Review

Medicinal Plants of the Flora of Kazakhstan Used in the Treatment of Skin Diseases

Gulzat Berganayeva , Bates Kudaibergenova , Yuliya Litvinenko , Irada Nazarova , Sandugash Sydykbayeva , Gulzira Vassilina , Nazerke Izdik , Moldyr Dyusebaeva *

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Abstract: The skin functions as an indicator of the physiological condition of the body's organs and systems, serving as a protective barrier against infections and physical damage. Throughout history, phytotherapy has been a primary form of treatment in folk medicine across various countries, including Kazakhstan, due to the abundance of plant-based remedies that are accessible to individuals. This article presents a comprehensive overview of several medicinal plants that are traditionally used in the treatment of skin diseases in the Republic of Kazakhstan. The chemical composition of these plants is analyzed, with a particular focus on the primary components responsible for their therapeutic efficacy in treating skin ailments.

Keywords: medicinal plants, ethnopharmacology, skin diseases, flora of Kazakhstan, atopic dermatitis, plant drugs, anti-inflammatory activity.

1. Introduction

According to the eminent scholar, philosopher, and physician Avicenna, "the doctor has three tools: the word, the plant, the knife." The plant kingdom is recognized as humanity's earliest and most ancient healing source, employed for the management and prevention of illnesses.

Tracing back through history, the most ancient documented proof of plants' utilization in medicine dates back to a Sumerian clay slab discovered in Nagpur roughly 5000 years ago. This artifact included a compilation of twelve medicinal recipes that involved over 250 diverse plant species. Sumerian healers extracted powders and infusions from plant roots and stems, while also crediting healing properties to pears and figs. Additionally, they utilized dried and ground young shoots of willow and plum trees, pine and fir needles as a component in compresses and poultices. Often, powders from animal and mineral sources were blended with those extracted from dried and crushed plants. Notably, in addition to water, wine and beer served as solvents. Thus, at least 80 centuries ago, people utilized the most uncomplicated medicinal plant-based preparations for treatment [1].

The "Pen T'Sao," an ancient Chinese text on roots and herbs, authored by Emperor Shen Nung approximately 2500 BC, contains descriptions of 900 medicaments (comprising dried components of medicinal plants). Several of these substances are still in use today, including Rhei rhisoma, camphor, Theae folium, Podophyllum, great yellow gentian, ginseng, datura, cinnamon bark, and ephedra [2].

Regarding Kazakh folk medicine, an area that has yet to be fully explicated and substantiated, it can be stated that the traditional medicinal knowledge of the Kazakh people transcends the mere treatment of ailments and rests on robust theoretical underpinnings. Oteiboydak Tleukabyluly (1388-1478), an astute healer and prominent figure in Kazakh folk medicine during the 15th century, comprehensively explicated the secrets of the healing art in his medical and ethnographic work "Medical Narrative," which he composed between 1466 and 1473 at the behest of az-Zhanibek Khan,

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who held him in high esteem as a great healer. This medical encyclopedia delineates the functions of various organs of the human body and provides a catalogue of the primary diseases associated with them. Furthermore, it includes a meticulous description of the methods used in traditional medicine at present, such as setting bones, listening to the pulse, and incantations. Through practical experimentation and experimentation conducted in the steppe laboratory, the healer formulated a total of 1,108 different medicinal compounds, of which 858 were derived from medicinal plants, 318 were extracted from animal organs, and roughly 60 were sourced from metals. The moniker "Teacher without a teacher" was bestowed on Oteiboydak Tleukabylov, who discovered methods for treating 1,050 different diseases [3].

At present, the employment of phytotherapy has gained widespread acceptance on a global scale. According to the World Health Organization's (WHO) global review of national policies concerning traditional, complementary, and alternative medicine, as well as the regulation of herbal medicines, there is an evident growth in the European and Asian market for herbal medicines [4].

Kazakhstan boasts a natural flora of over 6,000 plant species [5]. The exact number of medicinal plant species present in Kazakhstan remains uncertain, as the list continues to expand annually. More than 150 plant species have been employed in both official and folk medicine for various ailments. This review focuses on a selection of medicinal plants growing within the territory of the Republic of Kazakhstan that have traditionally been used to alleviate skin diseases. In conducting this study (2010-2023), emphasis was placed on the plants' phytochemical composition, with a particular focus on the principal components responsible for their therapeutic effects against inflammatory skin conditions such as dermatitis, atopic dermatitis, and eczema.

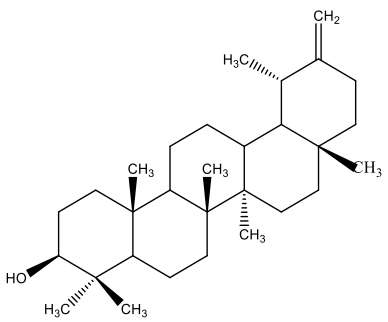
Taraxacum officinale* Web. Family – *Compositae

Taraxacum officinale Web is a plant species commonly found in temperate climatic zones of Europe, Asia, and North America [6,7]. It can also be found in Kazakhstan, where it grows in various habitats such as wetlands, meadows, and roadsides, and occasionally in the steppes [8].

Dandelion (*Taraxacum officinale* Web.) is a plant with a rich chemical composition. Its constituents include β-carotene [9], chicory acid [10], inulin [11], sesquiterpene lactones, and triterpene compounds [12], as well as flavonoids [13] and fatty acids [14]. Dandelion also contains a variety of vitamins (A, C, D, E, and B), inositol, lecithin, and minerals, such as iron, magnesium, sodium, calcium, silicon, copper, phosphorus, zinc, and manganese [15].

