalaya. *Indian J. Hill Farming* **2019**, 27–32.
78. Al-Snafi, A. Chemical constituents, pharmacological and therapeutic effects of eupatorium cannabinum-a review. *Indo Am. J. Pharm. Sci.* **2017**, *4*, 160–168.
79. Zhu, Z.; Yuan, J.; Xu, X.; Wei, Y.; Yang, B.; Zhao, H. Eucannabinolide, a novel sesquiterpene lactone, suppresses the growth, metastasis and BCSCS-like traits of TNBC via inactivation of STAT3. *Neoplasia* **2021**, *23*, 36–48. [CrossRef]
80. Reyes-Trejo, B.; Guerra-Ramírez, D.; Zuleta-Prada, H.; Santillán, R.; Sánchez-Mendoza, M.E.; Arrieta, J.; Reyes, L. Molecular Disorder in (–)-Encecanescin. *Molecules* **2014**, *19*, 4695–4707. [CrossRef]
81. Conner, W.E.; Boada, R.; Schroeder, F.C.; González, A.; Meinwald, J.; Eisner, T. Chemical defense: Bestowal of a nuptial alkaloidal garment by a male moth on its mate. *Proc. Natl. Acad. Sci. USA* **2000**, *97*, 14406–14411. [CrossRef]
82. Itoh, T.; Ohguchi, K.; Nozawa, Y.; Akao, Y. Intracellular Glutathione Regulates Sesquiterpene Lactone-induced Conversion of Autophagy to Apoptosis in Human Leukemia HL60 Cells. *Anticancer. Res.* **2009**, *29*, 1449.
83. Lee, J.; Park, J.; Kim, J.; Jeong, B.; Choi, S.Y.; Jang, H.S.; Yang, H. Targeted Isolation of Cytotoxic Sesquiterpene Lactones from Eupatorium fortunei by the NMR Annotation Tool, SMART 2.0. *ACS Omega* **2020**, *5*, 23989–23995. [CrossRef]

84. Chang, C.-H.; Wu, S.; Hsu, K.-C.; Huang, W.-J.; Chen, J.-J. Dibenzofuran, 4-Chromanone, Acetophenone, and Dithiecine Derivatives: Cytotoxic Constituents from *Eupatorium fortunei*. *Int. J. Mol. Sci.* **2021**, *22*, 7448. [CrossRef]
85. Tori, M.; Morishita, N.; Hirota, N.; Saito, Y.; Nakashima, K.; Sono, M.; Tanaka, M.; Utagawa, A.; Hirota, H. Sesquiterpenoids Isolated from *Eupatorium glehnii*. Isolation of Guaiaglehnin A, Structure Revision of Hiyodorilactone B, and Genetic Comparison. *Chem. Pharm. Bull.* **2008**, *56*, 677–681. [CrossRef]
86. Saito, Y.; Mukai, T.; Iwamoto, Y.; Baba, M.; Takiguchi, K.; Okamoto, Y.; Gong, X.; Kawahara, T.; Kuroda, C.; Tori, M. Germacranolides and their diversity of *Eupatorium heterophyllum* collected in PR China. *Chem. Pharm. Bull.* **2014**, *62*, 1092–1099. [CrossRef]
87. Abourashed, E.A. Bioavailability of Plant-Derived Antioxidants. *Antioxidants* **2013**, *2*, 309–325. [CrossRef]
88. Dubey, N. *Plants as a Source of Natural Antioxidants*; CABI International: Wallingford, UK, 2015.
89. Sikora, E.; Cieślik, E.; Topolska, K. The sources of natural antioxidants. *Acta Sci. Pol. Technol. Aliment.* **2008**, *7*, 5–17.
90. Saxena, M.; Saxena, J.; Pradhan, A. Flavonoids and phenolic acids as antioxidants in plants and human health review article. *Int. J. Pharm. Sci. Rev. Res.* **2012**, *16*, 130–134.
91. Krishnaiah, D.; Sarbatly, R.; Nithyanandam, R. A review of the antioxidant potential of medicinal plant species. *Food Bioprod. Process.* **2011**, *89*, 217–233. [CrossRef]
92. Barański, M.; Srednicka-Tober, D.; Volakakis, N.; Seal, C.; Sanderson, R.; Stewart, G.B.; Benbrook, C.; Biavati, B.; Markellou, E.; Giotis, C.; et al. Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: A systematic literature review and meta-analyses. *Br. J. Nutr.* **2014**, *112*, 794–811. [CrossRef]
93. Sharma, R.K.; Micali, M.; Pellerito, A.; Santangelo, A.; Natalello, S.; Tulumello, R.; Singla, R.K. Studies on the Determination of Antioxidant Activity and Phenolic Content of Plant Products in India (2000–2017). *J. AOAC Int.* **2019**, *102*, 1407–1413. [CrossRef]
94. Rezaeian, S.; Hamid Reza Pourianfar, H.; Janpoor, J. Antioxidant properties of several medicinal plants growing wild in northeastern Iran. *Asian J. Plant Sci. Res.* **2015**, *5*, 63–68.
