Artemisia Species with High Biological Values as a Potential Source of Medicinal and Cosmetic Raw Materials

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Abstract: Artemisia species play a vital role in traditional and contemporary medicine. Among them, Artemisia abrotanum, Artemisia absinthium, Artemisia annua, Artemisia dracunculus, and Artemisia vulgaris are the most popular. The chemical composition and bioactivity of these species have been extensively studied. Studies on these species have confirmed their traditional applications and documented new pharmacological directions and their valuable and potential applications in cosmetology. Artemisia ssp. primarily contain sesquiterpenoid lactones, coumarins, flavonoids, and phenolic acids. Essential oils obtained from these species are of great biological importance. Extracts from Artemisia ssp. have been scientifically proven to exhibit, among others, hepatoprotective, neuroprotective, antidepressant, cytotoxic, and digestion-stimulating activities. In addition, their application in cosmetic products is currently the subject of several studies. Essential oils or extracts from different parts of Artemisia ssp. have been characterized by antibacterial, antifungal, and antioxidant activities. Products with Artemisia extracts, essential oils, or individual compounds can be used on skin, hair, and nails. Artemisia products are also used as ingredients in skincare cosmetics, such as creams, shampoos, essences, serums, masks, lotions, and tonics. This review focuses especially on elucidating the importance of the most popular/important species of the Artemisia genus in the cosmetic industry.

Keywords: Artemisia abrotanum; Artemisia absinthium; Artemisia annua; Artemisia dracunculus; Artemisia vulgaris; chemical composition; pharmacological activities; cosmetic applications; safety of use

1. Introduction

Over the past few years, Artemisia species have gained huge research interest due to their chemical composition and biological activities. This increase in interest is undoubtedly due to the award of the Nobel Prize in medicine in 2015 for the discovery of artemisinin—a sesquiterpenoid lactone effective in the treatment of malaria, which is found in Artemisia annua. In addition to A. annua, Artemisia abrotanum, Artemisia absinthium, Artemisia dracunculus, and Artemisia vulgaris are also popular worldwide. Their applications are even found in historical traditional medicine. Today, their chemical composition and biological properties have been extensively studied. Of particular importance is the increase in interest in the application of these species in cosmetic products [1,2].

The habitats of different Artemisia ssp. differ from one another and are widely distributed. Natural habitats of these species are found in Europe, Asia, North Africa, North and South America, and Australia [1,2].

For years, plants have been used as remedies mainly in areas where they occurred naturally. Today, their ethnobotanical and ethnopharmacological indications have been proved by scientific studies. There are known species, such as Matthiola incana and Daphne mucronata as well as the plants from genus Aronia, Mimosa, Schisandra, and many others, that
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have proven therapeutic effects and are common recognized phytopharmaceuticals [3–7]. For centuries, Artemisia spp. have been considered effective in various ailments, e.g., parasitic disease, digestive ailments, irritation, and allergic rashes [8–12]. Currently, Artemisia spp. are also used in phytopharmacology. Contemporary pharmacological studies have been focused on confirming and explaining the mechanisms of these traditionally reported activities. Of late, Artemisia spp. extracts have been scientifically proved to exhibit many biological activities. Research studies have primarily focused on A. absinthium, which is reported to show hepatoprotective, neuroprotective, antidepressant, cytotoxic, and digestion-stimulating activities [13–19]. Furthermore, antitumor activity has been documented for A. abrotanum and A. dracunculus extracts [20,21]. A. vulgaris and A. dracunculus have been shown to have an interesting biological effect on the endocrine system. A. dracunculus normalizes the profile of thyroid hormones, whereas A. vulgaris shows estrogenic activity [22–24]. One of the most important biological properties of Artemisia spp. is their antiprotozoal activity, which has been proved for A. absinthium, A. annua, and A. dracunculus extracts [25–37].

Furthermore, the use of Artemisia spp. in the production of cosmetic products has been increasing significantly. They are used as ingredients in cosmetic products for skin and hair care and also in perfumes. Extracts of A. abrotanum and A. absinthium have scientifically proven effects against acne-causing bacteria (Propionibacterium acnes). In addition, A. abrotanum, A. absinthium, A. annua, A. dracunculus, and A. vulgaris extracts have been characterized by antioxidant activity. These properties are highly important due to their possible antiaging effect in cosmetic products [20,38–41].

While compiling this review, great efforts were invested to present the qualities of the most popular Artemisia spp. (A. abrotanum, A. absinthium, A. annua, A. dracunculus, and A. vulgaris) in detail, with a particular emphasis on their cosmeticological properties. In this review, chemical composition, biological activities, traditional and contemporary medicinal uses, and the safety of the abovementioned species are discussed.

2. Materials and Methods

A detailed literature review that included papers published from 1978 to 2022 was carried out. Several databases, such as Scopus, Google Scholar, PubMed, were explored in order to collect information on A. abrotanum, A. absinthium, A. annua, A. dracunculus, and A. vulgaris. Various publications, chapters and books were consulted. The species names and the synonyms names were used as keywords. The scientific names and their synonyms were validated using a standard database—The World Flora Online [42].

3. General Characteristics of Artemisia Species

Artemisia spp. gained huge research attention in 2015, when the Nobel Prize in medicine was awarded for the discovery of artemisinin [1,2], a sesquiterpenoid lactone isolated from A. annua (annual mugwort), proving its effectiveness in the treatment of malaria. Subsequently, the chemistry and biological activity of other Artemisia species have gained increasing attention [8–12]. There are more than 300 Artemisia species. Furthermore, some Artemisia spp. have many synonymous Latin names. In this review, the five most popular Artemisia spp. worldwide from a phytopharmacological point of view were studied: A. abrotanum, A. absinthium, A. annua, A. dracunculus, and A. vulgaris.

The natural habitats of Artemisia spp. are wide-ranging. A. abrotanum, A. absinthium, A. annua, A. dracunculus, and A. vulgaris are found mainly in Asia and Europe. However, the distribution of these species may differ from one another. A. abrotanum and A. dracunculus grow in Central Asia and Mediterranean countries. Additionally, A. abrotanum grows in Central and Northwestern Europe [1,43–47], whereas A. dracunculus grows in Eastern Europe and North America [2,47]. In West Asia, the natural habitats of A. absinthium and A. annua are found. The natural habitats of A. absinthium and A. annua are found in North and South Africa and Australia. The species A. vulgaris is widespread, as it is found in
many areas of Asia, including the Himalayas, throughout Europe, and in warm regions of North America [44–46,48] (Table 1).

Artemisia ssp. are also artificially cultivated across the world. For instance, *A. abrotanum* is cultivated in the USA, whereas *A. absinthium* is cultivated in southern Europe, the USA, and Brazil [8,9,49–51]. The successful cultivation of *A. annua* has been carried out in many tropical countries, such as Congo, India, and Brazil. It is also an industrial crop in China, Kenya, Tanzania, and Vietnam. The species *A. dracunculus* is widely cultivated in North and South America, Asia, and Europe [52–54], while *A. vulgaris* is cultivated on an industrial scale in Italy, France, Brazil, Japan, and in the mountainous regions of India and Sri Lanka [55].

The mentioned species—*A. abrotanum*, *A. absinthium*, *A. annua*, *A. dracunculus*, and *A. vulgaris*—are herbaceous plants that grow up to 1.5 m in height, except for *A. vulgaris*, which can grow up to 2.5 m. The shape of the leaves may differ between species. The flowers are yellow and can be lingual and tubular. Inflorescences may be branched panicles or raceme-like. In each species described, the fruit is achenes. Detailed information on the morphological features of leaves, flowers, and fruits is presented in Table 1.
Table 1. Comparison of botanical characteristics and occurrence of *Artemisia* ssp.

| Species       | Height           | Leaves                                                                 | Flowers                                                                 | Fruits                                      | Occurrence                                                                 |
|---------------|------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------|
| *A. abrotanum* | 0.7–1.5 m [56]   | Gray-green leaves with numerous covering hairs on the upper side; the smooth underside of the leaves; in the lower part of the stem are doubly pinnate with ensiform sections; in the upper parts a singly pinnate, tripartite, also with ensiform shape [57,58] | Tiny yellow tubular flowers, gathered in spherical or ovoid-spherical hanging heads, panicle forms | Small oblong achenes [57,58]               | Central Asia (Armenia, Iran, and Russia), Asia Minor (Turkey), Central and North Europe Europe (e.g., Albania and Croatia) [1,8] |
| *A. absinthium* | 0.8–1.5 m [8,9,59] | Gray-green color, densely pubescent on both sides; basal leaves with long petioles, triangular or oval blade, bi- or tripinnaatisect, the lower leaves not intensely divided, and the lanceolate top leaves [8,9,59] | Capitulum inflorescences gathered in loose panicles from the axes of the leaves; light-yellow ligulate female flowers, and tubular hermaphroditic flowers [9,59] | Small achene with brown stripes [59] | Europe, West Asia, and North Africa; introduced and acclimatized in North and South America and Australia [8,9,49–51] |
| *A. annua*    | 0.3–1 m [10]     | Alternate arrangement [60], the tripinnaatisect lower leaves from petioles, the middle leaves bipinnatisect, the upper leaves sessile with lanceolate shape [61], leaf blades can be ensiform or lanceolate, the edge of the blades serrated [8] | Flower heads in raceme-like inflorescences, small, spherical, yellow-green, only tubular flowers [8,61] | Small, long achenes [60] | Southeastern Europe, Western Asia, North and South America, Australia [8,51,60] |
| *A. dracunculus* | 0.5–1.5 m [2,62,63] | Alternate, sessile, the lower leaves tripartite at the apex, the middle and upper leaves lanceolate, tip of the leaf sharp and the leaf blade margins entire [2,62,63]; | Yellow, tubular flowers in hanging, spherical capitula forming loose panicles [2,62,63] | Small achenes [2,62,63] | Central Asia, South Europe, Eastern Europe, North America [2] |
| *A. vulgaris* | 0.5–2.5 m [8,64] | Dense and alternate, primarily in the upper parts of the stem, the lower leaves with short petioles divided into segments and feathery shape, the middle and upper ones smaller and single or double pinnate, the dorsal side of the leaves with dark green color, the ventral side whitish and tomentose [65,66] | Small, almost bare, yellowish or brown-red flowers embedded in small baskets form heavily branched panicles with numerous lanceolate bracts at the top of the shoots, inflorescences with ligulate flowers and tubular flowers [65,66] | Small dark brown shiny achenes [66,67] | Europe, Asia, abundantly in North America [57,64,66,67] |
4. Phytochemical Characteristics of Artemisia Species

The Artemisia species discussed here differ from each other in their chemical composition; although there are some common classes of compounds, variable chemical composition has been reported for different species.

A common characteristic of these species is sesquiterpenoid lactones. Artemisinin (Figure 1a) is a well-known sesquiterpenoid lactone present in A. annua, A. abrotanum, and A. vulgaris. Artemisinin was discovered by Prof. Youyou Tu, a Chinese scientist in the field of pharmaceutical chemistry, and for this achievement and proving the effectiveness of this compound in the treatment of malaria, she was awarded the 2015 Nobel Prize in medicine [68]. In addition to artemisinin, sesquiterpenoid lactones artemisinic acid and artanruin B are found in A. annua [69–74], whereas in A. vulgaris, the presence of 1,2,3,4-diepoxy-11(13)-eudesmen-12,8-olide, psilostachyin (Figure 1b), psilostachyin C, vulgarin, and yomogin is reported. Moreover, artemisin (Figure 1c) and santonin has been identified in A. abrotanum [58]. Studies have reported a wide range of sesquiterpenoid lactones in the herb of A. absinthium [75]. The major metabolite found is absinthin (Figure 1d)—a guaianolide dimer. Other compounds, such as anabsinthin, anabsin, artabsin, and absintholide—all being absinthin isomers—are also found in high concentrations [76]. In the herb extracts of A. dracunculus, artemether and dihydroartemisinin have been detected [77]. Additionally, various sesquiterpenoid compounds have been reported in essential oils of the discussed Artemisia ssp. (Table 2) [2,11,33,54,57,65,73,74,78–109].

![Chemical structure of sesquiterpenoid lactones found in Artemisia species: artemisinin (a); psilostachyin (b); artemisin (c); absinthin (d).](image-url)
Flavonoids are another important group of compounds found in *Artemisia* ssp. Similar to sesquiterpenoid lactones, flavonoid composition in the studied species differs from each other. The most frequently listed flavonoids characteristic of *Artemisia* ssp. are artemetin (Figure 2a) and casticin (Figure 2b), which are detected in extracts from the herb of *A. abrotanum*, *A. absinthium*, and *A. annua* [69,74,110,111]. Other *Artemisia* species also have flavonoids, such as apigenin, kaempferol, luteolin, and quercetin, as well as their derivatives, such as rutoside (Table 2).

![Figure 2. Chemical structure of flavonoids found in *Artemisia* species: artemetin (a); casticin (b).](image)

Another group of metabolites found in the discussed *Artemisia* ssp. are coumarins. Several coumarins have been found in *A. dracunculus*, such as arethinol, aridiodiol, artemidiol, artemidine, artemidinol, dacumerin, and their derivatives [2,54,97,102,112–115]. In addition, the presence of coumarin (Figure 3a), esculetin (Figure 3b), scopoline (Figure 3c), and herniarin (Figure 3d) has been documented in most of the discussed *Artemisia* ssp. (Table 2) [2,54,55,84,89,97,102,111–120].

![Figure 3. Chemical structure of coumarins found in *Artemisia* species: coumarin (a); esculetin (b); scopoline (c); herniarin (d).](image)

Phenolic acids are another group of compounds found in *Artemisia* spp. extracts. In the most of discussed *Artemisia* ssp., the presence of caffeic acid (Figure 4a), *p*-coumaric acid (Figure 4b), chlorogenic acid (Figure 4c), ferulic acid (Figure 4d), rosmarinic acid, syringic acid, and vanillic acid has been documented [20,35,54,58,74,76,84,97,101,111,113,114,116,121–128]. In addition to the abovementioned compounds, protocatechuic acid has also been found in *A. abrotanum* and *A. vulgaris* [20,58,116,127,128], whereas gallic acid and salicylic acid have been reported in *A. absinthium* [35,76,84,121,122]. All compounds present in the discussed *Artemisia* ssp. are listed in Table 2.
Figure 4. Chemical structure of phenolic acids found in *Artemisia* species: caffeic acid (a); *p*-coumaric acid (b); chlorogenic acid (c); ferulic acid (d).
| Species       | Sesquiterpenoid Lactones                                                                 | Flavonoids                                                                 | Coumarins                                                                 | Phenolic Acids                                                                 |
|--------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|--------------------------------------------------------------------------------|
|              | artemisin, santonin [58]                                                                   | apigenin, artemetin, casticin centaureidine, hyperoside, isoquercitrin, kaempferol, luteolin, myricetin, patuletin, rutoside, quercetin, quercetol [58] | coumarin, esculetin, herniarin, isofraxidine, scopoletin, umbelliferone [116,117] | caffeic acid, caftaric acid, p-coumaric acid, chlorogenic acid, ferulic acid, gentisic acid, isochlorogenic acid, protocatechuic acid, rosmarinic acid, sinapic acid, syryngic acid, vanillic acid [20,58,116] |
| A. absinthium | absintholide, absinthin, anabsin, anabsinthin, arabsin, artabin, artabsin, artenolide, caruifolin D, deacetyloglobicin, germacranolide, hydroxypelenolide, isoabsinthin, ketopelenolide, ketoepenolid-A, matricin, parishine B and C, β-santonin, santonin-related lactones [9,35,75,76,121,129,130] | apigenin, artemetin, Artemisia bis-isoflavonyl dirhamnoside, Artemisia isoflavonyl glucosyl diester, casticin, catechin, flavone, 5-hydroxy-3,3′,4′,6,7-pentamethoxyflavone, glycosides of quercetin, kaempferol, myristin, naringenin, quercetin, quercetin dihydrate, quercetin-3-rutinoside, 5,6,3,5′-tetramethoxy 7,4′-hydroxyflavone, rutoside [9,34,35,84] | coumarin, herniarin [84,89] | caffeic acid, 3′-O-caffeoylquinic acid, chlorogenic acid, coumaric acid, p-coumaric acid, 1′,3′-O-dicafeoylquinic acid, 1′,5′-O-dicafeoylquinic acid, 3′,5′-O-dicafeoylquinic acid, 4′,5′-O-dicafeoylquinic acid, ferulic acid, gallic acid, rosmarinic acid, salicylic acid, syryngic acid, tannic acid, vanillic acid [35,76,84,121,122] |
| Species         | Sesquiterpenoid Lactones                              | Flavonoids                                                                 | Coumarins                                                                 | Phenolic Acids                                                                 |
|-----------------|------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| A. annua        | artemisinic acid, artemisinin, artannuin B [69–74]  | acacetin, apigenin, apigenin 6-C-arabinosyl-8-C-glucoside, apigenin 6-C-glucosyl-8-C-arabinoside, apigenin derivatives, artemetin, astragalin, camferol, casticin, chrysin, chrysoeriol, chrysoeriol rutinoside, chrysoplenol C, chrysoplenol D, chrysoplenin, cinaroside, cirsilineol, dihydroartemisinin, 3,5-dihydroxy-3', 4', 6,7-tetramethoxyflavone, 3,5-dihydroxy-6,3', 4'-tetramethoxyflavone, 3,5-dihydroxy-6,7,4'-trimethoxyflavone, 3,5-dimethoxyquercetin, 3,4'-dimethyl-quercetin, 3-methyl-6-glucoside, eupatin, eupatorine, 7-O-glucoside of diosmetin, 3-O-glucoside of kaempferol, 3-O-glucoside of quercetin, 3-O-hexoside of marnsetin, isocempheride, isoquercetin, isorhamnetin, isorhamnetin derivatives, isorhamnetin 3-O-glucoside, isovitexin, jaceidin, kaempferol, kaempferol derivatives, kirsiliot, kirsimarin, laricitrin, luteolin, luteolin derivatives, luteol 7-O-glucoside, marnsetin glucoside, marnsetin, 8-methoxykaempferol, 3-methoxy-kaempferol glucoside, 7-methyl-luteolin ether, 3-O-methylquercetin, micanine, myrcetin, patuletin glucoside, quercetin, quercetin derivatives, quercetin 3-O-galactoside, quercimeritin, retina, rhamnetine, rutoside, syringetin, tamarixetine [69,74,111,119,123,124,131–134] | coumarin, esculetin, isofraxidine, cis-mellilotoside, trans-mellilotoside, scopoletin, scopolone, tomentin [111,118,119] | caffeic acid, 4-caffeoyl-3,5-di-succinylquinic acid, 3,5-caffeoylquinic acid, 3,4-di-caffeoylquinic acid, 3,5-di-caffeoylquinic acid, 3,5-di-O-caffeoylquinic acid, 4,5-di-caffeoylquinic acid, 4,5-diferuloquinic acid, 3,5-diferuloquinic acid, 4,5-diferuloquinic acid, 4-ferulquinic acid, 3-ferulquinic acid, 4-ferulquinic acid, 5-ferulquinic acid, rosmarinic acid [74,111,123,124] |
| Species   | Sesquiterpenoid Lactones                                                                                                                                                                                                 | Flavonoids                                                                 | Coumarins                                                                 | Phenolic Acids                                                                                     |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| \(A.\ dracunculus\) | astemether, dihydroartemisinin, [77] anangenin, apigenin, biocoverretin, davidigenin, 5,7-dihydroxy flavone, 2',4'-dihydroxy-4-methoxydihydrochalcone syn, 7,3'-dimethyleriodictol, DMC-2; 4-O-methylavidigenin, estragoniside, estroside, 7-O-β-D-glucopyranoside, hyperoside, isoorchiminetin glycosides, kaempferol, kaempferol glycosides, luteolin, luteolin glycosides, 7-methyleringenene, 7-methyleriodictiol, naringenin, patuletin hexoside, patuletin malonylhamnosylhexoside, patuletin 3-O-malonylrobinobioside, patuletin rhamnosylhexoside, 5,6,7,8,4'-pentahydroxymetoflavone, pinocembrin, quer cetin, quercetin glycosides, quercetin 3-O-rutinoside, rutoside, sacuranetine, 3,5,4-trihydroxy-7,3'-dimethoxyflavone 3,5,4',trihydroxy-7-methoxyflavone, vicenin [2,54,97,113–115,125,126,135,136] | arethiol, aridiodiol, artemidiol, arte midyl ether, artidin, capillarin, coumarin, ducumerin, 3,4-dehydrobernianin, (+)-(S,R)-epoxyxartemidin, esculetin, esculin, herniarin, 6-demethoxyxarpiarisine, γ,γ-dimethylallyl ether esculetin, (+)-(R)-(E)-3'-hydroxyxartemidine, 8-hydroxartemidin, 9-hydroxartemidin, 8-hydroxycaparlin, 4-hydroxycoumarin, isocoumarin, isoverate capillarin, (−)-(R)-20-methoxycoumarin, 7,8-methylenedioxy-6-methoxyxoumarin, methylenedaphnetin, 7-methyl daphnetin ether, scoparon, scapeotenin, skating [2,54,97,102,112–115] | arethiol, aridiodiol, artemidiol, artemidyl ether, artidin, capillarin, coumarin, ducumerin, 3,4-dehydrobernianin, (+)-(S,R)-epoxyxartemidin, esculetin, esculin, herniarin, 6-demethoxyxarpiarisine, γ,γ-dimethylallyl ether esculetin, (+)-(R)-(E)-3'-hydroxyxartemidine, 8-hydroxartemidin, 9-hydroxartemidin, 8-hydroxycaparlin, 4-hydroxycoumarin, isocoumarin, isoverate capillarin, (−)-(R)-20-methoxycoumarin, 7,8-methylenedioxy-6-methoxyxoumarin, methylenedaphnetin, 7-methyl daphnetin ether, scoparon, scapeotenin, skating [2,54,97,102,112–115] | caffeic acid, caffeoylquinic acid, chicory acid, chlorogenic acid, p-coumaric acid, p-coumaroyl-caffeoylquinic acid, p-coumaroyl-feruloylquinic acid, 3,5-O-dicaffeoylquinic acid, 4,5-di-O-caffeoylquinic acid, ferulic acid, ferulic acid hexoside, (E) 2-hydroxy-4-methoxycinnamic acid, 5-O-caffeoylquinic acid, hydroxybenzoic acid, 2-methoxycinnamic acid, sakuranetin, syringic acid, vanilllic acid [54,97,101,113,114,125,126] |
| \(A.\ vulgaris\) | artemisinin, 1,2,3,4-diepoxy-11(13)-eudesmen-12,8-olide, psilostachyin, psilostachyin C, vulgarin, yomogin [55,64,137–141] | apigenin, chrysoeriol, diosmetin, eriodictyol, eupaftolin, homoeriodictyol, hyperoside, isorhamnetin, jacosidin, kaempferol 3-glucoside, kaempferol 7-glucose, kaempferol 3-rhamnoside, kaempferol 3-rutinoside, luteolin, luteolin 7-glucose, quercetin, quercetin 3-galactoside, quercetin 3-glucoside, rutinoside, tricine, vitexin [23,55,142,143] | esculin, esculetin, umbelliferone [55,120] | caffeic acid, 3-O-caffeoylquinic acid, 5-O-caffeoylquinic acid, 1,5-di-O-cafeoylquinic acid, 3,5-di-O-caffeoylquinic acid, 4,5-O-di-cafeoylquinic acid, 5-feruloylquinic acid, protocatechic acid glucoside, quinic acid [127,128] |
Essential oils are the major components of the herb and leaves of *Artemisia* ssp. Studies have confirmed that the qualitative and quantitative compositions of essential oils depend on the location of the cultivation site, the salinity of the soil, and the age of the plant. The highest concentrations of essential oils are observed in two stages: at the beginning of leaf budding and at the beginning of flowering.