Traditional medicine has documented the tonic and diuretic properties of *Taraxacum officinale*, as well as its anthelmintic, anti-inflammatory, and sedative effects. Dandelion has also been shown to regulate metabolic disorders and leukoformula deviations, and has been used in the treatment of hepatitis, bronchitis, pneumonia, mastitis (as a local compress), and anemia. These therapeutic effects are attributed to the various phytochemical compounds present in dandelion, including sesquiterpene lactones, triterpene compounds, flavonoids, fatty acids, and vitamins and minerals such as vitamins A, C, D, E, and B, inositol, lecithin, and minerals like iron, magnesium, sodium, calcium, silicon, copper, phosphorus, zinc, and manganese [16–19].

Dandelion, being a versatile plant, has also found significant use in the field of dermatology owing to its potential in curing several skin diseases. Notably, *Taraxacum officinale* has been found to contain taraxasterol (1), a compound that exhibits therapeutic activity against melanoma [20].



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A mixture of sesquiterpene lactones present in dandelion has been found to exhibit therapeutic activity in the treatment of allergic and atopic dermatitis [21]. Additionally, the aqueous extract of dandelion has been observed to display high activity in inhibiting tyrosinase [22]. Dandelion extracts are commonly employed in the treatment of acne [23] and warts [24]. Furthermore, the ethyl acetate and n-butanol fractions of *Taraxacum officinale* Web. have exhibited anti-inflammatory and antibacterial properties [25], the chloroform extract has been shown to possess anticancer properties [26], polyphenolic compounds in dandelion have been found to have antioxidant properties [27,28], while methanol and petroleum ether extracts have been found to have choleretic effect [29].

Symphytum officinale* L. Borage family – *Boraginaceae

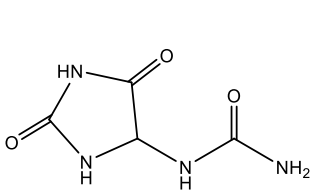
Symphytum officinale L., commonly known as comfrey, is distributed across the humid meadow and lakeside regions of Asia, Europe, and America, as supported by reference [30]. Its occurrence has also been recorded in the northwestern and eastern regions of Kazakhstan, as documented in reference [31].

Symphytum officinale L. contains various chemical compounds including phenolic compounds, flavonoids, fatty acids, polysaccharides, purine derivatives, and triterpenes [32–35].

In terms of ethnopharmacology, preparations made from the roots, leaves, or entire aerial parts of comfrey have been traditionally used since ancient times to treat various internal ailments such as respiratory, gastrointestinal, and genitourinary disorders, as well as external conditions such as bruises and tumors, through the administration of tinctures, infusions, decoctions, compresses, and ointments [36,37].

The literature indicates the potential therapeutic effects of *Symphytum officinale* L. The plant has been reported to possess anti-inflammatory, anti-apoptotic, antitumor, neuroprotective, and antioxidant properties [38]. Furthermore, comfrey has been shown to facilitate bone regeneration [39].

Allantoin (2) and rosmarinic acid (3), identified as active compounds in comfrey, exhibit significant skin healing properties and have been applied in the treatment of a range of skin conditions:



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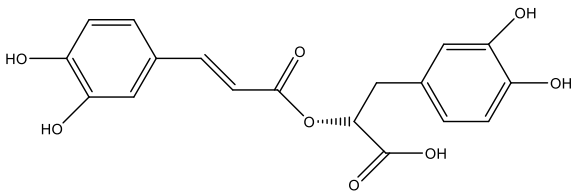

(3)

Allantoin (2) has been reported to stimulate cell proliferation and tissue repair, making it a promising therapeutic agent for wound healing. Several studies have demonstrated that allantoin can accelerate the healing process of wounds, reduce inflammation, and increase skin moisture, thus exhibiting a rejuvenating effect [40–42]. On the other hand, rosmarinic acid (3) possesses antimicrobial, anti-inflammatory, and antioxidant properties, which make it an effective treatment for various skin conditions, such as psoriasis, acne, and eczema. Studies have shown that rosmarinic acid can reduce oxidative stress and inhibit the production of inflammatory cytokines in the skin, leading to improved skin health [43]. Comfrey also contains tannins and pyrrolizidine alkaloids, which contribute to its anti-inflammatory and wound-healing effects [44,45].

Viscum album* L. Family Beltflower – *Lorantliaceae

Viscum album L., commonly known as white mistletoe, is an evergreen hemiparasitic plant that grows extensively in the Caucasus, Europe, and western and southern Asia [46,47].

Various chemical components have been identified in mistletoe through chemical studies, including viscotoxins (a mixture of amino acids), phenylpropanes, lignans, flavonoids, amines (viscalbin, norviscalbin, tyramine, β-phenylethylamine viscamine), α-viscol (β-amirin), β-viscol (lupeol), polysaccharides, lectins, fatty acids (oleic, linoleic, and palmitic acids), alcohols (pinit, inositol, quebrachite), resinous substances, and mineral salts [48–51]. Moreover, syringinin glycoside

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was detected in mistletoe bark [51]. Triterpene saponins (oleanolic and ursolic acids), vitamin C, carotene, vecerin, viscol, and choline derivatives (propionylcholine and acetylcholine) have also been found in this plant, the levels of which depend on the host tree on which the mistletoe grows, according to the authors of [52].