95. Agarwal, A.; Aponte-Mellado, A.; Premkumar, B.J.; Shaman, A.; Gupta, S. The effects of oxidative stress on female reproduction: A review. *Reprod. Biol. Endocrinol.* **2012**, *10*, 49. [CrossRef] [PubMed]
96. Salas-Pacheco, J.M.; Lourenco-Jaramillo, D.L.; Mendez-Hernandez, E.M.; Sandoval-Carrillo, A.A.; Hernandez Rayon, Y.I.; Llave-Leon, O.L.; Aguilar-Duran, M.; Lopez-Terrones, M.A.; Barraza-Salas, M.; Vazquez-Alaniz, F. Oxidative stress equilibrium during obstetric event in normal pregnancy. *J. Matern. Fetal Neonatal Med.* **2017**, *30*, 1836–1840. [CrossRef] [PubMed]
97. Mannaerts, D.; Faes, E.; Cos, P.; Briedé, J.J.; Gyselaers, W.; Cornette, J.; Gorbanev, Y.; Bogaerts, A.; Spaanderman, M.; Van Craenenbroeck, E.; et al. Oxidative stress in healthy pregnancy and preeclampsia is linked to chronic inflammation, iron status and vascular function. *PLoS ONE* **2018**, *13*, e0202919. [CrossRef]
98. Zielińska, M.A.; Wesołowska, A.; Pawlus, B.; Hamułka, J. Health Effects of Carotenoids during Pregnancy and Lactation. *Nutrients* **2017**, *9*, 838. [CrossRef]
99. Ziomkiewicz, A.; Sancilio, A.; Galbarczyk, A.; Klimek, M.; Jasienska, G.; Bribiescas, R.G. Evidence for the Cost of Reproduction in Humans: High Lifetime Reproductive Effort Is Associated with Greater Oxidative Stress in Post-Menopausal Women. *PLoS ONE* **2016**, *11*, e0145753. [CrossRef]
100. Marseglia, L.; D'Angelo, G.; Manti, S.; Arrigo, T.; Barberi, I.; Reiter, R.J.; Gitto, E. Oxidative Stress-Mediated Aging during the Fetal and Perinatal Periods. *Oxidative Med. Cell. Longev.* **2014**, *2014*, 358375. [CrossRef]
101. Ayoola, G.; Abayomi, F.; Adesegun, S.; Abioro, O.; Adepoju-Bello, A.; Coker, H. B Phytochemical and antioxidant screening of some plants of apocynaceae from South West Nigeria. *Afr. J. Plant Sci.* **2008**, *2*, 124–128.
102. Padmanabhan, P.; Jangle, S.N. Evaluation of DPPH Radical Scavenging Activity and Reducing Power of Four Selected Medicinal Plants and Their Combinations. *Int. J. Pharmac. Sci. Drug Res.* **2012**, *4*, 143–146.
103. Uyoh, E.A.; Chukwurah, P.N.; David, I.A.; Bassey, A.C. Evaluation of Antioxidant Capacity of Two *Ocimum* Species Consumed Locally as Spices in Nigeria as a Justification for Increased Domestication. *Am. J. Plant Sci.* **2013**, *4*, 9. [CrossRef]
104. Baptista, R.C.; Horita, C.N.; Sant'Ana, A.S. Natural products with preservative properties for enhancing the microbiological safety and extending the shelf-life of seafood: A review. *Food Res. Int.* **2020**, *127*, 108762. [CrossRef]
105. Mandim, F.; Petropoulos, S.A.; Dias, M.I.; Pinela, J.; Kostic, M.; Soković, M.; Santos-Buelga, C.; Ferreira, I.; Barros, L. Seasonal variation in bioactive properties and phenolic composition of cardoon (*Cynara cardunculus* var. altilis) bracts. *Food Chem.* **2021**, *336*, 127744. [CrossRef]
106. Garcia-Oliveira, P.; Barral, M.; Carpena, M.; Gullón, P.; Fraga-Corral, M.; Otero, P.; Prieto, M.A.; Simal-Gandara, J. Traditional plants from Asteraceae family as potential candidates for functional food industry. *Food Funct.* **2021**, *12*, 2850–2873. [CrossRef]
107. Ivorra, M.D.; Payá, M.; Villar, A. A review of natural products and plants as potential antidiabetic drugs. *J. Ethnopharmacol.* **1989**, *27*, 243–275. [CrossRef]
108. Ramanathan, S.; Sivakumar, T.; Sundaram, R.; Sivakumar, P.; Nethaji, R.; Gupta, M.; Mazumdar, U. Antimicrobial and Antioxidant Activities of *Careya arborea* Roxb. Stem Bark. *Iran. J. Pharmacol. Ther.* **2006**, *5*, 35–41.