Monoterpenoids are abundant in the essential oils of *A. abrotanum*, *A. absinthium*, *A. annua*, and *A. vulgaris*, whereas in the essential oil of *A. dracunculus*, phenylpropanoids are predominant. The discussed species differ in terms of the composition of their essential oils. The most commonly found monoterpenoids are 1-terpineol, *trans*-piperitol, 1,8-cineole, and camphor in *A. abrotanum* [81, 82, 109]; thujyl alcohol esters, *α*-thujone, *β*-thujone, camphene, *(Z)*-epoxyocimene, trans-sabinyl acetate, and chrysantenyl acetate in *A. absinthium* [9, 76]; camphene, camphor, *β*-pinene, borneol, and cuminal in *A. annua* [71, 73, 74, 90–95]; sabinene, terpinen-4-ol, *β*-ocimene, cis-ocimene, *α*-trans-ocimene, limonene, *α*-phellandrene, *β*-phellandrene, *(Z)*-artemidin, and capillene in *A. dracunculus* [2, 11, 54, 98, 99, 101, 144–146]; and 1,8-cineole, sabinene, camphor, camphene, caryophyllene oxide, *α*-thujone, and *β*-thujone in *A. vulgaris* [63, 65, 73, 88, 104–108, 147, 148]. In addition to monoterpenoids, sesquiterpenoids, phenylpropanoids, and diterpenoids are found in essential oils [9, 11, 33, 54, 55, 57, 65, 73, 74, 78–95, 97–109, 115, 144, 149–151]. Phenylpropanoids are detected in the essential oils of *A. abrotanum*, *A. absinthium*, and *A. dracunculus*, among which estragole, elemicine, eugenol, and their derivatives are the most common [11, 54, 80, 82, 89, 97–103, 109, 115, 144, 149, 150]. Moreover, triterpenoids and spiroterpenoids are reported in the essential oil of *A. abrotanum* [82, 109], whereas triterpenoids alone are reported in *A. dracunculus* [54]. All compounds found in the essential oils of the discussed *Artemisia* species are listed in Table 3.
Table 3. Chemical composition of essential oil from *Artemisia* species.

| Species      | Sesquiterpenoids                          | Monoterpenoids            | Diterpenoids       | Triterpenoids      | Phenylpropanoid Derivatives | Other Compounds                                      |
|--------------|--------------------------------------------|---------------------------|--------------------|--------------------|----------------------------|-----------------------------------------------------|
| *A. abrotanum* | δ-amorphene, aromadendrene, artedouglasia C, artedouglasia oxide A, artedouglasia oxide B, artedouglasia oxide D, bicyclogermacrene, *trans*-α-bisabolol, α-bisabolol, β-bourbonene, δ-cadinene, cadinol, α-cadinol, 3-carene, caryophyllene, β-caryophyllene, caryophyllene oxide, α-copaene, davanone, davanone B cedrene, citronellol, β-copaene, α-cubebene, (E)-β-damascenone, davana ether, davanon ether, davanone B, *cis*-davanone, α-dehydro-ar-himachalene, γ-dehydro-ar-himachalene, β-elemene, δ-elemen, α-epi-7-epi-5-eudesmol, epi-longipinanol, 7-epi-silphiperfol-5-ene, eudesma-5-en-11-ol, α-eudesmol, β-eudesmol, γ-eudesmol acetate, farnesyl butanoate, germacrene D, germacen-D-4-ol, guaiol, α-humulene, humulene epoxide I, isospathulanol, T-murolol, nerolidol, (E)-nerolidol, nornorvalane, β-selinene, silphiperfol-4,7 (14)-diene, silphiperfol-5-ene, silphiperfol-5-en-3-ol A, silphiperfol-5-en-3-one A, silphiperfol-5-en-3-one B, silphiperfol-6-α-ol, silphiperolen isomer, spathulenol | borneol, bornyl acetate, camphene, camphor, 3 (10)-carene-2-ol, *trans*- carveol, *cis*-carvone, *cis*-carvyl acetate, *trans*-carvyl acetate, cembrone, *cis*-chrysanthenol, chrysanthenone, *cis*-chrysanthenyl acetate, *trans*-chrysanthenyl acetate, 1,4-cineole, 1,8-cineole, cumylinal acetate, *p*-cymene, eugenol, geranyl isobutanoate, 2-hydroxy-1,8-cineole, isobornyl formate, isobornyl propionate, lavandulol, lavandulyl butanoate, lavandulyl caproate, lavandulyl isovalerate, limonene, ment-1,5-dien-7-ol, *p*-menth-1-en-8-ol, *p*-menth-2-en-1-ol, myrcene, linalool, β-myrcene, myrtanal, myrtenal, myrtanol, *E*-myrtanol, neryl isobutanoate, neryl propionate, β-oicinone, E-β-oicinone, Z-β-oicinone, *trans*-oicinone, *trans*-β-oicinone, *trans*-ocimol, α-pinene, *trans*-pinocamphone, *cis*-piperitol, *trans*-piperitol, piperitone, α-phellandrene, β-phellandrene, β-pinene, 2 (10)-pinen-2-one, pinocarvone, terpenyl acetate, α-terpenyl acetate, α-terpinene, γ-terpinene, α-terpineol, 1-terpineol, 4-terpineol, *cis*-β-terpinol, *δ*-terpinol acetate, terpinolene, α-terpinene, α-terpinyl acetate, 3-thujanol, α-thujenal, α-thujene, α-thujone, tricyclene, 4-tujanol, sabina ketone, sabinene, *cis*-sabinene hydrate, *trans*-sabinene hydrate, *trans*-sabinol | lupeol, phytol isomer [80,81] | agarospirol [82] | estragol (methyl chavicol), elemicine [80,82,109] | Spiroterpenoids: methyl eugenol [82,109] | Jasmonates: methyl *cis*-jasmonate [79] | Other: *cis*-arbusculone, *trans*-arbusculone, 1,4-dimethyl-4-propyl-2-one-1-(2)-cyclo-hexene, heptanal, hexanal, (E)-2-hexenal, (Z)-3-hexenol, α-(E)-ionone, isobutanoate ester of anisic acid, isopergol, *cis*-jasmon, (Z)-jasmon, lavender lactone, methyl p-anisate, 4-methylpent-2-enolide, nonanal, 1-octen-3-ol, 2-phenylacetaldehyde, 2,2,3-trimethyl-3-cyclopentene-1-acetaldehyde [80–83,109] |
| Species    | Sesquiterpenoids                                                                 | Monoterpenoids                                                                 | Diterpenoids                                                                 | Triterpenoids | Phenylpropanoid Derivatives | Other Compounds |
|------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------|---------------|-----------------------------|----------------|
| A. absinthium | allo-aromadendrene, ar-curcumene, α-(E)-bergamotene, bicyclogermacrene, α-bisabolene, (Z)-α-bisabolene, β-bisabolene, α-bisabolol, bisabolol oxide, bisabolol oxide B, β-bourbonene, cadinene, γ-cadinene, δ-cadinene, α-calacorene, caryophyllene, β-caryophyllene, (E)-caryophyllene, caryophyllene oxide, α-cedrene, α-copaene, γ-curcumene, cyperene, diepi-α-cedrene, curcumene, β-elemene, elemol, epi-β-santalene, β-eudesmol, (E,E)-farnesal, (Z,E)-α-farnesene, (E,E)-farnesyl acetate, (E,E)-farnesyl 3-methylbutanoate, (E)-β-farnesane, germacrene D, guaiazulene, γ-gurjunene, β-gurjunene, γ-gurjunene, guaiazulene, hexahydrofarnesyl acetone, α-himachalene, α-humulene, γ-humulene, humulene oxide II, α-isocorene, β-isocorene, γ-muurolene, nerolidol, (E)-nerolidol, (E)-nerolidyl propanoate, petasitene, pethybrene, presilphiperfol-7-ene, α-santalene, β-santalene, β-selinene, sifilen-1-en, silphiperfol-6-ene, 7-α-silphiperfol-5-ene, spathulenol [33,57,84–89] | allo-oicenene, Artemisia ketone, borneol, bornyl acetate, bornyl 3-methylbutanoate, camphene, camphor, carvacrol, (Z)-carveol, carvone, chrysanthrenol, (Z)-chrysanthrenol, chrysanthrenyl acetate, (Z)-chrysanthrenyl acetate, 1,8-cineole, p-cymene, p-cymen-8-ol, (E)-epoxycimene, (Z)-epoxycimene, (Z)-β-epoxycimene, (E)-6,7-epoxycimene, (Z)-6,7-epoxycimene, epoxycimene, eugenol, α-fenchene, fenchone, geraniol, geranyl acetate, geranyl isovalerate, geranyl 2-methylbutanoate, geranyl 3-methylbutanoate, geranyl pentanoate, isobornyl acetate, isobornyl propanoate, iso-3-thujanol, isoaltertul acetate, lavandulol, lavandulyl acetate, limonene, linalool, β-linalool, (E)-linalool oxide, (Z)-linalool oxide, linalyl acetate, linalyl butanoate, linalyl 3-methylbutanoate, linalyl propionate, lyratyl acetate, p-menth-3-en-9-ol, 3-methylbutanoate, myrcene, β-myrcene, neral, nerol, (Z)-nerolidol, neryl acetate, neryl 2-methylbutanoate, neryl 3-methylbutanoate, neryl 2-methylpropanoate, (E)-β-ocimene, (Z)-β-ocimene, phellandrene, α-phellandrene, β-phellandrene, phellandrene epoxide, pinene, α-pinene, β-pinene, 2-β-pinene, pulegone, sabine, (E)-sabinene hydrate, (Z)-sabinene hydrate, (E)-sabinol, sabi nyl acetate, (E)-sabinyl acetate, santolinatriene, α-terpinene, γ-terpinene, α-terpineol, terpinene-4-ol, terpinolene, α-terpinylacetate, α-thujene, thujol, α-thujone, β-thujone, (E)-thujone, (Z)-thujone, thuyyl acetate, thuyyl alcohol, thymol, tricyclem, (E)-verbenol, (Z)-verbenol [9,16,33,76,84,85,87–89,121] | 1-(E)-8-isopropyl-1,5-dimethyl-nona-4,8-dienyl-4-methyl-2,3-dioxabicyclo[2,2,2]oct-5-ene, iso-1-(E)-8-isopropyl-1,5-dimethyl-nona-4,8-dienyl-4-methyl-2,3-dioxabicyclo[2,2,2]oct-5-ene, vulgarol A, vulgarol B [9,73,80] | estragole, methyleugenol [89] | nd |
### Table 3. Cont.

| Species | Sesquiterpenoids | Monoterpenoids | Diterpenoids | Triterpenoids | Phenylpropanoid Derivatives | Other Compounds |
|---------|------------------|----------------|--------------|---------------|----------------------------|-----------------|
| A. annua | aristolon, bicyclogermacrene, β-bourbonene, β-cadinene, γ-cadinene, δ-cadinene, cis-cadin-4-en-7-ol, epi-α-cadinol, caryophyllene, β-caryophyllene, cis-β-caryophyllene, trans-β-caryophyllene, caryophyllene oxide, β-chamigrene, α-copaene, cubebin, β-cubenol, α-elemene, γ-elemene, α-farnesene, trans-β-farnesane, germacren A, germacren B, germacren D, β-gurjunene, γ-gurjunene, humulene, α-humulene, isoeldeene, (–)-isolongifolen-9-one, kopaene, trans-β-kopaene, α-longipinene, γ-murolene, nerolidol, nootkatone, β-selinene, selin-11-en-ol isomer, selin-3,11-dien-6α-ol, spathulenol [73,74,90–95] | Artemisia trien, artemisinin alcohol, artemisinin ketone, borneol, bornyl acetate, camphene, camphor, α-campholenal, cis-carveol, trans-carveol, carvone, cis-chrysanthemonol, 1,8-cineole, cuminal, cis-β-O-cymene, trans-β-O-cymene, p-cymene, dehydro-1,8-cineol, dehydrosabinaketone, dehydrosabinin, eugenol, α-felandrene, ipsdienol, limonene, linalool, p-mentha-2,4 (8)-diene, myrcene, myrcenol, myrtenal, myrtenol, myrtenyl acetate, neryl acetate, α-pinene, β-pinene, β-pinene oxide, trans-pinocarveol, cis-pinocarveol acetate, pinocarvone, pipertitone, sabinen, cis-sabinene hydrate, trans-sabinene hydrate, santolin alcohol, santolinatriene, α-terpinene, 4-terpinene, δ-terpinol, γ-terpinene, terpinolene, α-terpinolene, α-terpinene, thujene, α-thujone, α-thujone, verbenaol, verbenaone, yomogi alcohol [71,73,74,90–95,152] | vulgarone [90] | nd | nd | arteannuic acid, 2-H-1-benzopirrazone, benzyl benzoate, benzyl 3-methylbutanacetate, 1-dodecane, ethyl 2-methylbutanoate, eudesm-7(11)-en-4-ol, hexanal, 2-hexenyl 2-methylbutanoate, cis-2-hexenyl 3-methylbutanoate, isovalerate hexanoate, cis-jasmon, 2-methyl-2-butenyl 3-methylbutanoate, 3-methyl-3-butenyl 3-methylbutanoate nonanal, nonadecane, propyl 2-methylbutanoate [91–95] |
### Table 3. Cont.

| Species | Sesquiterpenoids | Monoterpenoids | Diterpenoids | Triterpenoids | Phenylpropanoid Derivatives |
|---------|------------------|----------------|--------------|--------------|-----------------------------|
| A. dracunculus | acoradiene, ar-curcumen, α-bergamotene, bicyclermacen, α-bisabolol, β-bisabolen, δ-cadinene, α-epi-cadinol, caryophyllene, β-caryophyllene, E-caryophyllene, E-β-caryophyllene, caryophyllene oxide, α-cedrene, α-copaene, elemene, δ-elemene, γ-elemene farnesane, cis-trans-α-farnesene, (E)-β-farnesene, (E,E)-farnesane, E,E-α-farnesane, germacrene D, germacrene-D-4-ol, gleenol, α-humulene, β-sesquiphellandrene, spatunelol, spatulenol, α-zingiberene [2,11,54,96–103] | allocimene, artemisinic ketone, borneol, bornyl acetate, camphene, camphor, 4-carene, Δ3-carene, carvacrol, trans-carveol, carveol, E-carveone oxide, 2- allo-cimene, 1,8-cineole, citronellol, citronellol acetate, citronellol formate, α-cymene, p-cymene, (E)-β-O-cymene p-mentha-1,3,8-triene, ethyl geranyl, geraniol, geranyl acetate, β-elemene, endo-isotenchene, α-fenchene, geranial, (E)-β-ionone, isobornyl acetate, isoterpinolene, limonene, D-limonene, linalool, myrcene, α-myrcene, myrtenal, nerol, neryl acetate, α-trans-oicimene, allo-oicimene, cis-β-oicimene, cis allo-oicimene, trans β-oicimene, trans allo-oicimene, β-oicimene, β-oicimene Y, E-β-oicimene, Z-β-oicimene, neo-allo-oicimene cis allo-oicymen hydrate, phellandrene, α-phellandrene, β-phellandrene, α-pine, β-pine, 2-β-pine, p-pine, pinocarveol, pseudolimonene, sabine, trans-sabinene acetate, cis-sabinene hydrate, β-sesquifellandrene, α-terpenyl acetate, terpineol, 4-terpineol, α-terpineol, α-terpine, γ-terpine, terpinolene, α-terpinolene, trans-4 thujanol, α-thujene, thymol, tricyclen [2,11,54,96–100,102,103,153] | phytol [99] | squalene [54] | (Z)-anethole, asarone, carpaci, dillapirole, elemycin, estragole (methy1chavicol, p-allylanisole), eugenol, isoelemycin, isoeugenol methyl ether, isoeugenol methyl trans-anethole, 3-(p-methoxyphenyl)-1,2-propanediol, methyl eugenol, prestragol [11,54,80,97–103,115,144,149,150] |
| Isocoumarins: | | | | | 3-(1-Z-butetyl) isocoumarin = (Z)-artemidin, 2-(1-E-butetyl)-isocoumarin = (E)-artemidin [2,11] |
| Polyacetylenes: | | | | | capillene, 1-phenyl-2,4-hexadiene, 1-phenyl-2,4-hexadiene-1-one [2,54,146,154,155] |
| Other: | | | | | acenaphthene, p-allyphenol, apiole, cinnamic acid, cinnamyl acetate, cyclohexylmorpholine, dehydro-1,8-cineole, 3-methoxycinnamaldehyde, methyl ester, methyl salicylate, myristicin, nonadecane, 1,3-oktadiene, 1-pentadecene, 5-phenyl-1,3-pentadiyne [11,102,103,146,153] |
| Species     | Sesquiterpenoids                                                                 | Monoterpenoids                                                                 | Diterpenoids | Triterpenoids | Phenylpropanoid Derivatives | Other Compounds |
|-------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------|--------------|-----------------------------|----------------|
| *A. vulgaris* | aromadendrene, α-trans-bergamotene, bicyclogermacrene, β-bisabolene, α-bisabololone, β-burbonen, α-cadinol, α-calacorene, caryophylla-(14,8(15)-diene-5-α-ol, caryophyllene, trans-caryophyllene, caryophyllene oxide, α-cedrene, β-chamigrene, α-copaen, cubebene, davanone, α-elemene, β-elemene, β-eudesmol, farnesene, farnesyl acetate, germacrene D, germacrene D-4-ol, α-humulene, humulene epoxide II, humulene oxide, α-isocomene, lanceol acetate, ledol, β-longipinene, modhephene, epi-α-muurolool, (E)-nerolidol, petasitene, presilphiperforol-7-ene, trans-salvane, salvial-4(14)-en-1-one, epi-β-santalene, saphin-1-ene, 7-α-silphiperforol-5-ene, silphiperfor-5-en-3-ol (Z)-β-farnesene, silphiperfor-4,7(14)-diene, sathuleneol, valerenone | *Artemisia* alcohol, *Artemisia* ketone, artemisyl acetate, borneol, bornyl acetate, camphene, camphor, trans-carveol, carvone, cis-chrysanthanol, chrysanthyl acetate, 1,8-cineol, cuminol, cymene, p-cymene-8-ol, dehydrosabinacetone, α-fenchene, isoborneol, isobornyl acetate, iso-3-thujanol, limonene, linalool, menthol, methyleugenol, p-mentha-1,4-dien-7-ol, β-myrcene, (E)-β-ocymen, (Z)-β-ocymen, α-pinene, β-pinene, trans-pinocarveol, piperitone, sabinaketone, sabinene, cis-sabinene hydrate, santolina triene, α-terpinene, γ-terpinene, α-terpineol, 4-terpineol, terpinolene, 3-thujanol, α-thujene, α-thujone, β-thujone, cis-thujone, thymol, *trans*-verbenol, verbetyl acetate | phytol, γ-terpinone | nd            | nd                          | nd              |
5. Applications in Medicine
5.1. Ethnopharmacological Uses of Artemisia Species

*Artemisia* ssp. have for long been used in the traditional European, Asian (mainly Chinese and Hindu medicine), and South American medicines (Table 4). The uses of infusions, extracts, and tinctures, as well as dried parts of plants, are here reported. In the traditional medicines of China and South America, *A. abrotanum*, *A. annua*, and *A. vulgaris* have been used, especially in malaria treatment [8,71,156].

In the European traditional medicine, *A. abrotanum* has been used in liver diseases, such as atony, the contractile states of the bile ducts, and the stagnation of or insufficient bile secretion. *Artemisia* ssp. infusions are recommended as an aid in cases of anorexia, flatulence, and hypoaedia [157]. *A. abrotanum* leaves have been used to stimulate menstruation [20].

The flowers of *A. absinthium* have been used in the European folk medicine to treat parasitic diseases and digestive ailments. The herb of this species was used to treat jaundice, constipation, obesity, splenomegaly, anemia, insomnia, bladder diseases, menstrual cramps, and injuries and nonhealing wounds [8–10]. The tincture of *A. absinthium* is a valuable tonic and digestive aid. Similarly, *A. absinthium* is used in the traditional Hindu medicine (Unani), in the drug “Afsanteen”, which is used to treat chronic fever, hepatitis, and edema [9].

All the parts of *A. annua* are used in the traditional medicines of China and India, such as flowers, leaves, stems, seeds, and essential oils. They are used to treat jaundice, bacterial dysentery, fever, bleeding wounds, and hemorrhoids [71,158].

In European traditional medicine, *A. dracunculus* is used to treat ailments of the digestive system and as an appetite and digestive stimulant [54,159]. According to the Hindu traditional medicine (Ayurveda), *A. dracunculus* is effective in the treatment of helminthiasis and intestinal smooth muscle spasms and in the regulation of the menstrual cycle [54,160]. In Arabic countries, *A. dracunculus* is used in the treatment of gingivitis and foot and mouth disease, whereas in Central Asia, including Russia, it is used to treat irritation, allergic rashes, and gastritis [11,12].

In European folk medicine, the oral administration of *A. vulgaris* stimulates the secretion of gastric juice. The species *A. vulgaris* is also used as a relaxant for the gastrointestinal tract and bile ducts and for relieving colic [55], whereas its laxative effect is observed in the treatment of obesity. In traditional Hindu medicine (Unani), many preparations based on *A. vulgaris* are used. These preparations are recommended for liver inflammation and obstruction, treating enlarged liver or spleen and nephrolithiasis, chronic fever, and dysmenorrhea [161]. In the Asian medicine, *A. vulgaris* is often used in the treatment of gynecological diseases [162,163]. Furthermore, *A. vulgaris* is recommended for inducing labor or miscarriage [164].