Viscum album L. has a rich ethnopharmacological history, with traditional uses including the treatment of various ailments such as epilepsy, anxiety, hypertension, internal bleeding, atherosclerosis, inflammation, and headaches. Additionally, it has been used as an antidote in some cultures [53,54].

Mistletoe-based preparations possess hypotensive and analgesic effects. For instance, a tincture of fresh mistletoe leaves, found in the "Akofit" preparation, is utilized to treat acute radiculitis [52]. The vasodilators "Omelen" and "Viskalen" are recommended for hypertension, while the liquid and dry extract "Reviscen" is useful for treating atherosclerosis, as it reduces blood pressure, dilates blood vessels, enhances cardiac activity, reduces nervous system excitability and intestinal atony, and acts as a hemostatic agent [55]. The active compound viscotoxin effectively combats cancer and inhibits its progression. The lectin present in mistletoe is a natural pesticide that hinders bacterial and parasitic infiltration into the body [56]. Additionally, *Viscum album* L. exhibits antioxidant [50], antitumor [54], antiviral, antibacterial, anti-inflammatory, antiepileptic, and immunostimulatory activity, and is also employed to treat neurological disorders [57–60]. Preparations containing white mistletoe are utilized in obstetric and gynecological practice and are prescribed for colpitis and prolonged uterine bleeding [61,62].

Mistletoe has shown promise in the field of dermatology, where it has been employed to manage various cutaneous conditions such as dermatitis [63], age-related pigmentation [64], moles, acne, and papillomas [62], as well as psoriasis and rashes [65].

Juglans regia* L. Walnut family – *Juglandaceae

This plant has been observed to grow in various regions across the globe, including East Asia, Europe, North Africa, and South America [66]. Its growth has also been documented in southern Kazakhstan and it is recognized as a protected species within the boundaries of the Sairam-Ugam State National Natural Park [67].

The chemical composition of walnut kernels is of significant nutritional value, given their abundant presence of polyunsaturated fatty acids (comprising up to 75% of total content), proteins, amino acids, as well as vitamins E, C, β-carotene, and essential minerals such as potassium, calcium, magnesium, sulfur, and phosphorus [68]. Further, walnut kernels are known to contain trace elements such as iron, zinc, and copper, which play a vital role in various biochemical processes within the human body [69]. The plant is also rich in fluorine salts, while the kernel partition contains trace amounts of organic substances, tannins, glycosides, alkaloids, and iodine.

The chemical composition of walnut leaves is characterized by the presence of various biologically active components, including trace amounts of iodine, α- and β-hydrojuglone, polyphenols, tannins, glycosides, flavonoids, terpenoids, vitamin C, carotene, vitamin B1, essential oils, and tannins [70–75]. Among these, polyphenolic compounds are the most prominent, with various derivatives of chlorogenic and hydroxycinnamic acids being the major components [76].

In a study by [77], it was demonstrated that the methanolic extract derived from the leaves of *Juglans regia* L. encompasses a cumulative 40 metabolites classified under megastigmane, tetralone, phenylpropanoid, neolignan, and juglone glycosides.

In traditional medicine, diverse components of *Juglans regia* L. are utilized to manage several ailments such as diabetes, infectious diseases, and periodontal disease [78]. Furthermore, the plant is reputed to have antipyretic, analgesic, anti-dandruff, and burn-healing properties [79,80]. Notably, the extract of walnut shell has demonstrated notable antibacterial and antibiofilm properties against coagulase-negative staphylococci [81]. Additionally, the lyophilized extract of the walnut septum has been reported to exhibit a marked antitussive, antioxidant, and anti-inflammatory effect [82].

The leaves of *Juglans regia* L. are traditionally used to alleviate skin inflammation and excessive sweating of the hands and feet. Moreover, they are recommended for the treatment of acne, warts, eczema, and psoriasis due to the presence of flavonoids, specifically quercetin derivatives, and

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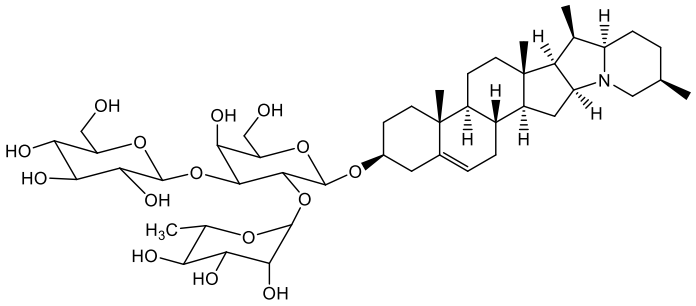
tannins [83–85]. The high concentration of α-tocopherol in the leaves of *J. regia* contributes to its antioxidant effect, which promotes the repair of damaged skin and strengthens the epidermal layer [86].

Solanum dulcamara* L. Solanaceae family – *Solonaceae

Solanum dulcamara L. exhibits a wide distribution across all continents except Antarctica, with the highest concentration found in tropical and subtropical regions of Australia, Africa, and select areas of Asia, including China, India, and Japan, as well as Central and South America [87]. Notably, the plant is found ubiquitously throughout Kazakhstan.

S. dulcamara is known to contain various bioactive phytocomponents, including steroidal saponins, terpenes, flavonoids, carbohydrates (such as glucose, galactose, xylose, and rhamnose), lipids (specifically cholesterol), steroidal sapogenins (such as diosgenin, tigogenin, and yamogenin), and pigments (such as lycopene and lycoxanthin) [88]. Notably, steroid alkaloids and glycoalkaloids are the primary chemical markers for this plant genus [87]. Additionally, *S. dulcamara* has been found to contain steroidal alkaloids, including solanine (4) in immature fruits, solasodine in flowers, and β-solamarin in roots [89,90].