109. Ahmad, I.; Ahmed, S.; Anwar, Z.; Sheraz, M.A.; Sikorski, M. Photostability and Photostabilization of Drugs and Drug Products. *Int. J. Photoenergy* **2016**, *2016*, 8135608. [CrossRef]
110. Kim, H.; Tse, Y.; Webb, A.; Mudd, E.; Abedin, M.R.; Mormile, M.; Dutta, S.; Rege, K.; Barua, S. PolyRad-Protection against Free Radical Damage. *Sci. Rep.* **2020**, *10*, 8335. [CrossRef]

111. Holick, M.F. Biological Effects of Sunlight, Ultraviolet Radiation, Visible Light, Infrared Radiation and Vitamin D for Health. *Anticancer Res.* **2016**, *36*, 1345–1356.
112. Jarco, S.; Pilawa, B.; Ramos, P. Free Radical Scavenging Activity of Infusions of Different Medicinal Plants for Use in Obstetrics. *Plants* **2021**, *10*, 2016. [CrossRef]
113. Li, C.; Chen, S.; Sha, J.; Cui, J.; He, J.; Fu, J.; Shen, Y. Extraction and purification of total flavonoids from *Eupatorium lindleyanum* DC. and evaluation of their antioxidant and enzyme inhibitory activities. *Food Sci. Nutr.* **2021**, *9*, 2349–2363. [CrossRef]
114. Yamashita, Y.; Hoshino, T.; Matsuda, M.; Kobayashi, C.; Tominaga, A.; Nakamura, Y.; Nakashima, K.; Yokomizo, K.; Ikeda, T.; Mineda, K.; et al. HSP70 inducers from Chinese herbs and their effect on melanin production. *Exp. Derm.* **2010**, *19*, e340–e342. [CrossRef] [PubMed]
115. Setyawati, A.; Yamauchi, K.; Mitsunaga, T. Potential of Medicinal Plants Extractives as Anti-Melanogenesis Ingredients. *Rev. Agric. Sci.* **2018**, *6*, 46–60. [CrossRef]
116. Britto, J. Comparative antibacterial activity study of *Solanum incanum*, L. *J. Swamy Bot. Club* **2001**, *18*, 81–82.
117. Rahman, M.A.; Yan, L.K.; Rukayadi, Y. Antibacterial activity of fingerroot (*Boesenbergia rotunda*) extract against acne-inducing bacteria. *Res. J. Pharm. Biol. Chem. Sci.* **2016**, *7*, 2157–2163.
118. Ramesh, P.; Subramani, A. Effect of antimicrobial activity of *Eupatorium odoratum* against clinical microbes. *Int. J. Sci. Res. Biol. Sci.* **2018**, *5*, 30–35. [CrossRef]
119. Cheriyan, B.V.; Venkatadri, N.; Viswanathan, S.; Kamalakannan, P. Screening of alcoholic extract of Eupatorium triplinerve Vahl and its fractions for its antinociceptive activity. *Indian Drugs* **2009**, *46*, 55–60.
120. Chakravarty, A.K.; Mazumder, T.; Chatterjee, S.N. Anti-Inflammatory Potential of Ethanolic Leaf Extract of *Eupatorium adenophorum* Spreng. through Alteration in Production of TNF-α, ROS and Expression of Certain Genes. *Evid. Based Complement. Altern. Med.* **2011**, *2011*, 471074. [CrossRef]
121. Kundu, A.; Saha, S.; Walia, S.; Ahluwalia, V.; Kaur, C. Antioxidant potential of essential oil and cadinene sesquiterpenes of *Eupatorium adenophorum*. *Toxicol. Environ. Chem.* **2013**, *95*, 127–137. [CrossRef]
122. Nong, X.; Ren, Y.J.; Wang, J.H.; Fang, C.L.; Xie, Y.; Yang, D.Y.; Liu, T.F.; Chen, L.; Zhou, X.; Gu, X.B.; et al. Clinical efficacy of botanical extracts from *Eupatorium adenophorum* against the scab mite, *Psoroptes cuniculi*. *Vet. Parasitol.* **2013**, *192*, 247–252. [CrossRef]
123. Ahluwalia, V.; Sisodia, R.; Walia, S.; Sati, O.P.; Kumar, J.; Kundu, A. Chemical analysis of essential oils of *Eupatorium adenophorum* and their antimicrobial, antioxidant and phytotoxic properties. *J. Pest Sci.* **2014**, *87*, 341–349. [CrossRef]
124. Yadav, M.; Khan, K. Antimicrobial activity of some ethnomedicinal plants used by tribes of rewa, madhya Pradesh. *Indian J. Life Sci.* **2012**, *1*, 35–38.