**Table 4.** Ethnopharmacological uses of *Artemisia* species.

| Species      | Traditional Activity                                      | Traditional Medicine | References        |
|--------------|----------------------------------------------------------|----------------------|-------------------|
| *A. abrotanum* | - liver diseases                                         | Europe               | [20,157]          |
|              | - contractile states of the bile ducts                    |                      |                   |
|              | - stagnation of or insufficient bile secretion            |                      |                   |
|              | - stimulate menstruation                                  |                      |                   |
| *A. absinthium* | - parasitic diseases and digestive ailments              | Europe               | [8–10]            |
|              | - treating jaundice                                       |                      |                   |
|              | - treating constipation                                   |                      |                   |
|              | - treating obesity                                        |                      |                   |
|              | - treating splenomegaly                                  |                      |                   |
|              | - treating anemia                                         |                      |                   |
|              | - treating insomnia                                       |                      |                   |
|              | - treating bladder diseases                               |                      |                   |
|              | - treating menstrual cramps                               |                      |                   |
|              | - treating injuries and nonhealing wounds                 |                      |                   |
### Table 4. Cont.

| Species | Traditional Activity | Traditional Medicine | References |
|---------|----------------------|----------------------|------------|
| • digestive aid <br> • treating chronic fever <br> • treating hepatitis <br> • treating edema | | Hindu medicine (Unani) | [9] |
| A. annua | • treating jaundice <br> • treating bacterial dysentery <br> • treating fever <br> • treating bleeding wounds <br> • treating hemorrhoids | China and India | [71,158] |
| | • ailments of the digestive system <br> • an appetite and digestive stimulant | Europe | [54,159] |
| A. dracunculus | • treatment of helminthiasis <br> • treatment intestinal smooth muscle spasms <br> • treatment in the regulation of the menstrual cycle | Hindu traditional medicine (Ayurveda) | [54,160] |
| | • treatment of gingivitis <br> • treatment foot and mouth diseases | Arabia | [11,12] |
| | • treating irritation <br> • treating allergic rashes <br> • treating gastritis | Central Asia | [11,12] |
| | • stimulates the secretion of gastric juice <br> • relaxant for the gastrointestinal tract and bile ducts <br> • relieving colic <br> • laxative effect in the treatment of obesity | Europe | [55] |
| A. vulgaris | • liver inflammation and obstruction, <br> • treating enlarged liver or spleen <br> • treating nephrolithiasis, <br> • treating chronic fever <br> • treating dysmenorrhea <br> • recommended for inducing labor or miscarriage | Hindu medicine (Unani) | [161,164] |

### 5.2. Contemporary Phytotherapy

There are many monographs published by the European Medicines Agency (EMA) on the homeopathic preparations of *A. abrotanum* [165]. Moreover, *A. abrotanum* is included in homeopathic medicine according to the French Pharmacopoeia. These preparations are recommended for the treatment of the inflammation of the colon, rosacea, frostbite, inflammation of the lymph nodes, mucous membranes, and anxiety [166–168].

Among *Artemisia* ssp., *A. absinthium* herb (*Absinthii herba*) alone has the pharmacopoeial monograph in the newest tenth edition of the European Pharmacopoeia [59]. The raw material is the herb collected from young plants—in their first year of vegetation, buttend leaves are cut off—and from older plants with sparsely leaved, flowing shoot tips. The essential oil content of this raw material is standardized; this content must not be less than 2 mL/kg in the dried herb. Moreover, the bitterness index of the raw material must not be less than 10,000 [59]. In addition, the European Pharmacopoeia and the French Pharmacopoeia have classified the fresh, flowering herb of *A. absinthium* as a homeopathic raw material. The tincture produced should contain a minimum of 0.05% (w/w) of derivatives of hydroxycinnamic acid, expressed in terms of chlorogenic acid [169]. In the homeopathic medicine, the plant is recommended for hallucinations, nightmares, nervousness, insomnia, dizziness, and epileptic seizures [170]. Additionally, *A. absinthium herba* has been discussed in a monograph in the German Pharmacopoeia. The herb of *A. absinthium* is indicated for the loss of appetite, digestive problems, and bile secretion disorders [171–173]. Furthermore,
the German Pharmacopoeia also mentions a tincture from the herb [174]. Homeopathic preparations from the herb of *A. absinthium* have been discussed in monographs published by EMA [165]. The species *A. absinthium herba* is recommended as the raw material in the temporary loss of appetite, mild dyspepsia, and gastrointestinal disorders. It can be used in different forms, e.g., finely divided or powdered herbal substance, fresh juice, or tincture from the herb. Commercial herbal preparations are made in solid or liquid forms, and the finely divided herb is used in herbal teas. Moreover, the herb of *A. absinthium* has been discussed in a monograph of the ESCOP (European Scientific Cooperative on Phytotherapy). It can be used in digestive disorders and anorexia [175].

There are no monographs in European pharmacopeias describing *A. annua*. However, monographs of *Artemisiae annuae folium* are found in the Chinese Pharmacopoeia and the Vietnamese Pharmacopoeia [176,177]. The raw material of *Artemisiae annuae folium* is standardized for the artemisinin content, which cannot be lower than 0.7% of dry weight. It is recommended for the treatment of fever of various origins and malaria [10]. It is worth noting that *Artemisiae annuae herba* is included in the International Pharmacopoeia published by the WHO [10].

It must be noted that *A. dracunculus* is not a pharmacopoeial species, and it is used only in the traditional medicine.

The species *A. vulgaris* is classified as a homeopathic raw material in the tenth edition of the European Pharmacopoeia [178] and in the French Pharmacopoeia [179]. Its preparations are recommended for the treatment of irregular menstrual cycles and menopausal symptoms [66], and nervous disorders such as sleepwalking, seizures, epilepsy, and anxiety [170]. In addition, *A. vulgaris herba* has been discussed in a monograph in the German Pharmacopoeia. It abovementioned uses are listed only in the traditional medicine, and it has been emphasized that the effectiveness of *A. vulgaris* preparations had not been confirmed; hence, they are not recommended for therapeutic uses [172]. Furthermore, *A. vulgaris* has been described in a monograph published by the European Food Safety Authority (EFSA) [148].

*Artemisia* ssp. extracts have scientifically proven biological activities. Most of the studies are concentrated on *A. absinthium*, which have confirmed that *A. absinthium* extracts have an influence on the digestion system, due to their appetite-stimulating, antiulcer, and hepatoprotective effects, among others activities [13,19,180–184]. Additionally, they have also shown, inter alia, cytotoxic, anthelmintic, antiprotozoal, analgesic, immunostimulating, cytotoxic, neuroprotective, and antidepressant activities [14–18,25,26,30–37,86,122,130,185–191].

Antitumor activity was confirmed in *A. abrotanum* leaf extracts and essential oil components [20,168]. Flavonoids from *A. abrotanum* are reported to relieve the symptoms of allergic rhinitis [117]. The extract from the leaves has shown antiparasitic activity [192].

Extracts of *A. annua* essential oil and its components have scientifically proven effects, such as immunosuppressive, cytotoxic, analgesic, neuroprotective, and antimalarial properties, and have shown auxiliary effects in obesity treatment [91,93,123,131,193–203].

Studies have confirmed the antitumor, hepatoprotective, immunosuppressive, antidepressant, and hypoglycemic activities of *A. dracunculus* extracts and their components. [21,40,112,114,149,204–207].

Hepatoprotective, anthelmintic, cytotoxic, analgesic, hypolipemic, antihypertensive, and bronchodilatory activities have been reported for of *A. vulgaris* extracts, inter alia [138,142,186,208–215].

Scientifically proven biological activities and mechanisms of action of *Artemisia* ssp. are presented in detail in Table 5.
| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|---------------------------------------|------------|
| Antitumor activity    | *A. abrotanum* | Essential oil | Aerial part | Monoterpenoids | Borneol, cymene, camphor, terpineol, 1,8-cineole, and aromadendrene | In vitro | Decrease in the survival of neoplastic cells of the RD (rhabdomyosarcoma). The viability of RD cells after the application of the essential oil at concentrations of 25, 50, and 100 µg/mL was 29.679%, 20.833%, and 20.256%, respectively. | [168] |
|                       |         | Methanolic extract | Leaves | Phenolic acids | Chlorogenic and isochlorogenic acids | In vitro | Methanolic extract of *A. abrotanum* leaves in serial concentrations of 50, 100, 200, 300, and 400 µg/mL and its components (including chlorogenic acid and isochlorogenic acid) inhibits the proliferation of cells of the Jurkat line (T-lymphoblastic leukemia line, IC_{50} = 82.64 µg/mL), MCF-7 line (breast adenocarcinoma line, IC_{50} = 71.04 µg/mL), HeLa line (cervical adenocarcinoma line, IC_{50} = 49.97 µg/mL), and HT-29 line (colorectal adenocarcinoma line, IC_{50} = 54.75 µg/mL). | [20] |
|                       | *A. dracunculus* | hexane, ethyl acetate, acetone, ethanol, acetonitrile and supercritical carbon dioxide (scCO_{2}) | Leaves | Polyphenols, alkamides | nt * | In vitro | Inhibition of the proliferation of mouse lymphoma cells (L5178YD) due to the presence of polyphenols and alkamides in leaf extracts. In the control group the tumor cell count was 17.969 × 10^6, the acetonitrile extract from *A. dracunculus* leaves reduced the cell count to 0.1 × 10^6. | [21] |
| Alleviating allergy symptoms | *A. abrotanum* | Essential oil and isolated flavonoids | Aerial part | Monoterpenoids, flavonoids | 1,8-Cineole, davanone, linalool, centaureidine dimethylether, casticin and quercetin | In vivo | Relief of symptoms of allergic rhinitis with possible concomitant allergic conjunctivitis, symptoms of bronchial obstruction, and symptoms of exercise-induced asthma by using a nasal spray with a mixture of essential oils and flavonoids present in *A. abrotanum*. | [117] |
| Direction of Activity       | Species       | Extract/Essential Oil | Part          | Classification | Compounds | Model/Assay     | Short Description of Performed Studies                                                                                                                                                                                                 |
|-----------------------------|---------------|-----------------------|---------------|----------------|-----------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Digestion-stimulating       | *A. absinthium*| Ethanol               | Herb          | nt             | nt        | In vivo        | Change in postprandial hemodynamics in the gastric digestive phase with increased hyperemia, probably due to the effects of bitter compounds contained in the herb of the plant.                                                            |
| Appetite-stimulating        | *A. absinthium*| nt                    | Aerial part   | nt             | nt        | In vivo        | Enrichment of sheep fodder with silage containing *A. absinthium* increases the amount of fodder consumed, improves digestion, induces nitrogen retention, and has a positive effect on the development of microorganisms involved in nitrogen assimilation. |
| Antiulcer activity          | *A. absinthium*| carbon tetrachloride, chloroform, methanol, ethanol, hexane | Aerial part and root | nt             | nt        | In vivo (rats) | Decrease in gastric juice volume, reduction in gastric acid and pepsin secretion, and decrease in the digestion rate.                                                                                                                  |

References:
[19]
[180]
[181]
[182]
Table 5. Cont.

| Direction of Activity | Species          | Extract/Essential Oil | Part             | Classification | Compounds | Model/Assay      | Short Description of Performed Studies                                                                 | References |
|-----------------------|------------------|-----------------------|------------------|----------------|-----------|------------------|---------------------------------------------------------------------------------------------------------|------------|
|                       |                  | Hydro-methanol        | Herb             | nt             | nt        | In vivo (rats)   | *A. absinthium* extracts (in dose 500 mg/kg) inhibit liver microsomal enzymes (20%) that are responsible for the metabolism of xenobiotics. | [183]      |
| Hepatoprotective      | *A. absinthium*  | Methanol              | Herb             | nt             | nt        | In vivo (rats)   | Methanolic extracts from the herb of the plant (in dose 50 mg/kg) protect liver cells by reducing ALAT (alanine aminotransferase) and ASPAT (aspartate aminotransferase) levels and by reducing oxidative damage. | [13]       |
| activity              |                  | Aqueous               | Herb             | nt             | nt        | In vivo (mice)   | Protection of the liver due to the immunomodulatory and/or antioxidant properties of *A. absinthium* (in dose 500, 100, or 200 mg/kg body weight/day). | [184]      |
|                       |                  | Hydro-ethanol         | Herb             | nt             | nt        | In vivo (rats)   | The extract (at dose 50, 100, or 200 mg/kg) decreased the levels of ALAT, ASPAT, alkaline phosphatase, and total bilirubin and increased total protein levels. | [40]       |
|                       | *A. dracunculus* | Hydro-ethanol         | Aerial part      | nt             | nt        | In vivo (mice)   | Prophylactic protective effect limiting inflammation, cellular edema, apoptotic cell count, and hyperemia of the hepatic parenchyma of hydro-ethanolic extract (at dose 600 mg/kg). | [209]      |
|                       |                  | Hydro-ethanol         | Aerial part      | nt             | nt        | In vivo (mice)   | Prophylactic protective effect limiting inflammation, cellular edema, apoptotic cell count, and hyperemia of the hepatic parenchyma of hydro-ethanolic extract (at dose 600 mg/kg). | [209]      |
| Antispasmyotic        | *A. vulgaris*    | Chloroform and methanol | Herb             | Sesquiterpenoids | Yomogin and 1,2,3,4-diepoxy-11(13)-eudesmen-12,8-olide | In vivo (guinea pigs) | Antagonism toward H1 histamine receptors. | [138,142]   |
| activity              |                  |                       |                  |                |           |                  |                                                                                                         |            |
### Table 5. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part       | Classification | Compounds | Model/Assay                                      | Short Description of Performed Studies                                                                                                                                                                                                 | References |
|------------------------|---------|-----------------------|------------|----------------|-----------|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Anthelmintic activity  |         | Aqueous and an ethanol | Aerial part | nt             | nt        | In vivo (sheep)                                  | Extracts from *A. absinthium* (in dose 2 g/kg body weight) cause paralysis and/or death of *Haemonchus contortus* nematodes and reduce (80.49%) the number of the parasite’s eggs in the host’s feces.                                        | [185]      |
|                        |         | Essential oil         | Aerial part | nt             | nt        | In vivo (mice)                                   | Lethal effect on *Trichinella spiralis* larvae.                                                                                                                                                                                                 | [86,186]   |
|                        |         | Ethanol               | Herb       | nt             | nt        | In vivo (rabbits)                                | Lethal effect of *A. absinthium* ethanolic extract on *Ascaris suum* eggs and *Trichostrongylus colubriformis* larvae.                                                                                                                   | [187]      |
|                        |         | Ethanol extract       | Aerial part | nt             | nt        | In vivo (sheep), in vitro (parasite motility inhibition test) | Lethal effect on *H. contortus* tested in vivo; reduction in its mobility in vitro.                                                                                                                                                        | [188]      |
|                        |         | Methanol              | Herb       | nt             | nt        | In vivo (rats)                                   | Extract (at dose 300 mg/kg) inhibited activity against *T. spiralis* by 75.6% and 63.5% in the tongue, 53.4% and 37.7% in the diaphragm, 67.8% and 46.2% in the quadriceps, and 66.7% and 60.5% in the biceps–triceps muscles of rats.            | [186]      |
| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|---------------------------------------|------------|
| Antiprotozoal activity | A. absinthium | Aqueous and ethanolic extracts | Aerial part | nt | nt | In vitro (mice) | Lethal effect of aqueous and ethanolic extracts from A. absinthium on Plasmodium berghei (in dose 74 mg/kg). | [25] |
| Hydro-ethanolic | Herb | nt | nt | In vitro | (chloroquine-resistant (K1) and chloroquine-sensitive (CY27) strains of Plasmodium berghei) | Lethal effect of the hydro-ethanolic extract P. berghei. IC\textsubscript{50} = 0.46 µg/mL for the K1 strain and IC\textsubscript{50} = 0.195 µg/mL for the CY27. | [26] |
| nt | Herb powdered | nt | nt | In vivo | (human) | Lethal effect of capsuled powdered herb of A. absinthium in dose 500 mg on Entamoeba histolytica. | [30] |
| Essential oil | Aerial part | Flavonoids, sesquiterpenoid lactone | Artemetin, casticin, hydroxypelenolide | In vitro | Lethal activity against the promastigotes and amastigotes forms of the protozoa Leishmania aethiopica and Leishmania donovani. MIC for both microorganisms in the promastigote form was 0.1565 µL/mL. | [32] |
| Ethanol | Aerial part | Sesquiterpenoids | (E)-Caryophyllene and 3,6-dihydrochamazulene | In vitro | Lethal activity in vitro against Leishmania infantum and Trypanosoma cruzi. | [33,34] |
| Essential oil | Aerial part | Sesquiterpenoids | Artemisinin, dihydroartemisinin | In vitro | Lethal effect of the essential oil on T. cruzi and on Trichomonas vaginalis. The compounds likely to be responsible for this activity are (E)-caryophyllene and 3,6-dihydrochamazulene. | [35] |
| Aqueous and ethanolic | Aerial part | Sesquiterpenoids lactones | | In vitro | Inhibition (100%) of Naegleria fowleri growth by sesquiterpenoid lactones from A. absinthium. | [36] |
| Aqueous | Aerial part | nt | nt | In vitro | Inhibition (88.9%) of A. absinthium aqueous extract against Plasmodium falciparum. | [37] |
| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| **A. annua**           | Methanol, ethanol, aqueous | Herb | Sesquiterpene lactone | Artemisinin | In vivo/In vitro | Lethal activity against *Artemisia castellani* of artemisinin and methanolic, ethanolic, and aqueous extracts from *A. annua* herb. | [27] |
| n-Hexane, ethanol, and water | Leaves and seeds | nt | nt | In vitro | Compounds present in *A. annua* seed and leaf extracts have lethal activity against *L. donovani*. | [29] |
| Hydro-ethanol | Herb | nt | nt | In vitro | The extract (at dose (100–1000 µg/mL) inhibited the development of the promastigote form of *Leishmania major*. The recorded MIC values of the extract after 24 h, 48 h and 72 h were: 962.03, 688.36 and 585.51 µg/mL. | [28] |
| Ethanol | Herb | nt | nt | In vivo (mice) | Induction of dendritic cell maturation by increasing the level of CD40 surface expression and by induction of cytokines. It was found that at 100 µg/mL extract the proliferation of T-lymphocytes was reduced by 78.2% relative to the control. | [189] |
| nt | Herb | Polysaccharides | nt | In vivo (mice) | Induction of TH1 immune response and stimulation of nitric oxide production by macrophages. | [190] |
Table 5. Cont.

| Direction of Activity | Species          | Extract/Essential Oil | Part          | Classification         | Compounds | Model/Assay          | Short Description of Performed Studies                                                                 | References |
|-----------------------|------------------|-----------------------|---------------|------------------------|-----------|---------------------|-------------------------------------------------------------------------------------------------------|------------|
| A. annua              | Ethanol          | Herb                  | nt            | nt                     | nt        | In vitro/In vivo    | Inhibition of lymphocyte proliferation and reduction in IgG, IgG1, and IgG2b antibody levels after the administration of A. annua whole-plant extract (at dose 0.25, 0.5, and 1.0 mg). | [91]       |
|                       | nt               | Herb                  | Sesquiterpene lactone | Artemisinin          | In vivo (mice) | Artemisinin obtained from A. annua inhibits late-type hypersensitivity response and has a suppressive effect on calmodulin responsible for activation of T lymphocytes. | [198]     |
| A. dracunculus        | Aqueous          | Herb                  | nt            | nt                     | In vivo (mice) | The extract (at dose 100 mg/kg) reduced IL-17 (interleukin 17) and IFN-γ (interferon gamma) production and intensification of the phagocytosis process carried out by macrophages. | [149]      |
|                       | Aqueous          | Herb                  | nt            | nt                     | In vivo (mice) | Lowering of IL-17 and IL-23 (interleukin-23) levels and reduction in the infiltration of leukocytes into brain cells. | [204]      |
|                       | Hydro-ethanol    | Leaves                | nt            | nt                     | In vivo (mice) | Increased neutrophil levels and decreased lymphocyte levels after intraperitoneal administration of the hydroethanolic extract from the leaves (at dose 200 mg/kg). | [205]      |
| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|----------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| Cytotoxic activity    | A. absinthium | Methanol | Leaves | nt | nt | In vitro | Inhibition of proliferation of breast cancer cells of MDA-MB-231 (50% at 20 g/mL) and MCF-7 lines (50%, at 25 g/mL). | [17] |
|                       | A. absinthium | Essential oil | Aerial part | Sesquiterpenoids | (E)-Caryophyllene, germacrene D | In vitro | The essential oil, in particular (E)-caryophyllene and/or germacrene D, is toxic to tumor lines A548, NCI-H292, HCT116, MCF-7, and SK-MEL-5. | [18] |
|                       | A. annua | Ethyl acetate | Aerial part | Polyphenols | Caffeic acid, syringic aldehyde, dicafeoylquinic acid isomer, quercetin 3-O-galactoside, dicafeoylquinic acid isomer, mearnsetin 3-O-hexoside isomer, kaempferol 3-O-glucoside, quercetin 3-O-glucoside, ferulic acid, caffeoylferuloylquinic acid isomer, isorhamnetin 3-O-glucoside, diosmetin 7-O-glucoside, luteolin 7-O-glucoside, diferuloylquinic acid, quercetin, dicafeoylferuloylquinic acid isomer, 3-O-methylquercetagetin, luteolin, 8-methoxycoumpferol, 3,5-dimethoxyquercetagetin, caffeoylferuloyl quinic acid, kaempferol, 3,5-dihydroxy-6,7,4′-trimethoxyflavone, and 3,5-dihydroxy-6,7,3′,4′-tetramethoxyflavone | Polyphenols present in A. annua inhibit adhesion of cancer cells to endothelial cells and inhibit epithelial–mesenchymal transition. | [123] |
Table 5. Cont.