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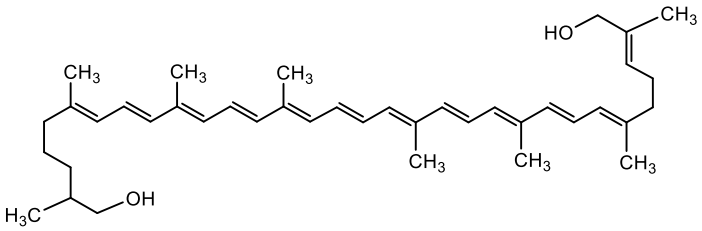
S. dulcamara stems have been traditionally employed in folk medicine as a narcotic agent and as a remedy for conditions such as rheumatism, migraine, and severe inflammation [91].

An ethyl acetate extract obtained from the ripe fruits of *S. dulcamara* demonstrates significant anti-inflammatory and antioxidant activity [92]. Moreover, *S. dulcamara* is reputed to possess a variety of therapeutic properties, including antimicrobial, analgesic, hepatoprotective, immunomodulatory, antitumor, and neurogenetic effects [93], as well as antioxidant [92], antihyperglycemic [94], antibacterial, and antimicrobial activity [95,96], and antirheumatic activity [97]. The aerial part of *S. dulcamara* is particularly rich in alkaloids, which contribute to its antibacterial activity against *Streptococcus pyogenes*, *Staphylococcus epidermidis,* and *S. aureus*.

S. dulcamara is a known remedy for the treatment of skin diseases and warts [98]. This plant is particularly rich in the alkaloid solanine, which is abundant in its immature fruits and has been traditionally used in Kenya to treat skin mycotic infections and other pathological conditions [99]. Saponins isolated from *S. dulcamara* possess remarkable antioxidant activity, as they are capable of absorbing free radicals. Due to their beneficial properties, saponins are often utilized in cosmetology, where they improve the rheological and foaming properties of body wash formulations, while reducing the risk of skin irritation [100]. The antioxidant properties of S. dulcamara are attributed to the presence of various phenolic compounds, flavonoids, anthocyanins, carotenoids - lycophyll (5), as well as hydroxy- and methoxy derivatives of coumarins [101].



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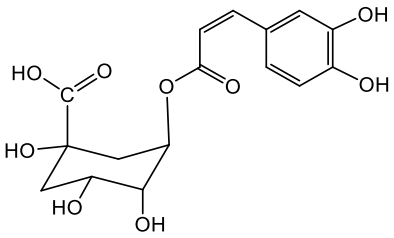
(5)

Through non-targeted LC/MS analysis, a comprehensive list of 83 metabolites has been identified in *S. dulcamara* fruit extracts, including 22 polyphenolic compounds comprising of 19 phenolic acid derivatives and 3 flavonoids (namely quercetin-3-O-rutinoside and kaempferol-3-O-rutinoside), 10 amides, 16 saponins, 14 steroid alkaloids, 6 lignans, and 15 other compounds [102]. Notably, the phenolic acids in these extracts are mainly composed of chlorogenic acid (6), caffeic acid and p-coumaric acid:



(6)

An investigation into the metabolites present in *S. dulcamara* found that unripe fruits contained a higher concentration of γ-solamarin, α-solazonin, α-solanine, abutiloside H, and solanandaine compared to ripe fruits. Moreover, methanol fruit extracts were found to exhibit significant potential in eliminating DPPH and hydroxyl radicals. Interestingly, the ability of methanol extracts to remove DPPH was found to be tissue-specific, with the outer tissue (skin) of the bittersweet fruits showing a higher antioxidant activity than the inner tissues (pulp and seeds), possibly due to the higher phenol content in the peel [102].

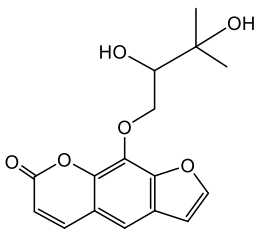
Pastinaca sativa* L. Seler family – *Apiaceae

Parsnip (*Pastinaca sativa* L.) is a plant species that is indigenous to Europe and Asia [103], and is also found growing in South Kazakhstan [104].

The root of parsnip is a rich source of numerous bioactive compounds, including coumarins, furanocoumarins, polyacetylenes, essential oils, terpenes, and flavonoids [**103**]. Additionally, parsnip root is a rich source of various minerals such as potassium, manganese, magnesium, phosphorus, zinc, and iron, as well as carotene, starch, pectin, vitamins, and sugars [105].

Parsnip has been employed in traditional medicine since antiquity. Avicenna's Canon recommends its topical and oral use to alleviate headache, stomatitis, ophthalmitis, dermatitis, and fever [103].

In 986 AD, the therapeutic use of plants containing furanocoumarins was documented for the treatment of skin conditions such as leprosy and vitiligo [106]. To date, furanocoumarins continue to be utilized for the treatment of certain dermatological conditions. Recent investigations have revealed that heraclenol (7) and oxypeucedanine hydrate (8) elicit a mild stimulatory effect on melanogenesis without affecting cell proliferation, as evidenced by studies examining the effect of furanocoumarins on the skin [103]. Moreover, furanocoumarins have been employed in the treatment of vitiligo and psoriasis [107].



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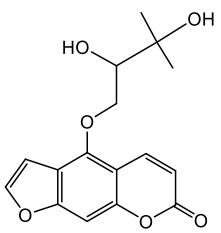

(8)

Numerous studies have demonstrated the pharmacological effects of *P. sativa* on various bodily systems, including the central nervous, respiratory, gastrointestinal, hepatic, skin, cardiovascular, and genitourinary systems [103], as well as its potential in mitigating stroke, atherosclerosis, and

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other coronary heart diseases. Additionally, *P. sativa* has been shown to have positive effects on cholecystitis, constipation, anorexia, stomach pain, bladder atony, spastic enterocolitis, mild insomnia, nephritis, dysuria, renal colic, endocrine disorders such as menstrual syndrome, rheumatism, vitamin deficiency, obesity, vascular diseases, infections, loss of appetite, dysmenorrhea, fever, atherosclerosis, detoxification, anemia, and diabetes [105]. Furthermore, furanocoumarins extracted from parsnips have the ability to dilate peripheral vessels and coronary vessels of the heart, eliminate spasms of the bronchi and smooth muscles of the abdominal cavity, and have a moderate sedative effect. In addition, *P. sativa* exhibits antioxidant and anticytolytic activities [108].

The dried seeds of *P. sativa* were subjected to steam distillation to isolate its essential oil, which was found to contain octyl acetate (78.49%) and octylhexanoate (6.68%) as its major constituents. Remarkably, this essential oil exhibited significant antioxidant activity [109].

Capsella bursa pastoris* L. Cabbage family – *Brassicaceae

Capsella bursa-pastoris L. is a wild plant with significant nutritional value that is fit for human consumption. This plant is widely distributed across many countries, including Cyprus, Europe, Saudi Arabia, Turkey, Pakistan, India, Iraq, Iran, China, Azerbaijan, and other Asian countries [110]. It is also commonly found in various regions of Kazakhstan.

Capsella bursa-pastoris L. contains a diverse range of chemical components including flavonoids, polypeptides, choline, acetylcholine, histamine, tyramine, fatty acids, sterols, organic acids, amino acids, sulforaphane, vitamins [111], and various trace elements. In addition, it contains phenolic compounds, flavonoids, tannins, saponins, alkaloids, and phytosterols [110,112–114], as well as volatile fractions consisting mainly of terpenoids, alkane hydrocarbons (such as nonacosane), and fatty acids (including palmitic and linoleic acids) [115].

In traditional medicine, *Capsella bursa-pastoris* L. has been used for centuries in China and Japan as a hemostatic, diuretic, and antipyretic agent [111]. The plant has been utilized for the treatment of conditions such as edema caused by nephritis, odynuria, hemaffetia, menorrhagia, chyluria, and hypertension [116]. The entire plant is used to make tea, which has been used as an antiscorbutic, astringent, diuretic, emmenagogue, hemostatic, hypotensive, tonic, stimulant, vasoconstrictor, and wound healing agent. This beverage has also been considered an excellent remedy for various types of bleeding, including those originating from the stomach, lungs, uterus, and kidneys. A homeopathic remedy for nosebleeds and urolithiasis is prepared from fresh *Capsella bursa-pastoris* L. plant [111].

Based on the literature, it has been reported that raw plant extracts and certain phytocomponents exhibit various pharmacological effects, such as anti-inflammatory, antispasmodic, antimicrobial, hepatoprotective, cardiovascular, anticancer, sedative, and antioxidant effects [110,113,117–120]. Furthermore, it has been suggested that these extracts possess infertility-reducing properties [121]. Extracts have also demonstrated inhibitory effects on acetylcholinesterase activity and significant antibacterial activity [113].

Capsella bursa-pastoris L. displays potent antioxidant activity attributed to its flavonoid compounds, namely quercetin, chrysoeriol, kaempferol, and isorhamnetin. In vitro studies have shown that its extracts possess antioxidant activity against various free radicals such as DPPH radicals, peroxyl radicals, hydroxyl radicals, and hydrogen peroxide [122]. Additionally, the plant extract has been found to have cytotoxic effects as reported by previous studies [112]. Furthermore, a moderate hepatoprotective activity has been observed with the extract containing specific flavonoids, including 4,7-dihydroxy-5-hydroxymethyl-6,8-diprenylflavonoid, chrysoeriol-7-O-d-glucopyranoside, sinensetin, and 6,8-diprenylgalangin [123].

Capsella bursa-pastoris L. has exhibited noteworthy efficacy in the treatment of eczema in dermatology [124]. Moreover, preparations derived from *Capsella bursa-pastoris* L. have been registered and recommended by the German Institute for Pharmaceuticals and Medicines for the adjunctive treatment of skin diseases and wounds [125].

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Tanacetum vulgare* L. Aster family – *Asteraceae

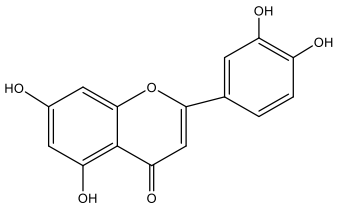
Tanacetum vulgare L. is a widely recognized medicinal plant that is distributed across Northern Europe, North America, Russia, China, North Korea, Kazakhstan, and Japan [126,127].

T. vulgare is abundant in phenolic acids, flavonoids, and their derivatives [128]. The plant contains surface flavonoids, such as the methyl esters of flavones sutellarin and 6-hydroxyluteolin, as well as vacuolar flavonoids, including apigenin and luteolin 7-glucorinides. Additionally, it contains caffeic acid, glycosides, sterols such as β-sitosterol, stigmasterol, cholesterol, and campesterol, and triterpenes such as α-amirin, β-amirin, and taraxasterol [129].