| Direction of Activity | Species     | Extract/Essential Oil | Part   | Classification     | Compounds                | Model/Assay | Short Description of Performed Studies                                                                                                                                 | References |
|-----------------------|-------------|-----------------------|--------|--------------------|--------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|                       | nt          | Herb                  | nt     | nt                 | Artemisinin              | In vivo     | Regression of prostate cancer in a patient treated (at dose 5 mg/day) with capsules containing a concentrate with *A. annua* and bicalutamide.                                                                 | [199]      |
|                       | Methanol    | Leaves                | nt     |nt                  |                          | In vitro    | Methanolic extract from *A. annua* leaves collected in Egypt showed significant cytotoxic activity against MCF-7 human breast adenocarcinoma cell line, human lung cancer cell line, and Chinese hamster ovary (CHO) cell line. | [201]      |
| *A. vulgaris*         | Methanol    | Aerial part           | nt     | nt                 |                          | In vitro    | Inhibition of tumor cell growth in cancer cell lines: MCF-7 (IC₅₀ = 190 ng/mL), HeLa (IC₅₀ = 284 ng/mL), A7R5 (IC₅₀ = 382 ng/mL), 293T (IC₅₀ = 317 ng/mL), and SW-480 (IC₅₀ = 778 ng/mL). | [210–212]  |
|                       | Methanolic  | Herb                  | nt     | nt                 |                          | In vivo (mice)| Reduction in temperature-induced pain in mice at doses of 300 mg/kg, 500 mg/kg or 1000 mg/kg.                                                                                   | [191]      |
| *A. absinthium*       | Essential oil/Aqueous | Aerial part          | nt     | nt                 | Camphor, 1,8-cineol, and α-pinene | In vivo (mice)| Reduction in episodes in the writhing test and delay in pain response in the hot plate test in mice after the administration of *A. absinthium* essential oil (at doses of 2, 4, or 8 mg/kg) or aqueous extract (50, 100, or 200 mg/kg). | [122]      |
| *A. annua*            | Essential oil | Herb                  | Monoterpenoids | Camphor, 1,8-cineol, and α-pinene | In vivo (mice) | Administration of essential oil (at dose 400 mg/kg) from *A. annua* herb, camphor, 1,8-cineol, and α-pinene in mice reduces (57%) writhing episodes caused by acetic acid. | [93]       |
| *A. vulgaris*         | Hydro-ethanol | Aerial part           | Flavonoids, phenolic acids | Rutoside, hydroxybenzoic acid derivatives, and caffeic acid and its derivatives | In vivo (mice) | Mild peripheral antinociceptive effect of extract (at dose 100 and 250 mg/kg).                                                                                       | [142]      |
Table 5. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| Inhibiting the activity of carbonic anhydrase I and II | A. dracunculus | Dichloromethane | Herb | Phenylpropanoid derivatives, sterols, coumarin | *trans*-Anethole, stigmasterol, herniarin, (2E,4E)-N-isobutylundeca-2,4-diene-8,10-diynamide, (2E,4E)-1-(piperidin-1-yl)undeca-2,4-diene-8,10-diyn-1-one and 1-(4'-methoxyphenyl)-1,2,3-trihydroxypropane | In vitro | Compounds present in herbal extracts reduce the activity of carbonic anhydrase I (hCA I) and II (hCA II) (IC$_{50}$ = 0.02 µg/mL for hCA I, and IC$_{50}$ = 0.31 µg/mL for hCA II). | [216] |
| Neuroprotective activity | A. absinthium | Methanol | Aerial part | nt | nt | In vivo (rats) | Methanolic extract (at dose 100 and 200 mg/kg) from *A. absinthium*, because of its antioxidant potential, reduces brain damage, inhibits lipid peroxidation, and restores the activity of enzymes involved in reducing oxidative stress. | [14] |
| | | Aqueous | Herb | nt | nt | In vivo (rats) | Protective effect of *A. absinthium* aqueous extract (at dose 200 mg/L) on glial cells and the dopaminergic system when exposed to lead. | [15] |
| | | Herb | Sesquiterpenoid dimer | Caruifolin D | In vitro (BV2 microglial cells) | Caruifolin D in *Absinthii herba* inhibits the production of proinflammatory microglia mediators and reactive oxygen species and also inhibits protein C kinase and stress-activated kinases. | [130] |
### Table 5. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|---------------------------------------|------------|
| **Antidepressant activity** | A. absinthium | Methanol | Aerial part | nt | nt | In vivo (mice) | Shortening of the period of mouse immobility in the forced swim test (at dose 1000 mg/kg) and in the tail suspension test (at dose 500 mg/kg). | [16] |
| | Ethanol | Herb | nt | nt | In vivo (mice) | Increased resistance to stressful situations and reduction in stress-related levels of inflammatory cytokines. | [206] |
| | Ethanol | Herb | Phenolic acids, flavonoids | Chlorogenic acid, caffeic acid or luteolin and quercetin | In vivo (mice) | Phenolic compounds and flavonoids contained in the A. dracunculus herb extract (at dose dose of 200 mg/kg) reduce the immobility response time in mice in the writhing test and in the forced swim test. | [114] |
| | Ethanol | Herb | Coumarins | Herniarin, skimmin c | In vitro | Mild inhibition of hMAO-A (human monoamine oxidase A) and hMAO-B (human monoamine oxidase B) by extracts of A. dracunculus and compounds. Herniarin and skimmin c showed the inhibitory effects against hMAO A (IC$_{50}$ = 51.76 and 73.47 µM, respectively) and hMAO B (IC$_{50}$ = 0.84 and 1.63 mM, respectively). | [112] |
| **Procognitive activity** | A. absinthium | Ethanol | Aerial part | nt | nt | In vitro (human cortical brain cells) | Extract in concentration 29 mg/mL had affinity for human muscarinic (99.8%) and nicotinic receptors (99.8%) responsible for cognitive functions. | [38] |
| **Neurotrophic activity** | A. absinthium | Methanol, ethanol and aqueous | Aerial part | nt | nt | In vitro (PC12D cells (cell line of rat pheochromocytoma tumor) | Methanolic, ethanolic, and aqueous extracts from A. absinthium induce the nerve growth factor, which stimulates development of neurites. | [217] |
| Direction of Activity | Species | Extract/Essential Oil | Part       | Classification | Compounds                                      | Model/Assay | Short Description of Performed Studies                                                                                   | References |
|-----------------------|---------|-----------------------|------------|----------------|------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------|------------|
| Nephroprotective activity | *A. annua* | Essential oil          | Aerial part | nt             | nt                                               | In vivo (rats) | Administration of *A. annua* essential oil to rats exposed to carbon tetrachloride prevents kidney damage.               | [93]       |
| Stabilizing cell membrane activity | *A. absinthium* | Hydroalcoholic        | Aerial part | nt             | nt                                               | In vitro     | Hydroalcoholic extract from *A. absinthium* prevents hemolysis of erythrocytes.                                          | [218]      |
| Auxiliary action in obesity treatment | *A. annua* | Essential oil          | Aerial part | nt             | nt                                               | In vitro     | Reduction in fat droplet accumulation and inhibition of PPARγ (peroxisome proliferator-activated receptor gamma), C/EBPα (CCAAT/enhancer-binding protein), SREBP-1c (Sterol regulatory element-binding protein 1), FAS, and ACC (Acetyl-CoA carboxylase) protein expression under the influence of *A. annua* essential oil. | [202]      |
|                        |         | Hydro-ethanol          | Leaves     | nt             | nt                                               | In vivo (mice) | Reduction in insulin resistance, liver steatosis, and fibrosis. Lowering the levels of SREBP-1c, ChREBP (carbohydrate-responsive element-binding protein), and COX-2 (cyclooxygenase-2). Inhibition of TGF-β1 and connective tissue growth factor. | [203]      |
| Hypoglycemic activity  | *A. dracunculus* | Ethanol            | Herb       | nt             | nt                                               | In vivo      | Encapsulated ethanolic extract of *A. dracunculus* (at dose 1000 mg for 90 days) decrease in glycated hemoglobin (5.8% in the control group, 5.6% in the test group), area under the curve for insulin (56.136 to 27.426 pmol/L in the control group, 44.472 to 23.370 pmol/L in the test group), total insulin secretion (0.45 to 0.23 in the control group, 0.35 to 0.18 in the test group), and systolic blood pressure (120 mm Hg in the control group, 113 mmHg in the test group), and increase in HDL-C. | [207]      |
### Table 5. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|-------------|----------------------------------------|------------|
| Hypolipemic activity  | *A. vulgaris* | Aqueous | Root | nt | nt | In vivo (rat) | Normalized serum lipid profile, a significant increase in paraoxonase-1 activity, and decrease in serum malondialdehyde, nitric oxide, and tumor necrosis factor-α levels and in hydroxymethylglutaryl-CoA reductase activity. Lowering total cholesterol, triglycerides, LDL (low-density lipoprotein), and VLDL (very low density lipoprotein), and increasing HDL (high density lipoprotein) and atherogenicity indicator (aqueous extract of *A. vulgaris* roots). | [213,214] |
| Antihypertensive activity | *A. vulgaris* | Aqueous and chloroform | Aerial part | nt | nt | In vivo (rats) | A 10% solution of the aqueous extract inhibiting the hypertensive effect of noradrenaline. | [215] |
| Bronchodilatory activity | *A. vulgaris* | Methanol | Aerial part | Alkaloids, coumarins, flavonoids, saponins, sterols, tannins, and terpenoids | nt | In vivo (rabbit jejunum and guinea pig trachea) | Anticholinergic and Ca$^{2+}$ antagonist mechanisms. Histamine H1 antagonism in the ileum and trachea. | [138,208] |
| Normalizing the profile of thyroid hormones | *A. dracunculus* | Aqueous | Herb | nt | nt | In vivo (rats) | Extract (at dose 300 mg/kg) caused increase in thyroxine and triiodothyronine levels, decrease in thyrotropin levels, increase in total antioxidant capacity, increase in glutathione, and decrease in malondialdehyde levels. | [22] |
**Table 5. Cont.**

| Direction of Activity | Species     | Extract/Essential Oil   | Part       | Classification          | Compounds                   | Model/Assay     | Short Description of Performed Studies                                                                                                                                                                                                 | References |
|-----------------------|-------------|-------------------------|------------|-------------------------|-----------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| **Estrogenic activity** | *A. vulgaris* | Ethyl acetate           | Aerial part | Flavonoids              | Eriodictyol and apigenin    | In vivo (rats) | Antagonism toward the estrogen receptor and activation of gene transcription. Induction of gene transcription by eriodictyol and apigenin. Anti-implantation activity and estrogenic activity on female Wistar rats.                                      | [23,24]    |
|                       | *A. abrotanum* | Toluene extract      | Herb       | Monoterpenoids, coumarins, phenolic acids | Camphor, coumarin and thuyl alcohol, chlorogenic acid and caffeic acid | In vivo       | Toluene extract from the herb *A. abrotanum* and the individual components of the extract showed an insect repellent effect against *Ixodes ricinus* and *Aedes aegypti*. After 4 and 8 h from the time of applying the ethanolic suspension of the toluene extract from the herb *A. abrotanum*, the recorded repellency rates were, respectively, 69.1% and 56.8% against *Ixodes ricinus*, and 100% and 86.7% against *Aedes aegypti*.           | [116]      |
|                       | *A. dracunculus* | Essential oil       | Herb       | nt                      | nt                          | In vitro       | Inhibition of *Calliphora vomitoria* egg laying on fresh beef, on which the essential oil of *A. dracunculus* herb (at dose 0.05 µL/cm²) was applied.                                                                                         | [96]       |
|                       |             | Essential oil       | Herb       | nt                      | nt                          | In vitro       | Larvadicl effect against *Anopheles stephensi* under the influence of nanomulsion of *A. dracunculus* essential oil (consisting of 0.35% tarragon oil, 10% of Tween 20 and deionized water).                                                     | [102]      |
Table 5. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Model/Assay | Short Description of Performed Studies | References |
|-----------------------|---------|------------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| Anti-animal parasites activity | *A. abrotanum* | Ethanol/water (1/1) | Leaves | nt | nt | In vivo | Notable antiprotozoal activity against *P. falciparum* under the influence of *A. abrotanum*-AgNPs in concentration ranging from 0.6 to 7.5 µg/mL. The inhibition dependent on concentration was 50%, 90%, and 99%. | [219] |
| | *A. annua* | Methanol | Herb | nt | nt | In vivo | Improvement in malaria symptoms after treating patients with infusion of *A. annua* herb. Inactivation of protozoan calcium pump. | [193] |
| | *A. annua* | Hydro-ethanol and aqueous | Leaves | nt | nt | In vivo | Lethal activity of hydroethanolic and aqueous extracts from *A. annua* leaves (at dose 20 mg/kg) against *P. falciparum* and *P. berghei*. | [194] |
| Antimalarial activity | *nt* | Herb | Sesquiterpenoid lactones | Artemisinin | In vitro | Interference of artemisinin with protein metabolism and mitochondrial activity of *Plasmodium* spp. protozoa. | [195] |
| | *nt* | Leaves | Sesquiterpenoid lactones | Artemisinin | In vitro | Synergism of action of artemisinin and other compounds present in *A. annua* leaves against *P. falciparum*. | [131] |
| | *A. vulgaris* | Ethanol | Leaves | nt | nt | In vitro | Activity against *Plasmodium yoelii* and *P. berghei*. The extract at doses of 500, 750, and 1000 mg/kg significantly inhibited parasitemia by 79.3%, 79.6%, and 87.3%, respectively. | [220,221] |

* nt—not tested.
6. Cosmetic Potential of *Artemisia* Species

6.1. From the History of Cosmetic Uses of *Artemisia* Species

In the twenty-first century, the terms “cosmetics” and “cosmetology”, meaning “the art of body care”, refer to not only a wide range of products and application techniques but also a multisector industry for which modern medical laboratories work, exclusively focusing on the beautifying aspect of the manufactured preparations. For this reason, the analysis of the historical sources in terms of possible cosmetic uses must be adapted to the time when the preparation was made or described.

In the therapeutic portrait of mugwort *A. vulgaris*, three forms of external application are shown, which can now be treated also as elements of cosmetic care: sit-ups, diaphoretic baths, and leg compresses [222–225].

Diaphoretic baths are used to regulate menstrual bleeding, especially in women experiencing trouble becoming pregnant.

Leg wraps, in the form of ointments or compression dressings, have the longest history of indication and are described in all epochs. They eliminate leg fatigue, reduce exercise pain in the lower limbs, and maintain the condition of the skin in these areas.

It is worth noting that although the use of *A. vulgaris* monopreparations without any admixtures is considered sufficient for each of the above indications, some authors have also provided recipes with an extended composition, e.g., with the addition of mugwort, chamomile flowers, mint pour, or lemon balm.

Most of the sources confirming the cosmetic use of *Artemisia* spp. refer to mugwort wormwood (*A. absinthium*).

In ancient Rome, wormwood (“artemisia” in Latin) was an ingredient in hair dyes. The use of wormwood ash, mixed with rose ointment, to anoint the hair to make it black, was mentioned by Pliny the Elder in *Historia Naturalis* (HN 15.87) [226].

Elagabalus, the Roman emperor who reigned from 218 to 222 AD, provided information about bathing in water flavored with rose petals and wormwood in another ancient work *Scripторes Historiae Augustae* [226].

According to Dioscorides (first century), a Greek physician and botanist, who is the author of the work on medicinal substances “*Peri hyles iatrikes*” (“De materia medica”), mugwort wormwood (“*Apsinthion bathypicron*” in Greek) should be used with water for blemishes formed at night and mixed with honey for bruises, eye problems, and rheumy ears. Wormwood cooked in raisin wine (“*passum*” in Latin) helped to ease eye pain, which was applied in the form of a soothing poultice and rubbed with oil to protect against insect bites [227].

Similar descriptions of the cosmetic uses of mugwort were also reported in the so-called renaissance Polish herbaria (herbaria), which were based on the works of ancient and medieval botanists.

Szymon Syrenski (Syrenius), the author of the *Herbarium* published in 1613, provided much information on the nurturing and healing properties of *A. absinthium* L. According to him, fresh wormwood, grated with honey and ground caraway seeds, removes dark circles below the eyes and bruises all over the body; in the case of bruises covered with blood, crushed wormwood, sprinkled with wine on a hot brick, should be used. It helps with itchy pimples, scabies, and lichens when grated with coating, cumin, and white pepper and served with white wine. A daily intake of wormwood juice mixed with wine and drunk is reported to remove skin problems (impetigo). Wormwood is also effective in eye ailments, such as redness, swelling, and pain. For bloodshot eyes, either a poultice of mashed wormwood mixed with the white of fresh egg or eye drops made of wormwood with breast milk and a little rose vodka was used. The hair care benefits of wormwood are listed in the Herbarium of Syrenius: washing with wormwood boiled in water can remove dandruff and scabs on the head and frequent washing with wormwood cooked with a tree (*A. abrotanum* L.) can treat baldness. Wormwood also repels lice, fleas, and clothing moths. Mermaid also wrote that wormwood cooked in vinegar can be used as a mouthwash to remove unpleasant odors [228].
Information on the use of *A. absinthium* in cosmetology was also found at the beginning of the nineteenth century. In 1805, a work by a pharmacist, professor of chemistry, and pharmacognosy, J.B. Trommsdorf (1770–1837), was published, entitled “Kallopistria, oder die Kunst der Toilette für die elegante Welt” (Wien, 1805), containing the first monographs on *A. absinthium* with regard to their cosmetic use. Trommsdorf mentioned wormwood (*A. absinthium*) leaves, used in perfume production, and tarragon vinegar (*A. dracunculus*) as raw materials for cosmetic products [229].

### 6.2. CosIng Database

Of late, *Artemisia* ssp. raw materials have been increasingly appearing in cosmetic products.

Information about forms of *Artemisia* available in cosmetology is provided in the European Union Special Cosmetic Ingredients database CosIng (Table 6) [230].

**Table 6.** Possible applications of *Artemisia* species in cosmetology as recommended by the CosIng database [231].

| Species | INCI Name | Description | Functions |
|---------|-----------|-------------|-----------|
| *A. abrotanum* | *Artemisia abrotanum* extract | Extract of the whole plant of the Southernwood, *A. abrotanum* | Skin protecting |
| | *Artemisia abrotanum* leaf/stem extract | Extract of the flowers, leaves, and stems of the Southernwood, *A. abrotanum* | Moisturizing, Skin conditioning |
| | *Artemisia absinthium* extract | Extract of the whole herb of the Wormwort, *A. absinthium* | Skin conditioning |
| | *Artemisia absinthium* herb extract | Extract obtained from the flowering herb of the Wormwort, *A. absinthium* | Perfuming |
| | *Artemisia absinthium* herb oil | “Wormwood Oil”, essential oil obtained from the flowering herb of the Wormwort, *A. absinthium*. It contains thujyl alcohol, thujyl acetate, thujone, phellandrene, cadinene, and a blue oil | Perfuming |
| | *Artemisia absinthium* oil | Volatile oil obtained from the whole plant of the Wormwort, *A. absinthium* | Antimicrobial |
| | *Artemisia absinthium*/Chamaecyparis obtusa wood extract | Extract of the whole plant, *A. absinthium*, and the wood of *C. obtusa* | Antimicrobial, Hair conditioning, Skin conditioning—emollient |
| | *Artemisia annua* (leaf/stem)/*Ficus carica* fruit/*Ginkgo biloba* leaf extract | Extract of the leaves and stems of *A. annua*, the fruit of *F. carica*, and the leaves of *G. biloba* | Skin conditioning |
| | *A. annua* callus extract | Extract of the callus of *A. annua* grown in culture | Antimicrobial, Antioxidant, Hair conditioning, Skin conditioning, Skin protecting |
| | *Artemisia annua* extract | Extract of the whole herb, *A. annua* | Fragrance |
| | *Artemisia annua* flower/leaf/stem extract | Extract of the flowers, leaves, and stems of *A. annua* | Skin conditioning—miscellaneous |
| | *Artemisia annua* herb oil | Essential oil obtained from the whole herbs of the plant *A. annua* | Perfuming |
| | *Artemisia annua* leaf extract | Extract obtained from the leaves of the plant *A. annua* | Antiseborrheic, Antimicrobial, Perfuming, Skin conditioning |
### Table 6. Cont.

| Species                  | INCI Name                | Description                                                                 | Functions                              |
|--------------------------|--------------------------|-----------------------------------------------------------------------------|----------------------------------------|
| *Artemisia annua* leaf/stem extract | Extract of the leaves and stems of *A. annua*                               | Skin conditioning                    |                                        |
| *Artemisia annua* meristem cell extract | Extract of the cultured meristem cells of *A. annua*                          | Antioxidant                           |                                        |
| *Artemisia annua* oil     | Volatile oil obtained from the whole plant, *A. annua*                       | Antioxidant                           | Humectant                              |
| *Artemisia annua* seed extract | Extract of the seeds of *A. annua*                                         | Skin conditioning—emollient           |                                        |
| *Artemisia annua* / *Citrus junos* fruit / *Pinus densiflora* leaf extract | Extract of the whole plant *A. annua*, the fruit of *C. junos*, and the leaves of *P. densiflora* | Skin protecting                        |                                        |
| *Artemisia dracunculus* flower | Flower of *A. dracunculus*                                                 | Skin conditioning                    |                                        |
| *Artemisia dracunculus* herb extract | Extract obtained from the whole herb of the Tarragon, *A. dracunculus*      | Perfuming                             |                                        |
| *Artemisia dracunculus* leaf/stem extract | Extract of the leaves and stems of the Tarragon, *A. dracunculus*          | Fragrance                             |                                        |
| *Artemisia dracunculus* oil | Essential oil obtained from the whole herbs of the Tarragon, *A. dracunculus* | Perfuming                             | Skin conditioning                    |
| *Artemisia dracunculus* root extract | Extract of the roots of the Tarragon, *A. dracunculus*                      | Skin conditioning                    |                                        |
| *Artemisia dracunculus* seed / *Anthemis nobilis* seed / *Hypericum androsaemum* seed extract | Extract of the seeds of the Tarragon, *A. dracunculus*, *A. nobilis*, and *H. androsaemum* | Skin conditioning                    |                                        |
| *Artemisia vulgaris* extract | Extract of the whole plant of the Common Mugwort, *A. vulgaris*             | Skin conditioning                    |                                        |
| *Artemisia vulgaris* herb extract | Extract obtained from the whole herb of the Common Mugwort, *A. vulgaris* | Perfuming                             | Antioxidant                            |
| *Artemisia vulgaris* leaf extract | Extract of the leaves of *A. vulgaris*                                      | Skin conditioning—emollient           | Skin protecting                        |
| *Artemisia vulgaris* oil   | Volatile oil obtained from the whole herb of the Common Mugwort, *A. vulgaris* | Perfuming                             | Skin conditioning                    |

Two forms of *A. abrotanum* are listed in the CosIng database, which show skin conditioning, skin protecting, and moisturizing activities.

In cosmetics, six forms of *A. absinthium* are reported, and they are reported as having antimicrobial, perfuming, skin conditioning (emollient), and hair conditioning activities. Moreover, *A. absinthium* filtrate obtained after fermentation of the leaves by *Lactobacillus* spp. is used in cosmetology.

Eleven forms of *A. annua* are listed in CosIng, which show skin conditioning, fragrance, perfuming, antiseborrheic, antioxidant, and skin protecting activities. In addition, it has been reported in CosIng that *A. annua* can be used as a cosmetic ingredient in the callus culture extracts of antimicrobial, antioxidant, hair conditioning, skin protecting, and skin conditioning activities. After the fermentation of its leaves by a microorganism, e.g., *Aspergillus* spp., *Bacillus* spp., *Lactobacillus* spp., and *Leuconostoc* spp., *A. annua* herb extracts are also used as a filtrate. Essential oils possess also the important position.

According to CosIng, *A. dracunculus* can be used in six forms, which have skin conditioning, perfuming, and fragrance properties.

In cosmetology, *A. vulgaris* can be used in nine forms as skin conditioning, perfuming, antioxidant, and skin protecting ingredients. In addition, original cosmetic ingredients,
such as filtrates obtained by fermentation with bacteria (Bacillus spp., Lactobacillus spp.) or fungi (Saccharomyces spp.) deserve attention [230] (Table 6).

6.3. Potential Cosmetic Biological Activities of Artemisia ssp. Confirmed by Scientific Studies

Artemisia ssp. as cosmetic ingredients are subject of numerous studies (Table 7). Essential oils or extracts of Artemisia ssp. discussed in this review have antibacterial, antifungal, and antioxidant activities [14,20,38,39,58,84,85,87,88,91–93,122,168,201,212,217,232–238].

From a cosmetic point of view, a very interesting scientifically proven activity against P. acnes strains has been reported for the extracts from the herb of A. abrotanum and A. absinthium. Studies have shown that these extracts can be used to create new therapeutic and cosmetic products for the treatment of acne and for skincare [233].

It has also been demonstrated that the antioxidant activity of Artemisia ssp. extracts is conditioned mainly by the presence of flavonoids and other polyphenol compounds. This antioxidant activity is very important as it is related to the antiaging effect in cosmetic products [20,38–41].

Extracts of A. absinthium, A. annua, A. dracunculus, and A. vulgaris have also shown scientifically proven anti-inflammatory activities [86,126,191,239–243].

Moreover, A. vulgaris herb extracts have been reported to help in decreasing skin and eye sensitivity [244].

In the Philippines, A. absinthum and A. vulgaris are traditionally used to treat skin diseases and ulcerative sores. An entire plant is made into a decoction and is used as a wash for many kinds of wounds and skin ulcers. The dried leaves are cut into small fragments to help induce a more rapid healing of wounds and are used in eczema, herpes, and purulent scabies [245].

The methanolic extracts of aerial parts of A. absinthium have been tested for the sun protection activity. Studies have indicated that A. absinthium extracts have a higher value of SPF in comparison with other species, such as Sambucus nigra, Sambucus ebulus, Orobanche orientalis, Vicia faba, Albizia julibrissin, Danae racemosa, and Echium amoenum. These activities are significantly correlated with the phenolic and flavonoid content, which was also studied [246].

Recent studies have investigated the efficacy and safety of a nail gel containing glycerin and A. abrotanum extract in the treatment of nail plate surface abnormalities. The findings of these studies have confirmed a significant reduction in roughness and an increase in smoothness. These values were observed after 2 and 8 weeks of using the preparation [247].

Studies of A. vulgaris extracts have focused on the antioxidant effect against the oxidative stress caused by UV radiation, which was tested on hairless mouse skin. The A. vulgaris extract and, for comparative purposes, a lotion as well as ascorbic acid were applied on mouse skin before exposure to UV radiation. The animals were then irradiated with increasing doses of UV-B for 4 weeks. Results suggested that the A. vulgaris extract was more effective than ascorbic acid extract in protecting hairless mouse skin from photoirradiation and that it can be used as a potential antiaging cosmetic ingredient [248].
Table 7. Cosmetic and potentially cosmetic properties of *Artemisia* species.

| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Modal/Assay | Short Description of Studies Performed | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| Antibacterial and antifungal activity | A. abrotanum | Ethanol | Aerial parts | nt * | nt | Cup plate method | Lethal effect on the bacteria *Bacillus stearothermophilus* (MIC = 250 µg/mL), *Klebsiella pneumoniae* (MIC = 250 µg/mL), *Micrococcus luteus* (MIC = 500 µg/mL), *Pseudomonas cepacia* (MIC = 500 µg/mL), and *Salmonella typhi* (MIC = 125 µg/mL), and the fungi *Candida albicans* (MIC = 250 µg/mL), *Saccharomyces cerevisiae* (MIC = 125 µg/mL), and *Trichosporon beigelii* (MIC = 125 µg/mL). | [232] |
| Essential oil | Aerial parts | nt | nt | In vitro/diffusion well agar method (*Escherichia coli, Proteus vulgaris, Pseudomonas aeruginosa, Staphylococcus aureus*)/paper disc diffusion method (*Candida albicans*)/ | Inhibition of the growth of *Escherichia coli* (inhibition zone diameter = 16 mm), *Proteus vulgaris* (inhibition zone diameter = 18.89 mm), *Pseudomonas aeruginosa* (inhibition zone diameter = 10.33 mm), *Staphylococcus aureus* (inhibition zone diameter = 20 mm), and *C. albicans* by components of *A. abrotanum* essential oil and essential oil. Some activity against *Aspergillus flavus* Lethal effect of the essential oil of *A. abrotanum* herb on *C. albicans* (inhibition zone diameter = 20.0 mm). | [80,168,237] |
| Methanol | leaves | nt | nt | A microtiter plate-based protocol (microdilution) | Inhibition of the growth of the bacteria *Bacillus cereus* (MIC = 0.41 mg/mL), *E. coli* (MIC = 0.39 mg/mL), *Listeria monocytogenes* (MIC = 0.45 mg/mL), *Micrococcus luteus* (MIC = 0.57 mg/mL), *P. aeruginosa* (MIC = 0.47 mg/mL), and *S. aureus* (MIC = 0.38 mg/mL), and the fungi *A. flavus* (MIC = 0.39 mg/mL), *Aspergillus niger* (MIC = 0.78 mg/mL), *Aspergillus ochraceus* (MIC = 0.55 mg/mL), *C. albicans* (MIC = 0.86 mg/mL), *Penicillium funiculosum* (MIC = 0.85 mg/mL), and *Penicillium ochrochloron* (MIC = 0.86 mg/mL) by leaf extracts of *A. abrotanum*. | [20] |
Table 7. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Modal/Assay | Short Description of Studies Performed | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| Ethanol               | herb    | nt                    | nt   | nt             | In vitro/micromethod of diffusion in agar | Moderate inhibition of the growth of the bacteria *Citrobacter freundii* (inhibition zones diameter = 8.81 mm), *Enterococcus faecalis* (inhibition zones diameter = 6.65 mm), *E. coli* (inhibition zones diameter = 6.44 mm); *P. aeruginosa* (inhibition zones diameter = 8.52 mm), *Streptococcus pyogenes* (inhibition zones diameter = 5.29 mm), *Streptococcus agalactiae* (inhibition zones diameter = 5.19 mm), *Streptococcus gordoni* (inhibition zones diameter = 5.89 mm); methicillin-susceptible: *S. aureus* (inhibition zones diameter = 6.34 mm) and *Staphylococcus epidermis* (inhibition zones diameter = 6.38 mm); methicillin-resistant: *S. aureus* (inhibition zones diameter = 7.20 mm) and *Staphylococcus haemolyticus* (inhibition zones diameter = 6.85 mm); and macrolides-resistant: *Propionibacterium acnes* (inhibition zones diameter = 8.71 mm) strains. Decrement of *C. albicans* (inhibition zones diameter = 5.79 mm) and *Candida tropicalis* (inhibition zones diameter = 7.09 mm) colonies and *A. niger* (inhibition zones diameter = 13.32 mm) spore germination. Synergistic action of *A. abrotanum* herb ethanolic extract with erythromycin against *S. aureus* with efflux mechanism of MLS-resistance. | [233]       |
### Table 7. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Modal/Assay | Short Description of Studies Performed | References |
|-----------------------|---------|------------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| Essential oil         | A. absinthium | Aerial parts       | nt   | nt             | In vitro  | Growth inhibition by the essential oil from *A. absinthium* and its lethal activity against *Clostridium perfringens*, *Enterobacter aerogenes*, *E. coli*, *Klebsiella oxytoca*, *K. pneumoniae*, *L. monocytogenes*, *Proteus mirabilis*, *P. aeruginosa*, *S. aureus*, and *Staphylococcus sonnei* and inhibition of growth fungi *Fusarium moniliforme*, *Fusarium oxysporum*, and *Fusarium solani*. The range of MIC values was from < 0.08 mg/mL for *P. mirabilis* and *E. aerogenes* isolated from stool and for *P. aeruginosa* and *S. aureus* isolated from wounds, up to 2.43 mg/mL for *K. oxytoca* isolated from stool. | [85,88,234] |
| Ethanol               | Herb    | nt                     | nt   | In vitro/micromethod of diffusion in agar | Lethal effect of *A. absinthium* extract on *B. cereus* (inhibition zones diameter = 20.40 mm), *Bacillus subtilis* (inhibition zones diameter = 14.40 mm), *Haemophilus influenzae* (inhibition zones diameter = 18.40 mm), *P. aeruginosa* (inhibition zones diameter = 7.22 mm), and *S. aureus* (inhibition zones diameter = 9.37 mm) and growth suppression in *P. acnes* (inhibition zones diameter = 7.26 mm). | [233,235] |
| Essential oil         | A. absinthium | Aerial parts       | nt   | nt             | In vitro  | Growth inhibition of the bacteria *L. monocytogenes* (inhibition zone = 20 mm) and methicillin-sensitive/resistant *S. cerevisiae var. chevalieri* (inhibition zone = 16 mm), *S. aureus* (inhibition zone = 25 mm), and the fungi *Fusarium culmorum* (inhibition zone = 45 mm), *Fusarium graminearum* (inhibition zone = 15 mm), *F. oxysporum* (inhibition zone = 19 mm), *Rhizoctonia solani* (inhibition zone = 25 mm), and *Sclerotinia sp.* (inhibition zone = 24 mm) by *A. absinthium* essential oil. | [84,87] |
### Table 7. Cont.

| Direction of Activity | Species | Extract/Essential Oil Part | Classification | Compounds | Modal/Assay | Short Description of Studies Performed | References |
|-----------------------|---------|----------------------------|----------------|-----------|------------|----------------------------------------|------------|
| Aerial parts          | Phenolic acids | Chlorogenic acid, 4,5-di-O-caffeoylquinic acid | In vitro | Some bactericidal activity of chlorogenic acid and efflux pump inhibition by 4,5-di-O-caffeoylquinic acid isolated from *A. absinthium.* | [122] |
| Essential oil Aerial parts | nt | nt | In vitro | Lethal action by essential oil *A. absinthium* against the fungi *Alternaria alternata, A. niger, Fusarium oxysporum, F. sambucinum, and F. solani* and the bacteria *Arthrobacter spp., Bacillus mycoides, Micrococcus lylae,* and *P. aeruginosa.* | [236] |
| Water Leaves | Monoterpenoids | 1,8-cineole, camphor | In vitro (disk diffusion method) | Lethal activity of *A. annua* leaf extracts against *E. coli.* | [201] |
| Essential oil Aerial parts | Monoterpenoids | 1,8-cineole, camphor | In vitro (disk diffusion method) | Lethal activity of essential oil and 1,8-cineole, camphor, and *Artemisia* ketone isolated from *A. annua* herb against *E. coli,* *L. monocytogenes,* *Salmonella enteritidis,* *S. typhi,* and *Yersinia enterocolitica.* Components of essential oil penetrate through the bacterial cell membrane, causing cellular dysfunction, increasing permeability of bacterial membrane and components. Low and moderate growth inhibition of the bacteria *B. cereus, E. coli, K. pneumoniae,* *Sarina lutea, Shigella,* *S. aureus,* and *S. enteritidis,* and fungi *Aspergillus fumigatus* and *C. albicans* by essential oil and 1,8-cineole, camphor and *Artemisia* ketone isolated from *A. annua* herb. | [91,93] |
| Essential oil Aerial parts | nt | nt | In vitro (disk diffusion method) | Essential oil inhibits growth of the bacteria *Acinetobacter baumannii, B. subtilis, E. faecalis, E. coli, K. pneumoniae, P. aeruginosa,* and *S. aureus,* and fungi *C. albicans, Candida famata,* and *C. utilis,* and also inhibits cell adhesion and reduces the expression of virulence factors. | [92] |
### Table 7. Cont.

| Direction of Activity | Species | Extract/Essential Oil Part | Classification | Compounds | Modal/Assay | Short Description of Studies Performed | References |
|-----------------------|---------|-----------------------------|----------------|-----------|------------|----------------------------------------|------------|
| A. dracunculus        | Herb    | nt                          | nt             | nt        | In vitro (disk diffusion method)       | Inhibition of the growth of B. cereus, B. subtilis, E. coli, K. pneumoniae, L. monocytogenes, M. luteus, P. aeruginosa, Salmonella sp., S. aureus, S. epidermidis, S. pyogenes, Streptococcus typhimurium, Shigella flexneri, and Shigella marcescens under the influence of the essential oil of the A. dracunculus herb. Corynebacterium diphtheriae, Proteus spp., and S. aureus colony growth inhibition after application of the essential oil. S. epidermidis showing the largest zone of inhibition (21.5 mm). | [101]      |
|                       | Leaves  | nt                          | nt             | nt        | In vitro (agar well diffusion)         | Essential oil of A. dracunculus leaves hampers the growth of B. cereus, Enterobacter cloacae, E. coli, L. monocytogenes, M. flavus, S. enteritidis, and S. aureus strains. P. aeruginosa, A.R P. aeruginosa, S. aureus, S. aureus MRSA (methylillin-resistant), and S. typhimurium colonies growth inhibition and bactericidal effect as well as inhibition of the growth of A. fumigatus, A. niger, A. ochraceus, A. versicolor, P. funiculosum, P. ochrochloron, Penicillium verrucosum, Trichoderma viride, and fungicidal activity under the influence of hydroethanolic extract of the Tarragon. The MIC value for these bacteria and fungi was determined using the essential oil at a concentration of 0.03 and 25 mg/mL. | [125,153,249] |
Table 7. Cont.

| Direction of Activity | Species | Extract/Essential Oil | Part     | Classification | Compounds | Modal/Assay | Short Description of Studies Performed                                                                                                                                                                                                 | References |
|-----------------------|---------|-----------------------|----------|----------------|-----------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Hydro-ethanol         | A. dracunculus | Leaves              | nt       | nt             | In vitro (disk diffusion method)/In vivo (mice) | Hydroethanolic extract of *A. dracunculus* leaves (at dose 200 mg/kg) significantly reduces the number of colony-forming units of *C. albicans* in the liver and kidneys of mice. Inhibition of the growth of the bacteria *B. cereus*, *B. subtilis*, *E. coli*, *P. aeruginosa*, *P. vulgaris*, *S. aureus*, and *S. pyogenes*, and fungi *A. fumigatus*, *C. albicans*, and *Penicillium expansum* under the influence of hydroethanolic herbal extract. The largest zone of growth inhibition was observed for *S. pyogenes* (18 mm), and the smallest for *P. aeruginosa* (9 mm). Inhibition of the growth of the bacteria *Corynebacterium diphtheria* (MIC 5.9 mg/mL), *Helicobacter pylori* (MIC 11.75 mg/mL), *S. aureus* (MIC 0.09 mg/mL), *S. aureus MRSA* (MIC 2.35 mg/mL), and *S. epidermis* (MIC 0.363 mg/mL), after the application of infusion of *A. dracunculus* and minimal inhibition effect in *Enterococcus hirae* (MIC 23.5 mg/mL) and *K. pneumoniae* colonies (MIC 47 mg/mL). | [100,126,205] |

| Essential oil         | A. vulgaris | Aerial parts         | nt       | nt             | In vitro/paper disc diffusion method (*Candida albicans*) | Inhibitory effect of the oil fraction on the development of *E. coli*, *K. pneumoniae*, *S. enteritidis*, *P. aeruginosa*, *S. enteritidis*, *S. aureus*, and *Streptococcus mutans*. Inhibitory effect of the oil fraction on the development of *A. niger* and *C. albicans* (inhibition zone diameter = 12.5 mm). | [44,80,88,151,250–252] |
| Direction of Activity | Species | Extract/Essential Oil | Part | Classification | Compounds | Modal/Assay | Short Description of Studies Performed | References |
|-----------------------|---------|-----------------------|------|----------------|-----------|------------|----------------------------------------|------------|
| **Antioxidant activity** |         |                       |      |                |           |            |                                        |            |
| A. abrotanum | | | | | | | | |
| Ethanol | Herb | Polyphenols | Apigenin, caffeic acid, chlorogenic acid, 3-coumaric acid, ferulic acid, gentisic acid, hyperoside, isouqueritrin, luteolin, rutloside, sinapic acid, quercitol, quercitrin, | In vitro | Moderate antioxidant activity ($IC_{50} = 284.50 \mu g/mL$) of A. abrotanum ethanolic extract in the test with DPPH (2,2-diphenyl-1-picrylhydrazyl). | [58] |
| Essential oil | Aerial parts | nt | nt | In vitro | Reducing potential and inhibition of lipid peroxidation (82.34%, 1000 µL) by the essential oil from the herb of A. abrotanum. | [237] |
| Methanol | Herb | Phenolic acids | Isochlorogenic acid, rosmarinic acid, quercitrin | In vitro | Reducing the potential of methanolic extract from A. abrotanum herb, in particular its components, rosmarinic acid, isochlorogenic acid, and quercitrin. | [20] |
| Methanol | Herb | Flavonoids, phenolic acids | nt | In vitro | Antioxidant activity of flavonoids and phenolic compounds in A. absinthium. In the DPPH test, the $IC_{50}$ value for radical scavenging activity was $612 \mu g/mL$. | [238] |
| A. absinthium | | | | | | | | |
| Methanol | Herb | nt | nt | In vitro/DPPH assay, FRAP assay | Methanolic extracts from A. absinthium herb have a significant reduction potential ($IC_{50} = 9.38 mg/mL$). Herb extracts reduced iron(III) ions, the $EC_{50}$ were lower than for the ascorbic acid control. | [84] |
| Essential oil | Aerial parts | nt | nt | In vitro/DPPH assay, ABTS assay | A. absinthium essential oil has the ability to scavenge radicals in DPPH and ABTS (2,2’-azobis(3- ethylobenzotiazolino-6-sulfonian)) tests. | [88] |
### Table 7. Cont.

| Direction of Activity | Species       | Extract/Essential Oil | Part       | Classification               | Compounds               | Modal/Assay | Short Description of Studies Performed                                                                                                                                                                                                 | References |
|-----------------------|---------------|-----------------------|------------|------------------------------|-------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Methanol              | Herb          | nt                    | nt         | In vivo (mice)               | Reducing properties of *A. absinthium* extract (at dose 100 or 200 mg/kg) and the ability to capture superoxide and hydrogen peroxide anions, hydroxy and nitric oxide radicals, inhibiting oxidative stress, reducing the concentration of TBARS (thiobarbituric acid reactive substances), and increasing the concentration of superoxide and glutathione dismutases. | [217]      |
| Methanol              | Leaves        | Phenolic acids, flavonoids | nt         | In vitro                     | Methanolic extracts from *A. annua* leaves have the highest concentration of phenolic and flavonoid compounds showing a reducing effect.                                                                                      | [39]       |
| Hexane, chloroform, methanol, and water | Leaves        | nt                    | nt         | In vitro                     | Reducing activity of *A. annua* leaf extracts in DPPH test.                                                                                                                                                           | [201]      |
| Essential oil        | Herb          | Monoterpenoids        | 1,8-cineol, and α-pinene | In vitro                     | Essential oil from *A. annua* herb and its components 1,8-cineol, *Artemisia* ketone, and α-pinene shows weak reducing activity in tests with DPPH, ABTS radical tests, and hydrogen peroxide.        | [93]       |
| Hydro-ethanol         | Herb          | Flavonoids, phenolic acids | nt         | In vitro                     | Reducing properties of the hydroethanolic herbal extract related to the presence of phenolic compounds and flavonoids. Reduction in DPPH and ABTS in the presence of phenolic compounds.                   | [40,100,113, 125] |
| Hydro-ethanol         | Herb          | Flavonoids, phenolic acids | nt         | In vitro                     | Proved by different methods, such as DPPH (IC<sub>50</sub> value was 65.5 µg/mL), lipid peroxidation, protein glycation, xanthine oxidases, ABTS, hydroxyl, superoxide, nitric oxide, ferric reducing power activity, and inhibition of lipid peroxidation by thiobarbituric acid reactive species assays. Increasing the level of ascorbic acid and glutathione. | [41,128,243, 253,254] |
| Direction of Activity | Species | Extract/Essential Oil | Part       | Classification | Compounds                                      | Modal/Assay | Short Description of Studies Performed                                                                                                                                                                                                 | References |
|-----------------------|---------|-----------------------|------------|----------------|------------------------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Anti-inflammatory activity | A. absinthium | Essential oil/Methanol | Aerial parts | nt             | nt                                             | In vivo (mice) | Reduction (41%) in inflammatory edema in mice after administration of the essential oil (at dose 4 and 8 mg/kg) or methanolic extract from *A. absinthium* (at dose 300, 500, and 1000 mg/kg).                                                             | [86,191]   |
|                       | A. annua | Methanol Herb          | Herb       | nt             | nt                                             | In vivo (rats) | Reduction in paw edema in rats given carrageenan and venom of *Montivipera xanthina* after the application of *A. absinthium* extract (at dose 25 and 30 mg/kg).                                                                                     | [241]      |
|                       |         | supercritical CO₂      | Herb       | nt             | nt                                             | In vivo       | Reduction in pain and stiffness in joints and improvement in mobility after using *A. annua* extract (at dose 150 mg).                                                                                                                        | [242]      |
|                       |         | Aqueous Leaves          | Phenolic acid | Rosmarinic acid | Use of aqueous extracts from *A. annua* leaves reduces secretion of proinflammatory cytokines, IL-8 and IL-6. Rosmarinic acid is largely responsible for this effect.                                                                                                          | [119]      |

**Table 7. Cont.**

| Direction of Activity | Species | Extract/Essential Oil | Part       | Classification | Compounds                                      | Modal/Assay | Short Description of Studies Performed                                                                                                                                                                                                 | References |
|-----------------------|---------|-----------------------|------------|----------------|------------------------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Anti-inflammatory activity | A. absinthium | nt                     | Aerial parts | flavonoid | 5,6,3',5'-tetramethoxy-7,4'-hydroxyflavone (p7F) | In vitro, In vivo (mice) | Inhibition of the expression of nitric oxide synthase and cyclooxygenase-2, reduction in the production of prostaglandin E2, nitric oxide, and tumor necrosis factor (TNF-α), reduction in the accumulation of reactive oxygen species by 5,6,3',5'-tetramethoxy-7,4'-hydroxyflavone isolated from *A. absinthium*. | [239]      |
|                       | A. annua | nt                     | Aerial parts | Chalcone | Cardamonin                                     | In vitro (THP-1 cell line of acute monocytic leukaemia) and RAW 264.7 cell line of mouse macrophages | Cardamonin isolated from *A. absinthium* inhibits the NFkB (nuclear factor kB) pathway by the direct inhibition of DNA transcription factors, which leads to reduced NO release. | [255]      |
### Table 7. Cont.

| Direction of Activity | Species | Extract/Essential Oil Part | Classification | Compounds | Modal/Assay | Short Description of Studies Performed                                                                                                                                                                                                                                                                         | References |
|-----------------------|---------|-----------------------------|----------------|-----------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|                       | *A. dracunculus* | Ethanol, Aqueous Herb | nt | nt | In vivo (mice) | Reduction in pain sensations and xylene-induced ear edema after the administration of the ethanolic herbal extract (at dose 50 and 100 mg/kg) to mice. Aqueous extract inhibited ROS (by 1.4%), IL-8 (by 4.0 and 4.8%), and TNF-α (by 7.8 and 5.2%). Their production imitated inflammation. | [255]      |
|                       | *A. vulgaris*     | Methanol Leaves            | nt | nt | In vivo (rats)      | Extract (at dose 400 mg/kg) caused the normalization of serum lipid profile, an increase in paraoxonase-1 activity, and a decrease in serum malondialdehyde, nitric oxide, and TNF-α level. Proved by lipoxygenase inhibitory activity assay and “Cotton Pellet Granuloma method.”   | [214, 243, 256] |
| Anti-allergenic activity | *A. vulgaris*     | Aqueous Aerial parts       | nt | nt | In vivo | Decrease in skin sensitivity and eye sensitivity.                                                                                       | [244]      |

* nt—not tested.
6.4. Artemisia ssp. in Cosmetology

Artemisia ssp. are used as ingredients in skincare cosmetics, such as creams, shampoos, essences, serums, masks, lotions, and tonics. Different cosmetic brands based on Artemisia spp. extracts or essential oils are available worldwide.