In the traditional medicine of southeastern Serbia, *T. vulgare* flowers are commonly used to prepare tea with various therapeutic benefits such as antihelminthic, carminative, antispasmodic, abdominal organ stimulant, tonic, menstruation stimulant, antidiabetic, diuretic, and antihypertensive properties [130,131]. Apart from medicinal use, *T. vulgare* is also utilized in the production of balms, cosmetics, dyes, insecticides, drugs, and preservatives [132]. Furthermore, *T. vulgare*-based preparations have been used for the treatment of several conditions including hysteria, migraine, neuralgia, rheumatism, renal failure, and fever [129]. The same source highlights the antibacterial, antiviral, antifungal, anti-inflammatory, and immunomodulatory activity exhibited by *T. vulgare.*

The bioactive components of *T. vulgare*, including sesquiterpene lactones, volatile oils, flavonoids, and phenolic acids, have been found to possess antioxidant, anticancer, anti-inflammatory, and antiulcer properties [131].

Taraxasterol (1) (see above), luteolin (9) and taraxic acid (a sesquiterpene lactone) present in *T. vulgare* are responsible for its anti-inflammatory and anti-allergic effects, making it a potential treatment for skin diseases such as atopic dermatitis, eczema, and psoriasis [133–135].



(9)

Inulin and chlorogenic acid (6) (see above) have demonstrated antioxidant, prebiotic, and anti-inflammatory effects, which suggest their potential use as a therapeutic approach for managing skin disorders like acne, rosacea, and photoaging [136–138].

Plantago major* L. Family – *Plantaginaceae

Plantago major L. (Plantain) is a widely recognized and extensively utilized medicinal plant. The genus *Plantago L.* comprises approximately 300 diverse species that flourish in temperate areas globally, including 16 plant species that occur in Kazakhstan [**139,140**]. In arid zones, *P. major* is comparatively scarce and is primarily found along riverbanks and in intensely irrigated crops.

Plantain is a botanical specimen that contains a diverse array of chemical constituents, including carbohydrates such as polysaccharides, pectic acid, mucus, mannitol, and sorbitol, lipids both saturated and unsaturated, nitrogen compounds like allantoin, essential and non-essential amino acids, caffeic acid derivatives, flavonoids including baicalein, scutellarein, luteolin, baicalin, apigenin, among others, phenolcarboxylic acids and their derivatives such as lilac, vanillic, ferulic, salicylic, benzoic, cinnamic, gentisic, chlorogenic, and neochlorogenic, iridoid glycosides like aucubin, catalpol, and aukubozid, terpenoids, alicyclic compounds like loliolid. Furthermore, the leaves of Plantain exhibit a significant concentration of phenols and their derivatives such as ferulic acid and tyrosol, tannins, and vitamin K. The seeds of Plantain contain organic acids like succinic acid, mucus, iridoids like aucubin, sterols such as β-sitosterol, stigmasterol, campesterol, saponins, alkaloids, tannins, flavonoids like isoquercitrin, and fatty oil. These findings have been reported in numerous sources [141–144].

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Plantain has been recognized for centuries as possessing therapeutic properties. Various parts of the plant, including mature seeds, leaves, and juice, are used for medicinal purposes. Plantain leaves have been employed in the treatment of numerous diseases, including digestive, reproductive, and circulatory ailments, as well as inflammatory skin disorders [145] and urogenital and infectious diseases [146]. Moreover, plantain has been utilized for pain relief and to reduce fever [147].

The specific therapeutic effects of psyllium are attributed to its phytochemical components. The mucus, enzymes, and phytoncides present in psyllium provide an enveloping and mucolytic effect that restores the protective function of the ciliated epithelium in the respiratory tract, leading to increased secretion of bronchial mucus and liquefaction of sputum for easy expectoration. The glycoside plantagin inhibits the cough reflex [148]. The anti-inflammatory and analgesic effects of water extract from psyllium have been demonstrated by several studies [149,150]. Psyllium also possesses wound healing, antiulcer, antidiabetic, antidiarrheal, antibacterial, antiviral, antioxidant, and immunomodulatory properties [151]. A comprehensive overview of the medicinal properties and chemical components of psyllium published in journals between 1937 to 2015 was conducted and is available from PubMed, ScienceDirect, and Google Scholar [152]. A study on the antiviral activity of aqueous extract and pure compounds of Plantain revealed that while the aqueous extract of Plantain had negligible activity against the herpes virus, some pure compounds belonging to five different classes of chemicals found in the plant extracts exhibited potent antiviral activity. Among them, caffeic acid showed the highest activity against herpes simplex virus HSV-1, while chlorogenic acid had the strongest activity against adenovirus ADV-11. Recent pharmacological studies have reported a range of biological activities of Plantain extracts, including immunomodulatory, antioxidant, lipid-lowering, hypoglycemic, intestinal function, anti-cancer, anti-inflammatory, and anti-complementary activities [139].

According to the authors of a recent study [148], the hemostatic properties of Plantain can be attributed to its high content of vitamin K, which, along with tannins, facilitates blood clotting. Additionally, the plant's anti-inflammatory, wound-healing, and ulcer-healing effects are linked to the presence of polysaccharides, pectin, tannins, benzoic acid, and salicylic acid. Plantain is also used in cosmetic dermatology to treat acne scars [137]. Polysaccharides stimulate the formation of interferon, while zinc and flavonoids aid in the normalization of phagocytosis. The combination of polysaccharides with enzymes and vitamins promotes regeneration. Organic and phenol carboxylic acids, flavonoids (such as derivatives of luteol quercetin and apigenin), ascorbic acid, copper, and zinc provide a pronounced antihypoxic effect. Plantain also regulates digestion and increases appetite, with iridoid glycosides such as aucubin and catalpol, as well as bitterness, stimulating glandular secretion. Furthermore, leaf extracts have sedative and hypotensive effects, while saponins, hydroxycinnamic acids, flavonoids, and pectin substances help to reduce blood cholesterol levels.

Plantain is prescribed in various forms, including roasted seeds, decoction, syrup, ointment, rinse, rectal enema, vaginal suppositories, eye and nasal drops, depending on the disease being treated. Galenic preparations are commonly used to treat respiratory diseases, gastric and duodenal ulcers, and kidney disease, while Plantain preparations are applied externally to treat inflammation of the oral cavity and nasopharynx, wounds, bruises, burns, and furunculosis. They also serve as a bacteriostatic and wound healing agent. *P. major* extracts are known to have a sedative and hypotensive effect, and the fresh leaf juice is effective in treating corneal wounds. P. major leaf juice has been found to inhibit the growth of pathogenic staphylococcus at a dilution of 1:2, Escherichia coli at a ratio of 1:4, and to retard the growth of hemolytic streptococcus at a ratio of 1:2. Plantaglucid, a preparation containing a mixture of Plantain polysaccharides, is commonly used to treat hypoacid gastritis and gastric ulcer during exacerbation and to prevent relapses [153].

Artemisia absinthium* L. Aster family – *Asteraceae

Artemisia absinthium L., a plant species commonly known as wormwood, is widely distributed in Asia, the Middle East, Europe, and North Africa. It grows everywhere in Kazakhstan [154–156].

A. absinthium is a plant species that possesses various biologically active compounds. The grass of this plant is utilized as a source material for oil production. The oil mainly consists of thujone esters, α- and β-thujone (10), camphene, α-cadinene, guaiazulene, (Z)-epoxycymene, (E)-sabinyl

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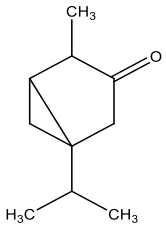
acetate, (Z)-chrysanthenyl acetate, as well as bitter sesquiterpenoid lactones, azulene group compounds, and tannins [157]. Moreover, it contains terpenoids (such as myrcene, germacrene D, camphor (10), chamazulene), flavonoids (quercetin, kaempferol, apigenin, artemetin, and rutoside), phenolic acids (chlorogenic, ferulic, gallic, coffee, syringic, vanillic, and caffeylquinic acid derivatives), and flavonoid glycosides [158]. The composition of the *A. absinthium* extract is dependent on the type of solvent utilized in the extraction process. The alcoholic extract, in particular, has a considerably higher concentration of flavonoids, phenols, and tannins in comparison to the aqueous and chloroform extracts [157].



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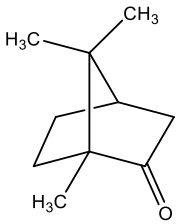

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For thousands of years, *A. absinthium* has been utilized in traditional medicine for a wide range of ailments, particularly parasitic diseases and digestive disorders, as well as fever reduction [159]. The leaves are employed to alleviate fever, while the flowers are used to aid with stomach disorders and helminthiasis. The *A. absinthium* tincture is highly esteemed as a tonic and digestive aid. In a published paper [160], the wormwood herb is noted for its effectiveness in treating jaundice, constipation, obesity, splenomegaly, anemia, insomnia, bladder diseases, and non-healing wounds from traumas. Furthermore, the plant is utilized as a foundation for producing skin ointments and balms [159].

A. absinthium demonstrates a diverse array of biological activities, including but not limited to antibacterial, anti-inflammatory, hepatoprotective, antidepressant, antispasmodic, and antipyretic effects [161,162]. Moreover, it exhibits antimicrobial, antiviral, antistress, hepatoprotective, antioxidant, and anticancer effects [154,163].

In the field of dermatology, the essential oil derived from *A. absinthium* has been shown to expedite wound healing, diminish inflammation, and exhibit antimicrobial and wound-healing properties [164].

Agropyron repens* L. Lacquer family – *Gramineae

Agropyron repens L. is distributed widely across Europe, Asia, and Africa [165]. It can be found ubiquitously throughout Kazakhstan [166].

The chemical composition of the plant encompasses a broad spectrum of constituents, including carbohydrates such as fructose, glucose, inositol, and mannitol, as well as mucous substances, pectin, triticin, thianogenic glycosides, flavonoids, saponins, essential oil, monoterpenes (such as carvacrol, carvone, transanethol, thymol, and menthol), and sesquiterpenes. Additionally, the plant contains vanillin glucoside, iron, minerals, and significant quantities of silica. Among the phenolic compounds found in the plant are p-hydroxybenzoic, vanillic, and p-coumaric acids, as well as chlorogenic acid, p-hydroxycinnamic acids, and p-hydroxycinnamic acid esters. The rhizomes contain polysaccharides, glycosides such as quercetin and luteolin, phenolic glucosides, fatty acids, and amino acids (including γ-aminobutyric acid, proline, valine, asparagine, histidine, arginine, and tryptophan) [167,168]. Furthermore, the seeds of wheatgrass contain triticin, mucus, saponins, sugar alcohols (namely, mannitol, inositol, and 2-3% of the total composition), essential oils with polyacetylenes or carvone, a small amount of vanilloside (vanillin), phenol carboxylic acids, silicic acid, and silicates [169].