The species A. abrotanum is used in the products of Australian, German, Japanese, Polish, and US cosmetic companies, whereas A. absinthium is very often used in the cosmetics from South Korean, Canadian, French, Russian, and USA. Furthermore, A. annua is used as a cosmetic ingredient in Malaysia, Swiss, Singapore, South Korea, and US cosmetic products, while A. dracunculus is primarily used by UK, South Korea, and US cosmetic companies (Table 8).

The essential oil of A. dracunculus obtained by steam distillation is widely used as an ingredient in perfumes [2]. It is also used in aromatherapy during massages and baths and in facial masks and compresses [113,145]. The essential oil of A. dracunculus is also very often used by prestigious fashion brands, such as the Italian Prada, Versace, Dolce & Gabbana; the French Givenchy and Chloé; the American Calvin Klein and Tom Ford; and many others.

The use of A. vulgaris is widespread in the cosmetic industry. Various companies from Canada, France, the United Kingdom, New Zealand, Norway, Russia, Indonesia, Israel, and South Korea use the A. vulgaris herb extract and A. vulgaris essential oil in the production of different cosmetics (Table 7). An original form of A. vulgaris—the filtrate obtained as a result of fermentation by bacteria (Bacillus sp., Lactobacillus sp.) or fungi (Saccharomyces sp.)—is used in cosmetic products. During fermentation, Bacillus sp. produces valuable physiologically active substances, such as peptides, viscous compounds (with polysaccharide structure), antioxidants, and fibrins. A combination of A. vulgaris and Bacillus sp. has been shown to enhance the effects of fermentation and to increase the antiaging and antiwrinkle effects by inhibiting the production of matrix metalloproteinase-1 and metalloproteinase-9 enzymes (decomposed of collagen) and increasing cell regeneration and collagen synthesis [35,76,84,121,122].
Table 8. Examples of some cosmetics based on *Artemisia* species.

| *Artemisia* ssp. | Producer          | Country of Origin | Trade Name | Cosmetic Form | The Form of *Artemisia* ssp. in the Composition of the Cosmetic (INCI) | Properties of the Cosmetic According to the Producer | References |
|------------------|-------------------|-------------------|------------|---------------|----------------------------------------------------------------------|------------------------------------------------------|------------|
| *A. abrotanum*   | Alpha Keri        | Australia         | Breast Lift And Firm Cream | *A. abrotanum* extract | Firming the skin of the bust | [257] |
|                  | Dr. Hauschka      | German            | Sensitive care conditioner Ampoules | *A. abrotanum* flower/leaf/stem extract | Firming the skin of the bust | The treatment in sensitive ampoules for day and night is intended for sensitive skin prone to redness and dilated blood vessels | [258] |
|                  | Laura Mercier     | Japan             | Infusion De Rose Moisturizing Glow Mask Mask | *A. abrotanum* extract | Hydrates and soothes skin | [259] |
|                  | Dermika           | Poland            | Neocollagen M + Phytoestrogen Anti-Wrinkle Cream Cream | *A. abrotanum* extract | Regenerating, antiwrinkle effect | [260] |
|                  | Aveeno            | USA               | Fresh Essentials Daily Nourishing Moisturizer SPF 30 Cream | *A. abrotanum* extract | Regenerating, antiwrinkle effect | For daily skin hydration and protection against UV radiation | [261] |
|                  | Christophe Robin  | USA               | Cleansing Mask With Lemon Mask | *A. abrotanum* extract | Cleans colored and thin hair | Cleans colored and thin hair | [262] |
|                  | Paris             |                   | Intensité Complete Anti-Aging Eye Serum Serum | *A. abrotanum* extract | Antiaging decreases the appearance of lines and wrinkles and gives skin a smoother, more youthful appearance | [263] |
|                  | RéVive            | USA               | Hydrating + Lifting Sheet Mask Mask | *A. abrotanum* extract | Antiaging decreases the appearance of lines and wrinkles and gives skin a smoother, more youthful appearance | [264] |
| Artemisia ssp. | Producer | Country of Origin | Trade Name | Cosmetic Form | The Form of Artemisia ssp. in the Composition of the Cosmetic (INCI) | Properties of the Cosmetic According to the Producer | References |
|---------------|----------|-------------------|------------|---------------|--------------------------------------------------|-------------------------------------------------|------------|
| A. absinthium | Cera Skin Care | Canada | Timeless Retinol Night Mask | Mask | A. absinthium extract | Diminishes the appearance of fine lines, wrinkles, pore size, and problematic skin imperfections | [265] |
| It cosmetics | France | No. 50 Serum Collagen Veil Anti-Aging Face Primer | Serum | A. absinthium extract | Hydrating and antiaging activity | [266] |
| Natura Siberica | Russia | Super Siberica Krasnika, Amaranth & Arginine, Care Cream | Cream | A. absinthium herb oil | Makes hair soft and manageable | [267] |
| MAN:YO | South Korea | Zaodam Sooc Essence Toner | Toner | A. absinthium extract | Soothes essence toner to quickly treat damaged skin | [268] |
| Mizon | South Korea | Multi-function formula all in one snail repair cream | Cream | A. absinthium extract | Intense regenerative, moisturizing effect; narrows pores; regenerates, firms, and helps to lighten discoloration | [269] |
| Bioelements | USA | Restorative Clay | Mask | A. absinthium oil | Cleansing skin pores | [270] |
| Kiehl’s | USA | Calendula Deep Cleansing Foaming Face Wash | Foam | A. absinthium extract | Deeply cleansing face, cleansing foam | [271] |
| MALIN + GOETZ | USA | Resurfacing Serum | Serum | A. absinthium oil | Smoothens, clarifies, and brightens skin | [272] |
| Neogen Dermatology | USA | Vita Lightening Serum | Serum | A. absinthium extract | Helps to reduce the appearance of discolorations for illuminating radiance and its potent antioxidant ingredients; moisturizes and revitalizes skin | [273] |
| Pixi | USA | Rose Glow Mist | Essence | A. absinthium extract | | [274] |
| Artemisia ssp. | Producer | Country of Origin | Trade Name | Cosmetic Form | The Form of *Artemisia* ssp. in the Composition of the Cosmetic (INCI) | Properties of the Cosmetic According to the Producer | References |
|---------------|----------|-------------------|------------|---------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------|------------|
| *A. annua*    | Commonlabs | Malaysia           | Vitamin E Micro Needle Spot Cream | Cream       | *A. annua* extract                                                                                  | Antiacne activity                                      | [275]      |
|               | Kingnature | Swiss              | Artemisia creme                       | Cream       | *A. annua* extract                                                                                  | Protects and cares for the skin and has a supporting effect on skin irritations and skin problems | [276]      |
|               | Su:m37    | Singapore          | Losec Summa Elixir Foam Cleanser      | Gel         | *A. annua* extract                                                                                  | Purifies and comforts the skin                         | [277]      |
|               | Dr. Oracle | South Korea        | Artemisia Ultra Calming Serum         | Serum       | *A. annua* extract, *A. annua* leaf extract                                                        | Skin-soothing effect to irritated or sensitive skin    | [278]      |
|               | MISSHA    | South Korea        | Artemisia Calming Ampoule             | Essence     | *A. annua* extract                                                                                  | Controls the balance of hydration and lubrication of the skin, soothes irritation and redness | [279]      |
|               | Neogen Dermatology | USA              | Dermalogy Green Tea Moist PHA Gauze Peeling | Peeling     | *A. annua* extract                                                                                  | Exfoliates and moisturizes skin                        | [273]      |
|               | PURE'AM   | USA                | Authentic Barrier Cream Balm          | Cream       | *A. annua* extract                                                                                  | Nourishes, repairs, and strengthens natural skin barrier | [280]      |
| *A. dracunculus* | ESPA      | Great Britain      | Age-Rebel Moisturiser                | Cream       | *A. dracunculus oil                                                                                  | Moisturizes, nourishes, and smoothens skin             | [281]      |
|               | Lush      | Great Britain      | Dirty Shampoo                        | Shampoo     | *A. dracunculus oil                                                                                  | Cleanses hair                                          | [282]      |
|               | Hayejin    | South Korea        | Blessing Of Sprout Radiance Toner    | Toner       | *A. dracunculus leaf/stem extract                                                                  | Brightens skin’s complexion, balances pH level, and moisturizes the skin | [283]      |
|               | Onekind   | USA                | Mega Multitasker All-Day Moisturizer | Cream       | *A. dracunculus oil                                                                                  | Hydrating, has antioxidant activity, and defends against daily damage | [284]      |
| Artemisia ssp. | Producer       | Country of Origin | Trade Name                        | Cosmetic Form | The Form of Artemisia ssp. in the Composition of the Cosmetic (INCI) | Properties of the Cosmetic According to the Producer                                                                 | References |
|---------------|---------------|-------------------|-----------------------------------|---------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------|
| A. vulgaris   | Humphrey      | Canada            | Mugwort Anti Acne Serum Serum     | A. vulgaris extract | Treats acne, reduces inflammation on acne-prone skin, soothes and moisturizes skin | [285]                                                                |            |
|               | Vgam          | Canada            | Pure Artik Gel                    | A. vulgaris extract | Gently removes impurities and protects skin                             | [286]                                                                |            |
|               | Annayake      | France            | Makeup Remover Gel Gel           | A. vulgaris extract | Cleanses face and eye and removes makeup                                | [287]                                                                |            |
|               | Cherry Brenchez | Great Britain    | Venus Reviver Serum Serum         | A. vulgaris oil | Moisturizes skin, reduces spots and fine lines, and protects skin from sun damage | [288]                                                                |            |
|               | Monuskin      | Great Britain     | Rosewood Reviving Mist Essence    | A. vulgaris oil | Refreshes and revitalizes skin                                         | [289]                                                                |            |
|               | R10 Labs      | Great Britain     | Hybrid Iq Shaving Gel-Oil Gel     | A. vulgaris oil | Softens the hair and makes it easier to shave                          | [290]                                                                |            |
| Somethinc     | Indonesia     | AHA 7% BHA 1% PHA 3% Weekly Peeling Solution | Peeling | A. vulgaris extract | Helps clean clogged pores and remove dead skin cells                  | [291]                                                                |            |
|               | Moraz         | Israel            | Body Oil Skin Saver Oil           | A. vulgaris extract | Hydrating and reduces burns, redness, itching and dryness             | [292]                                                                |            |
| Manuka Doctor | New Zealand   | Apiclear Purifying Facial Peel Peeling | A. vulgaris extract | Removes dead cells and stimulates cell renewal | [293] | |
| Skintific     | Norway        | Mugwort Anti Pores & Acne Clay Mask Pore Clarifying Wash Off Pack Mask | A. vulgaris extract | Helps clean clogged pores, reduces skin changes, and brightens skin | [294] | |
Table 8. Cont.

| Artemisia ssp. | Producer            | Country of Origin | Trade Name                     | Cosmetic Form | The Form of Artemisia ssp. in the Composition of the Cosmetic (INCI) | Properties of the Cosmetic According to the Producer | References |
|----------------|---------------------|-------------------|--------------------------------|---------------|---------------------------------------------------------------------|-----------------------------------------------------|------------|
|                | Natura Siberica     | Russia            | Anti Dandruff Shampoo          | Shampoo       | A. vulgaris extract                                                  | Cleanses the hair and has antidandruff properties   | [267]      |
|                | Aprilskin           | South Korea       | Artemisia Essence Rice Toner   | Toner         | A. vulgaris extract                                                  | Calms and hydrates skin and makes skin firm          | [295]      |
|                | I’m From            | South Korea       | Mugwort Spot Gel               | Gel           | A. vulgaris oil                                                      | Stabilizes sebum production and soothes skin         | [296]      |
|                | Manyo Factory       | South Korea       | Herb Green Cleansing Oil       | Cleansing oil | A. vulgaris oil                                                      | Cleanses skin                                       | [268]      |
|                | Dermalogica         | USA               | Overnight Active Clearing Gel  | Gel           | A. vulgaris oil                                                      | Removes skin cells and regulates excess sebum        | [297]      |
|                | Rms Beauty          | USA               | “re” Evolve Radiance Locking Hydrating Primer | Primer | A. vulgaris oil                                                      | Keeps makeup all day long                            | [298]      |
7. Safety of Artemisia ssp. Use

Artemisia ssp. may have limitations in use depending on other ingredients used along with them or depending on the oral intake of other ingredients simultaneously, due to which various side effects could occur.

Studies on patients taking homeopathic remedies, herbal mixtures, or single-ingredient preparations from A. abrotanum extracts have reported no serious adverse effects. In a previous study, only two patients out of the 236 studied showed side effects. The intake of a preparation composed of A. abrotanum and Matricaria recutita extracts was reported to cure ailments such as stomach pain and allergy [299].

The species A. absinthium is rich in compounds that have toxic effects, of which α- and β-thujone deserve particular attention, with α-thujone being thought to be two to three times more harmful [300]. The EFSA listed α- and β-thujone, absinthin, and anabisinthin as potentially dangerous. However, the conclusions of the EFSA report regarding A. absinthium contain information that the plant can be safely used as a basic substance. Furthermore, A. absinthium has a known toxicological profile, and its compounds that were previously considered harmful are currently being investigated as medicinal substances [300]. Nonetheless, A. absinthium should not be recommended if the patient has gastric or duodenal ulcers, biliary obstruction, or liver disease or if he/she is allergic to plants of the family Asteraceae. It should not be used during pregnancy and breastfeeding [171,175]. Studies confirmed no skin irritation after the application of undiluted A. absinthium essential oil [301]. The dangers of drinking absinthe are worth mentioning. Absinthe consumption initially causes the feeling of well-being and hallucinations, slowly leading to a depressive stage. In recent years, it has been speculated that absinthe causes misdiagnosed alcoholism. The symptoms characteristic of absinthism can be attributed to ethanol itself [302]. The FDA (US Food and Drug Administration) has listed A. absinthium as an allergenic species. The source of allergens is the pollen, which can also be present in the extracts of the plant [303].

The species A. annua can cause inflammation of the skin, and due to its highly allergenic pollen, susceptible people may develop allergies. Adverse effects after consumption of preparations with A. annua extracts are as follows: abdominal pain, bradycardia, diarrhea, nausea, vomiting, decreased appetite, flu-like symptoms, reticulocytopenia, and fever. The use of A. annua products is contraindicated in patients with ulcers and gastrointestinal disorders [8,304,305]. The EFSA listed A. annua leaves as a raw material that is not health-neutral due to the high concentration of camphor (2.58–37.5%) in the essential oil [306].

The FDA has listed A. dracunculus and the essential oils and extracts derived from this species as safe for use [307]. However, there have also been reports of the potential toxicity of the main components of the essential oil of A. dracunculus—estragole and methyl eugenol [54]. In animal studies, these components showed the adverse effects of causing, inter alia, liver tumors and neuroendocrine tumors in the glandular stomach, kidneys, and mammary glands [308]. After analyzing the available data, the EFSA has classified estragole and methyl eugenol as genotoxic and carcinogenic compounds. However, a safe threshold for the consumption of estragole and methyl eugenol has not yet been established. The EFSA recommends limiting the use of both compounds [308].

Herbal extracts of A. vulgaris used in therapeutic doses may not have any side effects. However, A. vulgaris can cause allergies, as confirmed by the FDA. Its pollen contains allergenic glycoproteins that cause type I (immediate) allergic reactions. In addition, in a few individuals, anaphylactic shock has been observed after swallowing the pollen [55,303]. The species A. vulgaris is also considered to be the primary cause of hay fever and allergic asthma in Northern Europe, North America, and a few regions of Asia [148,309]. People allergic to herbal ingredients from other plants of the Asteraceae family should avoid contact with these preparations. It has been reported that A. vulgaris cross-reacts with pollen from other plants as well as with food substances, such as birch, cabbage, grasses, hazelnuts, honey, pollen of the European olive, and sweet pepper, as well as with royal jelly, sunflower, kiwi, peach, mango, apple, celery, and carrot [148,310]. Apart from respiratory system
ailments, allergic skin lesions have also been observed and allergic skin reactions, such as dermatitis and urticaria, may also occur [309,311–313].

The EFSA classified the essential oil components of *A. vulgaris*, such as α-thujone, β-thujone, camphor, and 1,8-cineol, as having potentially adverse effects on human health when taken with food or dietary supplements [306]. Therefore, *A. vulgaris* should be used with caution in patients with diabetes as it can increase blood glucose levels [148].

8. Conclusions

The multidirectional ethnopharmacological indications and recent popularity of artemisinin resulted in a huge increase in interest in the chemism of *Artemisia* species and in the biological activity of extracts obtained from these plants and essential oils. Research studies have confirmed their many valuable directions of biological activity, such as hepatoprotective, neuroprotective, and antidepressant effects. Some of the proven biological properties, e.g., antibacterial, antifungal, and antioxidant activities, are of particularly utility from the perspective of the cosmetic industry. In the data presented by the European Commission, in the CosIng database, the number of cosmetic raw materials approved for the production of cosmetics includes as many as 37 raw materials based on the five species characterized in this review. Cosmetics based on these raw materials are becoming more popular not only in European but also in North American and East Asian countries.

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**References**

1. Podbielkowski, Z.; Sudnik-Wójcikowska, B. *Słownik Roślin Użytkowych*; Wydanie VI; Państwowe Wydawnictwo Rolnicze i Leśne: Warszawa, Poland, 2003. (In Polish)
2. Aglarova, A.M.; Ziflikarow, I.N.; Severtseva, O.V. Biological characteristics and useful properties of tarragon (*Artemisia dracunculus* L.) (review). *Pharm. Chem. J.* 2008, 42, 81–86. [CrossRef]
3. Majeed, I.; Rizwan, K.; Ashar, A.; Rasheed, T.; Amarowicz, R.; Kausar, H.; Zia-ul-haq, M.; Marceau, L.G. A comprehensive review of the ethnotraditional uses and biological and pharmacological potential of the genus Mimosa. *Int. J. Mol. Sci.* 2021, 22, 7463. [CrossRef] [PubMed]
4. Ashraf, I.; Zubair, M.; Rizwan, K.; Rasool, N.; Jamil, M.; Khan, S.A.; Tareen, R.B.; Ahmad, V.U.; Mahmood, A.; Riaz, M.; et al. Chemical composition, antioxidant and antimicrobial potential of essential oils from different parts of *Daphne mucronata* Royle. *Chem. Cent. J.* 2018, 12, 135. [CrossRef] [PubMed]
5. Rasool, N.; Afzal, S.; Riaz, M.; Rashid, U.; Rizwan, K.; Zubair, M.; Ali, S.; Shahid, M. Evaluation of antioxidant activity, cytotoxic studies and GC-MS profiling of *Matthiola incana* (Stock flower). *Legum. Res.* 2013, 36, 21–32.
6. Ekiert, H.; Kubica, P.; Szopa, A. Successful cultivation and utilization of *Aronia melanocarpa* (Michx.) Elliott (Black Chokeberry), a species of North-American origin, in Poland and the biosynthetic potential of cells from in vitro cultures. In *Medicinal Plants. Sustainable Development and Biodiversity*; Ekiert, H.M., Ramawat, K.G., Arora, J., Eds.; Springer: Cham, Switzerland, 2021; Volume 28, pp. 69–111.
7. Jafernik, K.; Ekiert, H.; Szopa, A. Schisandra chinensis and *Schisandra sphenanthera*—From traditional Far Eastern medicine to international utilization. In *Medicinal Plants. Sustainable Development and Biodiversity*; Ekiert, H.M., Ramawat, K.G., Arora, J., Eds.; Springer: Cham, Switzerland, 2021; Volume 28, pp. 179–227.
8. The Herb Society of America. *Artemisia: An Essential Guide* 2014; The Herb Society of America: Kirtland, OH, USA, 2014.
9. Ahamad, J.; Mir, S.R.; Amin, S. A Pharmacognostic review on *Artemisia absinthium*. *Int. Res. J. Pharm.* 2019, 10, 25–31. [CrossRef]
10. World Health Organization. *WHO Monograph on Good Agricultural and Collection Practices (GACP) for Artemisia annua L.*; World Health Organization: Geneva, Switzerland, 2006.
11. Sharpopov, F.S.; Salimov, A.; Numonov, S.; Bakri, M.; Sangov, Z.; Habasi, M.; Akker Aisa, H.; Setzer, W.N. Chemical compositions and biological activities of essential oils—original article phytochemical study on the essential oils of tarragon (Artemisia dracunculus L.) growing in Tajikistan and its comparison with the essential oil of the species in the rest. Nat. Prod. Commun. 2020, 15, 1–7.

12. Mamedov, N.; Grdner, Z.; Craker, L.E. Medicinal plants used in Central Asia for the treatment of selected skin conditions. J. Herbs Spices Med. Plants 2004, 11, 191–222. [CrossRef]

13. Mohammadian, A.; Moradkhani, S.; Ataei, S.; Shayesteh, T.H.; Sedaghat, M.; Kheiripour, N.; Ranjbar, A. Antioxidative and hepatoprotective effects of hydroalcoholic extract of Artemisia absinthium L. in rat. J. HerbMed Pharmacol. 2016, 5, 29–32.

14. Bora, K.S.; Sharma, A. Neuroprotective effect of Artemisia absinthium L. on focal ischemia and reperfusion-induced cerebral injury. J. Ethnopharmacol. 2010, 129, 403–409. [CrossRef]

15. Sansar, W.; Gamrani, H. The pharmacological effect of Artemisia absinthium extract in protecting adult rats against lead neurotoxicity. J. Neuro. Sci. 2013, 333, e598. [CrossRef]

16. Mahmoudi, M.; Ebrahimzadeh, M.A.; Ansaroudi, F.; Nabavi, S.F.; Nabavi, S.M. Antidepressant and antioxidant activities of Artemisia absinthium L. at flowering stage. African J. Biotechnol. 2009, 8, 7170–7175.

17. Shafi, G.; Hasan, T.N.; Syed, N.A.; Al-Hazzani, A.A.; Alshawi, A.A.; Jyothi, A.; Munshi, A. Artemisia absinthium (AA): A novel potential complementary and alternative medicine for breast cancer. Mol. Biol. Rep. 2012, 39, 7373–7379. [CrossRef]

18. Fiamegos, Y.C.; Kastritis, P.L.; Exarchou, V.; Han, H.; Bonvin, A.M.J.J.; Vervoort, J.; Lewis, K.; Hamblin, M.R.; Tegos, G.P. Antimicrobial and efflux pump inhibitory activity of caffeoylquinic acids from Artemisia absinthium against Gram-positive pathogenic bacteria. PLoS ONE 2011, 6, e18127. [CrossRef]

19. McMullen, M.K.; Whitehouse, J.M.; Whitton, P.A.; Towell, A. Bitter tastants alter gastric-phase postprandial haemodynamics. J. Ethnopharmacol. 2014, 154, 719–727. [CrossRef]

20. Elansary, H.O.; Szopa, A.; Ekiert, H.; El-Ansary, D.O.; Al-Mana, F.A.; Mahmoud, E.A. Polyphenol content and biological activities of Ruta graveolens L. abrotanum L. in northern Saudi Arabia. Processes 2020, 8, 531. [CrossRef]

21. Navarro-Salcedo, M.H.; Delgado-Saucedo, J.I.; Siordia-Sánchez, V.H.; González-Ortiz, L.J.; Castillo-Herrera, G.A.; Puebla-Férez, A.M. Artemisia dracunculus extracts obtained by organic solvents and supercritical CO2 produce cytotoxic and antitumor effects in mice with L5178Y lymphoma. J. Med. Food. 2017, 20, 1076–1082. [CrossRef]

22. Mohammadi, M.M.; Saeb, M.; Nazifi, S. Experimental hypothyroidism in adult male rats: The effects of Artemisia dracunculus aqueous extract on serum thyroid hormones, lipid profile, leptin, adiponectin, and antioxidant factors. Comp. Clin. Path. 2020, 29, 485–494. [CrossRef]

23. Lee, S.J.; Chung, H.Y.; Maier, C.G.A.; Wood, A.R.; Dixon, R.A.; Mabry, T.J. Estrogenic flavonoids from Artemisia vulgaris L. J. Agric. Food Chem. 1998, 46, 3325–3329. [CrossRef]

24. Shaik, A.; Kanhere, R.S.; Cuddapah, R.; Nelson, K.S.; Vara, P.R.; Sibyala, S. Antifertility activity of Artemisia vulgaris leaves on female Wistar rats. Chin. J. Nat. Med. 2014, 12, 180–185. [CrossRef]

25. Zafar, M.M.; Hamdard, M.E.; Hameed, A. Screening of Artemisia absinthium for antimalarial effects on Plasmodium berghei in mice: A preliminary report. J. Ethnopharmacol. 1990, 30, 223–226.

26. Ramazani, A.; Sardari, S.; Zakeri, S.; Vaziri, B. In vitro antiplasmodial and phytochemical study of five Artemisia species from Iran and in vivo activity of two species. Parasitol. Res. 2010, 107, 593–599. [CrossRef] [PubMed]

27. Tahir, M.; Siddiqui, M.M.H.; Khan, A.B. Effect of Afsanteen (Artemisia absinthium Linn.) in acute intestinal amoebiosis. Hamdard Med. 1997, 40, 24–27.

28. Valdés, A.F.C.; Martínez, J.M.; Lizama, R.S.; Vermeersch, M.; Cos, P.; Maes, L. In vitro anti-microbial activity of the Cuban medicinal plants Simarouba glauca DC, Melaleuca leucadendron L and Artemisia absinthium L. J. Ethnopharmacol. 2008, 103, 615–618. [CrossRef] [PubMed]

29. Tariku, Y.; Hymete, A.; Hailu, A.; Rohloff, J. In vitro evaluation of antiileishmanial activity and toxicity of essential oils of Artemisia absinthium and Echinops kebericho. Chem. Biodivers. 2011, 8, 614–623. [CrossRef]

30. Gonzalez-Coloma, A.; Bailen, M.; Diaz, C.E.; Fraga, B.M.; Martinez-Diaz, R.; Zuniga, G.E.; Contreras, R.A.; Cabrera, R.; Burillo, J. Major components of Spanish cultivated Artemisia absinthium populations: Antieedent, antiparasitic, and antioxidant effects. Ind. Crops Prod. 2012, 37, 401–407. [CrossRef]

31. Bailen, M.; Julio, L.F.; Diaz, C.E.; Sanz, J.; Martinez-Diaz, R.A.; Cabrera, R.; Burillo, J.; Gonzalez-Coloma, A. Chemical composition and biological effects of essential oils of Artemisia absinthium L. cultivated under different environmental conditions. Ind. Crops Prod. 2013, 49, 102–107. [CrossRef]

32. Martinez-Diaz, R.A.; Ibáñez-Escribano, A.; Burillo, J.; de las Heras, L.; del Prado, G.; Agulló-Ortuño, M.T.; Julio, L.F.; Gonzalez-Coloma, A. Trypanocidal, trichomonacidal and cytotoxic components of cultivated Artemisia absinthium Linnaeus (Asteraceae) essential oil. Mem. Inst. Oswaldo Cruz 2015, 110, 693–699. [CrossRef]

33. Mendiola, J.; Bosa, M.; Perez, N.; Hernandez, H.; Torre, D. Extracts of Artemisia abrotanum and Artemisia absinthium inhibit growth of Naegleria fowleri in vitro. Trans. R. Soc. Trop. Med. Hyg. 1991, 85, 78–79. [CrossRef]

34. Hernandez, H.; Mendiola, J.; Torres, D.; Garrido, N.; Perez, N. Effect of aqueous extracts of Artemisia on the in vitro culture of Plasmodium falciparum. Fitoterapia 1990, 41, 540–541.

35. Wasowicz, A. Occurrence of Artemisia annua L in Wroclaw city area (Lower Silesia, Poland). Acta Bot. Silesica 2004, 1, 141–146.
65. Anwar, F.; Ahmad, N.; Alkharfy, K.M.; Gilani, A.H. Mugwort (Artemisia vulgaris) Oils; Preedy, V.R., Ed.; Academic Press: London, UK, 2016; ISBN 9780124166448.

66. Barney, J.N.; DiTommaso, A. The biology of Canadian weeds. 118. Artemisia vulgaris L. Can. J. Plant Sci. 2003, 83, 205–215. [CrossRef]

67. Gleason, H.A.; Cronquist, A. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd ed.; The New York Botanical Garden: New York, NY, USA, 1991.

68. Effertth, T.; Zacchino, S.; Georgiev, M.; Liu, L.; Wagner, H.; Panossian, A. Nobel Prize for artemisinin brings phytotherapy into the spotlight. Phytomedicine 2015, 22, A1–A3. [CrossRef]

69. Willcox, M.; Bodeker, G.; Bourdy, G.; Dhingra, V.; Falquet, J.; Ferreira, J.F.S.; Graz, B.; Hirt, H.; Hsu, E.; De Magalhães, P.M.; et al. Traditional Medicinal Plants in Malaria; Willcox, M.L., Bodeker, G., Rasanoaivo, P., Eds.; CRC Press: Boca Raton, FL, USA, 2004; ISBN 0415301122.

70. Cala, A.C.; Ferreira, J.F.S.; Chagas, A.C.S.; Gonzalez, J.M.; Rodrigues, R.A.F.; Foglio, M.A.; Oliveira, M.C.S.; Sousa, I.M.O.; Magalhães, P.M.; Barioni, W. Anthelmintic activity of Artemisia annua L. extracts in vitro and the effect of an aqueous extract and artemisinin in sheep naturally infected with gastrointestinal nematodes. Parasitol. Res. 2014, 113, 2345–2353. [CrossRef]

71. Garcia, L.C. A Review of Artemisia annua L.: Its genetics, biochemical characteristics, and anti-malarial efficacy. Int. J. Sci. Technol. 2015, 5, 38–46.

72. Elfawal, M.A.; Towler, M.J.; Reich, N.G.; Golenbock, D.; Weathers, P.J.; Rich, S.M. Dried whole plant Artemisia annua as an antiinflammatory therapy. PLoS ONE 2012, 7, e52746. [CrossRef]

73. Bora, K.S.; Sharma, A. The genus Artemisia: A comprehensive review. Pharm. Biol. 2011, 49, 101–109. [CrossRef]

74. Weathers, P.J.; Towler, M.; Hassanali, A.; Lutgen, P.; Ogwang Engeu, P.; Dried-leaf Artemisia annua: A practical malaria therapeutic for developing countries? World J. Pharmacol. 2014, 3, 39–35. [CrossRef]

75. Lachenmeier, D.W.; Walch, S.G.; Padosch, S.A.; Kröner, L.U. Absinthe—A review. Crit. Rev. Food Sci. Nutr. 2006, 46, 365–377. [PubMed]

76. Beigh, Y.A.; Ganai, A.M. Potential of Wormwood (Artemisia absinthium Linn.) herb for use as additive in livestock feeding: A review. Pharma Innov. J. 2017, 6, 176–187.

77. Singh, P.; Bajpai, V.; Khandelwal, N.; Varshney, S.; Gaikwad, A.N.; Srivastava, M.; Singh, B.; Kumar, B. Determination of bioactive compounds of Artemisia spp. plant extracts by LC–MS/MS technique and their in-vitro anti-adipogenic activity screening. J. Pharm. Biomed. Anal. 2021, 193, 113707. [CrossRef]

78. Pino, J.A.; Marbot, R.; Marti, M.P. Leaf oil of Artemisia abrotanum L. grown in Cuba. J. Essent. Oil Res. 2011, 23, 119–120.

79. Chongphrom, P.; Misaki, M.; Suzuki, M.; Shimomura, M.; Suzuki, H.; Seki, H.; Munaraka, T. Identification and characterization of (+)-ã-bisabolol and 7-epi-silphiperfol-5-ene synthases from Artemisia abrotanum. Phytochemistry 2019, 164, 144–153. [CrossRef] [PubMed]

80. Khalid, K.A.; El-Gohary, A.E. Productivity of wormwood (Artemisia abrotanum) enhanced by trace elements. Bull. Natl. Res. Cent. 2020, 44, 120.

81. Obistioiu, D.; Cristina, R.T.; Schmerold, I.; Chizzola, R.; Stolze, K.; Nichita, I.; Chiurciu, V. Chemical characterization by GC-MS and in vitro activity against Candida albicans of volatile fractions prepared from Artemisia dracunculus, Artemisia abrotanum, Artemisia vulgaris and Artemisia vulgaris. Chem. Sci. J. 2014, 6, 6. [CrossRef] [PubMed]

82. Aruba, O.S.; Jasim, G.A.; Nasser, A.A. Detection of terpenes of Iraqi Artemisia abrotanum L. by GC/MS in hexane extract. Al Mustansiriyah J. Pharm. Sci. 2019, 19, 239–248. [CrossRef]

83. Khodakov, G.V.; Kotikov, I.V.; Pankovetskii, V.N. Component composition of essential oil from Artemisia dracunculus and A. dracunculus. Chem. Nat. Compd. 2009, 45, 755–758. [CrossRef]

84. Saunoriate, S.; Ragazinskiene, O.; Ivanauskas, L.; Marks, M. Essential oil composition of Artemisia abrotanum L. during different vegetation stages in Lithuania. Chemija 2020, 31, 52–56. [CrossRef]

85. Juteau, E.; Jerkovic, I.; Masotti, V.; Miolo, M.; Mastelic, J.; Bessière, J.M.; Viano, J. Composition and antimicrobial activity of the essential oil of Artemisia absinthium from Croatia and France. Planta Med. 2003, 69, 158–161.

86. Safayhi, H.; Sabieraj, J.; Sailer, E.; Amnon, H. An antioxidant-type inhibitor of leukotriene B4 formation. Planta Med. 1994, 60, 410–413. [CrossRef]

87. Garcia-Rodriguez, J.J.; Andres, M.F.; Ibanez-Escribano, A.; Julio, L.F.; Burillo, J.; Bolas-Fernandez, F.; Gonzalez-Coloma, A. Selective nematocidal effects of essential oils from two cultivated Artemisia absinthium populations. Z. Für Naturforsch. C 2015, 70, 275–280. [CrossRef]

88. Msaada, K.; Salem, N.; Bachrouch, O.; Bousselmi, S.; Tammar, S.; Alaffy, A.; Al Sane, K.; Ben Ammar, W.; Azeiz, S.; Haj Brahim, A.; et al. Chemical composition and antioxidant and antimicrobial activities of wormwood (Artemisia absinthium L.) essential oils and phenolics. J. Chem. 2015, 2015, 804658. [CrossRef]

89. Blagojević, P.; Radulović, N.; Palić, R.; Stojanović, G. Chemical composition of the essential oils of Serbian wild-growing Artemisia absinthium and Artemisia vulgaris. J. Agric. Food Chem. 2006, 54, 4780–4789.

90. Ali, M.; Abbasi, B.H. Ilshan-ul-haq Production of commercially important secondary metabolites and antioxidant activity in cell suspension cultures of Artemisia absinthium L. Ind. Crops Prod. 2013, 49, 400–406. [CrossRef]

91. Hwang, D.I.; Won, K.J.; Kim, D.Y.; Yoon, S.W.; Park, J.H.; Kim, B.; Lee, H.M. Anti-adipocyte differentiation activity and chemical composition of essential oil from Artemisia annua. Nat. Prod. Commun. 2016, 11, 539–542.
117. Remberg, P.; Björk, L.; Hedner, T.; Sterner, O. Characteristics, clinical effect profile and tolerability of a nasal spray preparation of Artemisia abrotanum L. for allergic rhinitis. *Phytomedicine* 2004, 11, 36–42. [CrossRef]

118. Van Der Kooy, F.; Sullivan, S.E. The complexity of medicinal plants: The traditional *Artemisia annua* formulation, current status and future perspectives. *J. Ethnopharmacol.* 2013, 150, 1–13. [CrossRef]

119. Melillo De Magalhães, P.; Dupont, I.; Hendrickx, A.; Joly, A.; Raas, T.; Dessy, S.; Sergent, T.; Schneider, Y.J. Anti-inflammatory effect and modulation of cytokine P450 activities by *Artemisia annua* tea infusions in human intestinal Caco-2 cells. *Food Chem.* 2012, 134, 864–871. [CrossRef]

120. Wallnofer, B.; Hofner, O.; Greger, H. Polyacylenyles from the *Artemisia ‘Vulgares’* group. *Phytochemistry* 1989, 28, 2687–2691. [CrossRef]

121. Hatzieremia, S.; Gray, A.; Ferro, V.; Paul, A.; Plevin, R. The effects of cardamonin on lipopolysaccharide-induced inflammatory protein production and MAP kinase and NF-jB signalling pathways in monocytes/macrophages. *Br. J. Pharmacol.* 2006, 149, 188–198. [CrossRef]

122. Hadi, A.; Hossein, N.; Shirin, P.; Najmeh, N.; Abolfazl, M. Anti-inflammatory and analgesic activities of *Artemisia absinthium* and chemical composition of its essential oil. *Int. J. Pharm. Sci. Res.* 2014, 38, 237–244.

123. Ko, Y.S.; Lee, W.S.; Panchanathan, R.; Joo, Y.N.; Choi, Y.H.; Kim, G.S.; Jung, J.M.; Ryu, C.H.; Shin, S.C.; Kim, H.J. Polyphenols from *Artemisia annua* L inhibit adhesion and EMT of highly metastatic breast cancer cells MDA-MB-231. *Phytother. Res.* 2016, 30, 1180–1188. [CrossRef]

124. Carbonara, T.; Pascale, R.; Argentieri, M.P.; Papadia, P.; Fanizzi, F.P.; Villanova, L.; Avato, P. Phytochemical analysis of a herbal tea from *Artemisia annua* L. *J. Pharm. Biomed. Anal.* 2012, 62, 79–86.

125. Ribeiro, A.; Barros, L.; Calhelha, R.C.; Carocho, M.; Ćirić, A.; Sokovic, M.; Dias, M.M.; Santos-Buelga, C.; Barreiro, M.F.; Ferreira, I.C.F.R. Tarragon phenolic extract as a functional ingredient for pizza dough: Comparative performance with ascorbic acid (E300). *J. Funct. Foods* 2016, 26, 268–278. [CrossRef]

126. Majdan, M.; Kiss, A.K.; Haláša, R.; Granica, S.; Osířská, E.; Czerwińska, M.E. Inhibition of neutrophil functions and antibacterial effects of tarragon (*Artemisia dracunculus* L.) infusion—phytochemical characterization. *Front. Pharmacol.* 2020, 11, 947. [CrossRef]

127. Carnat, A.; Heitz, A.; Fraisse, D.; Carnat, A.P.; Lamaison, J.L. Major dicafeoylquinic acids from *Artemisia vulgaris*. *Fitoterapia* 2000, 71, 587–589.

128. Melguizo-Melguizo, D.; Diaz-de-Cerio, E.; Quirantes-Piné, R.; Švarc-Gajié, J.; Segura-Carretero, A. The potential of *Artemisia vulgaris* leaves as a source of antioxidant phenolic compounds. *J. Funct. Foods* 2020, 5, 192–200. [CrossRef]

129. Ahamad, J.; Naqvi, K.; Ali, M.; Mir, S. New glycoside esters from the aerial parts of *Artemisia absinthium* Linn. *Nat. Prod. J.* 2014, 3, 260–267.

130. Zeng, K.W.; Liao, L.X.; Song, X.M.; Lv, H.N.; Song, F.J.; Yu, Q.; Dong, X.; Jiang, Y.; Tu, P.F. Caruifolin D from *Artemisia annua* L inhibits neuroinflammation via reactive oxygen species-dependent c-jun N-terminal kinase and protein kinase c/NF-κB signaling pathways. *Eur. J. Pharmacol.* 2015, 767, 82–93. [CrossRef] [PubMed]

131. Remberg, P.; Björk, L.; Hedner, T.; Sterner, O. Characteristics, clinical effect profile and tolerability of a nasal spray preparation of Artemisia abrotanum L. for allergic rhinitis. *Phytomedicine* 2004, 11, 36–42. [CrossRef]

132. Ko, Y.S.; Lee, W.S.; Panchanathan, R.; Joo, Y.N.; Choi, Y.H.; Kim, G.S.; Jung, J.M.; Ryu, C.H.; Shin, S.C.; Kim, H.J. Polyphenols from *Artemisia annua* L inhibit adhesion and EMT of highly metastatic breast cancer cells MDA-MB-231. *Phytother. Res.* 2016, 30, 1180–1188. [CrossRef]

133. Phadungrakwittaya, R.; Chotewuttakorn, S.; Piwtong, M.; Thamsermsang, O.; Laohapand, T.; Akarasereenont, P. Identification of hypoglycemic bioactive principles of *Artemisia dracunculus* leaves as a source of antioxidant phenolic compounds. *J. Funct. Foods* 2020, 5, 192–200. [CrossRef]

134. Han, J.; Ye, M.; Qiao, X.; Xu, M.; Wang, B.R.; Guo, D.A. Characterization of phenolic compounds in the Chinese herbal drug *Artemisia annua* by liquid chromatography coupled to electrospres ionization mass spectrometry. *J. Pharm. Biomed. Anal.* 2008, 47, 516–525. [CrossRef]

135. Yu, Y.; Simmeler, C.; Kuhn, P.; Poulev, A.; Raskin, I.; Ribnicky, D.; Floyd, Z.E.; Pauli, G.F. The designer approach helps decipher the hypoglycemic bioactive principles of *Artemisia dracunculus* (Russian Tarragon). *J. Nat. Prod.* 2019, 82, 3321–3329. [CrossRef] [PubMed]

136. Bhutia, T.D.; Valant-vetschera, K.M. Chemodiversity of *Artemisia dracunculus* L. from Kyrgyzstan: Isocoumarins, coumarins, and flavonoids from aerial parts. *J. Pharm. Biomed. Anal.* 2018, 149, 79–86. [CrossRef] [PubMed]

137. Geissman, T.A.; Ellestad, A. Vulgarin, a sesquiterpene lactone from *Artemisia vulgaris* L. *J. Org. Chem.* 1961, 27, 1855–1859. [CrossRef]

138. Natividad, G.M.; Broadley, K.J.; Kariuki, B.; Kidd, E.J.; Ford, W.R.; Simons, C. Actions of *Artemisia vulgaris* extracts and isolated sesquiterpene lactones against receptors mediating contraction of guinea pig ileum and trachea. *J. Ethnopharmacol.* 2011, 137, 808–816.

139. Numonov, S.; Sharopov, F.; Salimov, A.; Sukhrobov, P.; Atolikshoeva, S.; Safarzoda, R.; Habasi, M.; Aisa, H. Assessment of artemisinin contents in selected *Artemisia* species from Tajikistan (Central Asia). *Medicines* 2019, 6, 23.

140. Nganthoi, M.; Sanatombi, K. Artemisinin content and DNA profiling of Artemisias species of Manipur. *S. Afr. J. Bot.* 2019, 125, 9–15. [CrossRef]

141. Marco, J.A.; Sanz, T.J.; Del Hierro, P. Two eudesmane acids from *Artemisia vulgaris*. *Phytochemistry* 1991, 30, 2403–2404. [CrossRef]
173. Bundesinstitut für Arzneimittel und Medizinprodukte (Germany). *German Commission D Monographs*; Blaumenthal, M.T., Hall, R., Rister, B., Eds.; American Botanical Council: Austin, TX, USA, 1994.

174. Housselle, K. *Anonymous. German Pharmacopoeia*; Rudolf Ludwig Decker: Berlin, Germany, 1872; Available online: [https://wiki.ubk.ac.at/noscemus/Pharmacopoeia_Germanica](https://wiki.ubk.ac.at/noscemus/Pharmacopoeia_Germanica) (accessed on 4 August 2022).

175. The Scientific Foundation for Herbal Medicinal Products. *E/S/C/O/P Monographs*, 2nd ed.; E/S/C/O/P: Exeter, UK, 2003.

176. Chinese Pharmacopoeia Commission. *Pharmacopoeia of the People’s Republic of China*; China Chemical Industry Press: Beijing, China, 2005.

177. Nguyen, T. *Vietnamese Pharmacopoeia*; Vietnamese Pharmacopoeia Commission: Hanoi, Vietnam, 2005.

178. European Directorate for the Quality of Medicine & HealthCare. *European Pharmacopoeia 10.0*; Council of Europe: Strasbourg, France, 2021.

179. Française Pharmacopée. *Pharmacopée Française*, 11th ed.; Noulak, A., Ed.; Georg Olms: Hildesheim, Germany; New York, NY, USA, 2020; Volume 37.

180. Kim, S.C.; Adesogan, A.T.; Shin, J.H. Effects of dietary addition of wormwood (Artemisia montana) silage on feed intake, digestibility and ruminal fermentation characteristics of sheep. *Anim. Feed Sci. Technol.* 2006, 128, 1–13. [CrossRef]

181. Kim, S.C.; Adesogan, A.T.; Kim, J.H.; Ko, Y.D. Influence of replacing rice straw with wormwood (*Artemisia annua*) silage on growth performance, carcass characteristics, and muscle fatty acid profiles of beef cattle. *Anim. Feed Sci. Technol.* 2012, 177, 15–22. [CrossRef]

182. Shafi, N.; Khan, G.A.; Ghauri, E.G. Antiulcer effect of *Artemisia absinthium*.

183. Gilani, A.U.H.; Janbaz, K.H. Preventive and curative effects of *Artemisia absinthium* on acetaminophen and CCl4-induced hepatotoxicity. *Gen. Pharmacol.* 1995, 26, 309–315. [CrossRef]

184. Caner, A.; Döskaya, M.; Değirmenci, A.; Can, H.; Baykan, Ş.; Üner, A.; Başdemir, G.; Zeybek, U.; Gürüz, Y. Comparison of the immunosuppressive activity of a molecule isolated from *Artemisia annua* and cyclosporin A. *Immunopharmacol. Immunotoxicol.* 2009, 31, 173–179. [CrossRef] [PubMed]

185. Tariq, K.A.; Chishti, M.Z.; Ahmad, F.; Shawl, A.S. Anthelmintic activity of extracts of *Artemisia absinthium* against ovine nematodes. *Vet. Parasitol.* 2008, 119, 83–88. [CrossRef] [PubMed]

186. Zhang, Y.X.; Sun, H.X. Immunosuppressive effect of ethanol extract of *Artemisia annua* on lymphocytes isolated from mice against ovalbumin. *Immunopharmacol. Immunotoxicol.* 2008, 30, 250–254. [CrossRef]

187. Danilets, M.G.; Bel’skii, I.P.; Gur’ev, A.M.; Belousov, M.V.; Bel’skaia, N.V.; Trofimova, E.S.; Uchasova, E.G.; Alhmedzhanov, R.R.; Shahnazi, M.; Azadmehr, A.; Hajiaghaee, R.; Mosalla, S.; Latifi, R. Effects of *Artemisia absinthium* on DTH responses compared with cyclosporin A.

188. Amirmohammadi, M.; Khajoenia, S.; Bahmani, M.; Rafieian-Kopaei, M.; Eftekhari, Z.; Qorbani, M. In vivo evaluation of *Artemisia absinthium* growing in western Anatolia against trichinellosis (*Trichinella spiralis*) in rats. *Exp. Parasitol.* 2009, 119, 173–179. [CrossRef]

189. Urban, J.; Kokoska, L.; Langrova, I.; Matejkova, J. In vitro anthelmintic effects of medicinal plants used in Czech Republic. *Pharm. Biol.* 2008, 46, 808–813. [CrossRef]

190. Singh, O.P.; Tiwari, S.K.; Ohja, D. *Pilgrisia versicolor* vis-a-vis sidhma and its ayurvedic management. *Sadwitra Ayurveda* 1994, 46, 920.

191. Shahnazi, M.; Azadmehr, A.; Hajiaaghaee, R.; Mosalla, S.; Latifi, R. Effects of *Artemisia absinthium* on the maturation and function of dendritic cells. *Jundishapur J. Nat. Pharm. Prod.* 2015, 10, e20163. [CrossRef]

192. Danilets, M.G.; Bel’skii, I.P.; Gur’ev, A.M.; Belousov, M.V.; Bel’skaia, N.V.; Trofimova, E.S.; Uchasova, E.G.; Ahmad, F.; Shawl, A.S. Anthelmintic activity of extracts of *Artemisia absinthium* against ovine nematodes. *Vet. Parasitol.* 2008, 119, 83–88. [CrossRef] [PubMed]

193. Nageeb, A.; Al-Tawashi, A.; Emwas, A.-H.; Al-Talla, Z.; Al-Rifai, N. Comparison of *Artemisia annua* isolated from *Artemisia absinthium* L. growing in western Anatolia against trichinelliosis (*Trichinella spiralis*) in rats. *Exp. Parasitol.* 2009, 119, 173–179. [CrossRef]

194. Noori, S.; Naderi, G.A.; Hassan, Z.M.; Habibi, Z.; Bathaie, S.Z.; Hashemi, S.M.M. Immunosuppressive activity of a molecule isolated from *Artemisia annua* on the maturation and function of dendritic cells. *Jundishapur J. Nat. Pharm. Prod.* 2015, 10, e20163. [CrossRef]

195. Tang, C.; Zhao, Y.; Huang, S.; Jin, Y.; Liu, J.; Luo, J.; Zheng, J.; Shi, D. Influence of *Artemisia annua* extract derivatives on proliferation, apoptosis and metastasis of osteosarcoma cells. *Pak. J. Pharm. Sci.* 2005, 18, 773–779. [CrossRef]

196. Nageeb, A.; Al-Tawashi, A.; Emwas, A.-H.; Al-Talla, Z.; Al-Rifai, N. Comparison of *Artemisia annua* bioactivities between Traditional Medicine and Chemical Extracts. *Curr. Bioact. Compl.* 2014, 9, 324–332. [CrossRef]

197. Willcox, M. *Artemisia* species: From traditional medicines to modern antimalarials—And back again. *J. Altern. Complement. Med.* 2009, 15, 101–109. [CrossRef]

198. Mueller, M.S.; Runyambo, N.; Wagner, I.; Borrmann, S.; Dietz, K.; Heide, L. Randomized controlled trial of a traditional preparation of *Artemisia annua* L. (Annual Wormwood) in the treatment of malaria. *Trans. R. Soc. Trop. Med. Hyg.* 2004, 98, 318–321. [CrossRef]
226. Stewart, S. Cosmetics & Perfumes in the Roman World; Tempus Publishing Limited: Stroud, Gloucestershire, 2007.
227. Dioscorides. De Materia Medica: Being an Herbal with Many Other Medicinal Materials Written in Greek in the First Century of the Common Era. A New Indexed Version in Modern English by Tess Anne Osbaldeston and Robert P. A. Wood; IBIDIS Press: Johannesburg, South Africa, 2000.
228. Syreruski, S. Zielnik Herbarzem z Języka Łacińskiego Zowia: To lest Opisanie Wlasne Imion, Kształtu, Przyrodzenia, Skutków moc ziół Wszelakich... I Polskim Językiem Zebrany y na Ośmioro Ksiąg Rozłożony [...]. Kraków, Poland, 1613. (In Polish)
229. European Commission Cosing CosIng—Cosmetic Database. Available online: https://ec.europa.eu/growth/tools-databases/cosing/index.cfm?fuseaction=search.simple (accessed on 9 August 2022).
230. European Commission Cosing CosIng—Cosmetic Database. Available online: https://ec.europa.eu/growth/tools-databases/cosing/index.cfm?fuseaction=search.simple (accessed on 9 August 2022).
231. Suresh, J.; Vasavi Reddy, A.; Rajan, D.; Ihsanullah, M.; Nayeeemullah Khan, M. Antimicrobial activity of Artemisia abrotanum and Artemisia pellens. Int. J. Pharmacogn. Phytochem. Res. 2011, 3, 18–21.
232. Hrytsyk, R.A.; Kutsyk, R.V.; Yurchyshyn, O.I.; Struk, O.A.; Kireev, I.V.; Grytsyk, A.R. The investigation of antimicrobial and antifungal activity of some Artemisia L. species. Pharmacia 2021, 68, 93–100. [CrossRef]
233. Moslemi, H.R.; Hoseinzadeh, H.; Badoe, M.A.; Kashefouzani, K.; Fard, R.M.N. Activity of Artemisia absinthium against surgical wounds infected by Staphylococcus aureus in a rat model. Indian J. Microbiol. 2012, 52, 601–604. [CrossRef] [PubMed]
234. Habibipour, R.; Rajabi, M. Antibacterial effects of Arctium lappa and Artemesia absinthium extracts in laboratory conditions. J. HerbMed Pharmacol. 2015, 4, 133–137.
235. Kordali, S.; Kotan, R.; Mavi, A.; Çakir, A.; Al, A.; Yildirim, A. Determination of the chemical composition and antioxidant activity of the essential oil of Artemisia dracunculus and of the antifungal and antibacterial activities of Turkish Artemisia absinthium, A. dracunculus, Artemisia santonicum, and Artemisia spicig. J. Agric. Food Chem. 2005, 53, 9432–9438. [CrossRef]
236. Al-Zubairi, A.S.; Al-Mamary, M.A.; Al-Ghasani, E. The antibacterial, antifungal and antimicrobial activity of essential oil from Artemisia abrotanum L. growing in Western Ghats of India. Int. J. Pharm. Biol. Sci. 2013, 51, 888–892. [CrossRef]
237. Evans, T.C.; Gavrilovich, E.; Mihai, I.E.L.; Isbasescu, I.E.L.; Thelen, D.; Martin, J.A.; Allen, S.M.; Sa, S. Production of Organic Acid and Ammonium Oxide. Patent Application Publication US 2006/0222585 A1, 5 October 2006.
238. Lee, H.G.; Kim, H.; Oh, W.K.; Yu, K.A.; Choe, Y.K.; Ahn, J.S.; Kim, D.S.; Kim, S.H.; Dinarello, C.A.; Kim, K.; et al. Tetramethoxy hydroxylflavone p7F downregulates inflammatory mediators via the inhibition of nuclear factor κB. Ann. N. Y. Acad. Sci. 2004, 1030, 555–566. [CrossRef]
239. Joshi, R.K. Volatile composition and antimicrobial activity of the essential oil of Artemisia absinthium growing in Western Ghats region of North West Karnataka, India. Pharm. Biol. 2013, 51, 888–892. [CrossRef]
240. Nalbantsov, A.; Erel, Ş.B.; Köksal, Ç.; Göçmen, B.; Yildiz, M.Z.; Karabay Yavvaşoğlu, N.U. Viper venom induced inflammation with Montviperina xanthina (Gray, 1849) and the anti-snake venom activities of Artemisia absinthium L. in rat. Toxicon 2013, 65, 34–40. [CrossRef]
241. Stebbings, S.; Beattie, E.; McNamara, D.; Hunt, S. A pilot randomized, placebo-controlled clinical trial to investigate the efficacy and safety of an extract of Artemisia annua administered over 12 weeks, for managing pain, stiffness, and functional limitation associated with osteoarthritis of the hip and knee. Clin. Rheumatol. 2016, 35, 1829–1836.
242. Ben Nasr, S.; Aazza, S.; Mnif, W.; Miguel, M. In-vitro antioxidant and anti-inflammatory activities of Pituranthos chloranthus and Artemisia vulgaris from Tunisia. Int. J. Appl. Pharm. Sci. Res. 2020, 11, 605–614. [PubMed]
243. Olsen, O.T.; Frolund, L.; Heinig, J.; Jacobsen, L.; Svendsen, U.G. A double-blind, randomized study investigating the efficacy and specificity of immunotheraphy with Artemisia vulgaris or Phleum pratense/Betula verrucosa. Allergol. Immunopathol. 1995, 23, 73–78.
244. Aburjai, T.; Natsheh, F.M. Plants Used in Cosmetics. Phyther. Res. 2003, 17, 987–1000. [CrossRef]
245. Hashemi, Z.; Ebrahimzadeh, M.A.; Kahili, M. Sun protection factor, total phenol, flavonoid contents and antioxidant activity of medicinal plants from Iran. Trop. J. Pharm. Res. 2019, 18, 1443–1448. [CrossRef]
246. Varothai, S.; Bunyaratavej, S.; Leeyaphan, C.; Phaitoonwattanikij, S.; Winayanuwattikun, W. Pilot study of the efficacy and safety of nail gel containing Artemisia abrotanum extract and glycerin in the treatment of nail plate surface abnormality. Siriraj Med. J. 2021, 73, 204–208. [CrossRef]
247. Park, S.H.; Cho, D.M.; Choi, B.D.; Choi, Y.J.; Choi, J.H. Antioxidative effects of skinned mugwort (Artemisia vulgaris L.) extracts on UV-irradiated hairless mouse skin. J. Korean Soc. Food Sci. Nutr. 2008, 37, 20–26. [CrossRef]
248. Raj Singh, B.; Singh, V.; Karan Singh, R.; Toppo, S.; Haque, N.; Ebiben, N. Antimicrobial effect of Artemisia vulgaris essential oil. Nat. Prod. A 
 Indian J. 2011, 5, 5–12.
249. Hiremath, S.K.; Kolume, D.G.; Muddapur, U.M. Antimicrobial activity of Artemisia vulgaris Linn. (Damanaka). Int. J. Res. Ayurveda Pharm. 2011, 2, 1674–1675.
250. Singh, R.; Verma, P.; Singh, G. Total phenolic, flavonoids and tannin contents in different extracts of Artemisia absinthium. J. Interdisc. Ethnopharmacol. 2012, 1, 101. [CrossRef]
253. Temraz, A.; El-Tantawy, W.H. Characterization of antioxidant activity of extract from *Artemisia vulgaris*. *Pak. J. Pharm. Sci.* 2008, 21, 321–326. [PubMed]

254. Oyedemi, S.; Coopoosamy, R. Preliminary studies on the antibacterial and antioxidative potentials of hydroalcoholic extract from the whole parts of *Artemisia vulgaris L.* *Int. J. Pharmacol.* 2015, 2, 561–569. [CrossRef]

255. Eidi, A.; Oryan, S.; Zaringhalam, J.; Rad, M. Antinociceptive and anti-inflammatory effects of the aerial parts of *Artemisia dracunculus* in mice. *Pharm. Biol.* 2016, 54, 549–554. [CrossRef] [PubMed]

256. Afsar, S.K.; Rajesh Kumar, K.; Venu Gopal, J.; Raveesha, P. Assessment of anti-inflammatory activity of *Artemisia vulgaris* leaves by cotton pellet granuloma method in Wistar albino rats. *J. Pharm. Res.* 2013, 7, 463–467. [CrossRef] [PubMed]

257. Alpha Keri. Available online: https://www.alphakeri.com.au (accessed on 10 December 2021).

258. Dr Hauschka. Available online: https://www.drhauschka.de (accessed on 10 December 2021).

259. Laura Mercier. Available online: https://www.lauramercier.com (accessed on 10 December 2021).

260. Dermika. Available online: https://dermika.pl/ (accessed on 10 December 2021).

261. Aveeno. Available online: https://www.aveeno.com (accessed on 10 December 2021).

262. Christophe Robin Paris. Available online: https://www.christopherobin.com (accessed on 10 December 2021).

263. Revive. Available online: https://reviveskincare.com/ (accessed on 10 December 2021).

264. USANA Celavive Skincare. Available online: https://www.celavive.com (accessed on 10 December 2021).

265. Cera Skin Care. Available online: https://caraskincare.ca/ (accessed on 10 December 2021).

266. It Cosmetics. Available online: https://www.itcosmetics.com (accessed on 10 December 2021).

267. Natura Siberica. Available online: http://naturasiberica.ru/ (accessed on 10 December 2021).

268. MAN-YO. Available online: https://manyo.us (accessed on 10 December 2021).

269. Mizon. Available online: http://www.mizon.co.kr/ (accessed on 10 December 2021).

270. Bioelements. Available online: https://www.bioelements.com/ (accessed on 10 December 2021).

271. Kiehl’s. Available online: https://www.kiehls.com/ (accessed on 10 December 2021).

272. MALIN+GOETZ. Available online: https://www.malinandgoetz.com/ (accessed on 10 December 2021).

273. Neogen Dermatology. Available online: https://www.neogenlab.us (accessed on 10 December 2021).

274. Pixi. Available online: https://pixibeauty.co.uk (accessed on 10 December 2021).

275. Commonlabs. Available online: https://commonlabsmalaysia.com (accessed on 10 December 2021).

276. Kingnature. Available online: https://www.kingnature.ch (accessed on 10 December 2021).

277. Su:m37. Available online: https://www.sум37.com.sg/ (accessed on 10 December 2021).

278. Dr. Oracle. Available online: https://oraclearcosmetic.com/ (accessed on 10 December 2021).

279. MISSHA. Available online: https://missha.com/%25A0https://missha.com/%25A0A (accessed on 10 December 2021).

280. PURE’AM. Available online: https://www.pureambeauty.com/ (accessed on 10 December 2021).

281. ESPA. Available online: https://www.espaskincare.com (accessed on 10 December 2021).

282. Lush. Available online: https://www.lush.com (accessed on 10 December 2021).

283. Hayejin. Available online: https://hayejincosmetic.com (accessed on 10 December 2021).

284. Onekind. Available online: https://onekind.us (accessed on 10 December 2021).

285. Humphrey. Available online: https://humphreyderm.com/%25A0 (accessed on 10 December 2021).

286. Vgam. Available online: https://vgambiome.ca (accessed on 10 December 2021).

287. Annayake. Available online: https://www.annayake.com (accessed on 10 December 2021).

288. Cherry Brenchez. Available online: https://brenchezbeauty.com/ (accessed on 10 December 2021).

289. Hayejin. Available online: https://hayejincosmetic.com (accessed on 10 December 2021).

290. PURE’AM. Available online: https://www.pureambeauty.com/ (accessed on 10 December 2021).

291. Lark. Available online: https://www.larkinc.com (accessed on 10 December 2021).

292. Christophe Robin Paris. Available online: https://www.christopherobin.com (accessed on 10 December 2021).

293. Neogen Dermatology. Available online: https://www.neogenlab.us (accessed on 10 December 2021).

294. Pixi. Available online: https://pixibeauty.co.uk (accessed on 10 December 2021).

295. Commonlabs. Available online: https://commonlabsmalaysia.com (accessed on 10 December 2021).

296. Kingnature. Available online: https://www.kingnature.ch (accessed on 10 December 2021).

297. Su:m37. Available online: https://www.sум37.com.sg/ (accessed on 10 December 2021).

298. Dr. Oracle. Available online: https://oraclearcosmetic.com/ (accessed on 10 December 2021).

299. MISSHA. Available online: https://missha.com/%25A0https://missha.com/%25A0A (accessed on 10 December 2021).

300. ESPA. Available online: https://www.espaskincare.com (accessed on 10 December 2021).

301. Skintific. Available online: https://www.skintificbeauty.com/ (accessed on 10 December 2021).

302. Lachenmeier, D.W. Wormwood (*Artemisia absinthium* L.)*: A curious plant with both neurotoxic and neuroprotective properties? *J. Ethnopharmacol.* 2010, 131, 224–227. [CrossRef]
303. Food and Drug Administration. Pollens—Weeds and Garden Plants; Food and Drug Administration: Silver Spring, MD, USA, 2011.
304. Leng, X.; Ye, S.T. An investigation on in vivo allergenicity of Artemisia annua leaves and stems. Asian Pac. J. Allergy Immunol. 1987, 5, 125–128.
305. Tang, R.; Sun, J.L.; Yin, J.; Li, Z. Artemisia allergy research in China. Biomed Res. Int. 2015, 2015, 179426. [CrossRef]
306. European Food Safety Authority. Compendium of botanicals reported to contain naturally occurring substances of possible concern for human health when used in food and food supplements. EFSA J. 2012, 10, 2663. [CrossRef]
307. Food and Drug Administration. CPG Sec 525.750 Spices—Definitions FDA. Available online: https://www.fda.gov/ (accessed on 9 August 2022).
308. European Commission Health & Consumer Protection Directorate -General. Opinion of the Scientific Committee on Food on Estragole (1- Allyl-4-methoxybenzene). Int. J. Mod. Phys. Conf. Ser. 2001. [CrossRef]
309. Ipsen, H.; Formgren, H.; Loswenstein, H.; Ingemann, L. Immunochemical and biological characterization of a Mugwort (Artemisia vulgaris) pollen extract. Allergy 1985, 40, 289–294. [CrossRef]
310. Yong, W.L.; Soo, Y.C.; Eun, K.L.; Jung, H.S.; Park, J.W.; Hong, C.S. Cross-allergenicity of pollens from the Compositae family: Artemisia vulgaris, Dendranthema grandiflorum, and Taraxacum officinale. Ann. Allergy, Asthma Immunol. 2007, 99, 526–533.
311. Ulbricht, C.E. Natural Standard, Herb and Supplement Guide, An Evidence-Based Reference; Mosby Elsevier: Maryland Heights, MO, USA, 2010.
312. Wrangsjö, K.; Ros, A.M.; Wahlberg, J.E. Contact allergy to Compositae plants in patients with summer-exacerbated dermatitis. Contact Dermat. 1990, 22, 148–154. [CrossRef]
313. Haw, S.; Cho, H.-R.; Lee, M.-H. Allergic contact dermatitis associated with mugwort (Artemisia vulgaris). Contact Dermat. 2010, 62, 61–63. [CrossRef]