Agropyron repens L. has been used in folk medicine as a sedative diuretic to relieve pain and spasms in the urinary tract, and as a sedative and tonic [165,168–170]. The traditional medicinal use of *Agropyron repens* L. in urolithiasis has been scientifically validated, with confirmed

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pharmacological actions including hypoglycemic, hypolipidemic, anti-inflammatory, and antidiabetic effects, as well as effects on motility and benefits in urinary tract infections [165,168,171].

The presence of flavonoids, alkaloids, and coumarin in the composition of this plant suggests its potential activity in the treatment of skin diseases, such as inflammatory skin diseases, atopic dermatitis, and acne [172,173].

Matricaria recutita* L. Aster family – *Asteraceae

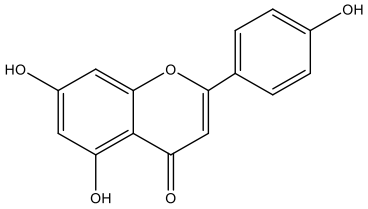
Matricaria chamomilla L. is a globally distributed, well-known medicinal plant [174,175].

Matricaria Chamomilla L. contains a wealth of biologically active compounds, including flavonoids (such as apigenin and luteolin) and their glycosides, as well as coumarins (including gerniarin and umbelliferone) [176]. The essential oil extracted from chamomile flowers is composed of 52 different components, with the highest concentration of terpenoids, including β-farnesene, α-farnesene, α-bisabolol, chamazulene, and germancrene, as well as spiroether [174,177,178].

Matricaria Chamomilla L. has been widely employed in traditional medicine for treating a diverse range of ailments, including infections, neuropsychiatric disorders, respiratory tract, gastrointestinal and liver diseases. Furthermore, the plant possesses sedative, antispasmodic, antiseptic, and antiemetic properties [174].

Therapeutic indications for *Matricaria Chamomilla* L. encompass a diverse array of medical conditions, including inflammatory conditions, bacterial infections, and lesions of the skin and mucous membranes such as those found in the oral cavity, gastrointestinal tract, and respiratory tract. Additionally, the plant has been employed as a remedy for spasms and ulcers of the gastrointestinal tract, insomnia, and nervous breakdown [179–185]. Furthermore, the plant has demonstrated pain-relieving properties [186], wound-healing effects [187], and acted as a protective agent for the kidneys and liver [188].

Matricaria Chamomilla L. is regarded as a viable alternative owing to its abundance of bioactive secondary metabolites that have therapeutic potential for the treatment of diverse skin conditions, such as wounds, abscesses, and skin diseases. The plant's therapeutic efficacy in treating skin conditions is attributed to the presence of α-bisabolol (12) and apigenin (13), a natural flavonoid:



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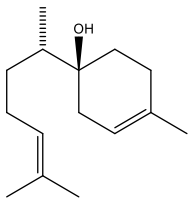

(13)

α-Bisabolol (12) possesses anti-inflammatory, antibacterial, and anti-irritant properties, making it suitable for use in a variety of products that provide protection against skin irritation caused by environmental factors. Due to its non-allergenic nature, it is widely used in hand and body lotions, aftershave creams, lipsticks, sun and after-sun care products, and baby care products [189,190]. On the other hand, apigenin (13) has been found to alleviate the symptoms of skin inflammatory diseases by protecting skin cells from oxidative stress-induced death. Apigenin also affects the synthesis of skin barrier factors and the influx of calcium ions. Therefore, it can potentially be used to treat skin inflammatory diseases and cancer [191].

Sorbus aucuparia* L. Rose family – *Rosaceae

Sorbus aucuparia L., a botanical species known for its nutritional and medicinal benefits, is considered a valuable source of edible fruits. This plant is characterized by its ability to thrive in cold and harsh environments, and is found in abundance across various regions spanning Northern Europe, the Caucasus, the Middle East, and East Asia [192–195].

Sorbi fructus, commonly known as Rowan fruits, serve as essential medicinal resources. The berries are harvested during their complete maturation phase, from August to September, before the advent of frost. During collection, it is advisable to exercise caution and avoid damaging the branches.

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The harvested raw materials are meticulously cleansed of their stalks and subsequently subjected to a drying process in well-ventilated rooms or dryers, employing a temperature range of 60-80ºC [196].

This fruit, popularly referred to as a "superfruit," contains a diverse array of phytochemicals, comprising phenolic acids (neochlorogenic and chlorogenic acids), flavonoids, proanthocyanidins, iridoids, coumarins, hydrolysable tannins, carotenoids, and anthocyanins, as well as vitamins (ascorbic acid, α-tocopherol, B1, B2, P, PP, K, and folic acid) [195,197,198]. Furthermore, it harbors various sugars (glucose, fructose, sucrose, sorbitol alcohol, etc.), phospholipids, pectin, organic acids, bitter substances, sorbic and parasorbic acids, essential oil, and macro- and microelements. The leaves of the plant contain vitamin C and flavonoids, while rowan seeds contain fatty oil (up to 22%) and glycoside amygdalin; the bark contains tannins [199,200].

Throughout history, the fruits of *Sorbus aucuparia* L. have been utilized in traditional medicine to alleviate ailments related to cardiovascular and digestive systems. In addition to their medicinal applications, these fruits can be consumed raw or utilized in the production of jams, syrups, and as flavoring agents in alcoholic and non-alcoholic beverages, including beer and wine [201].

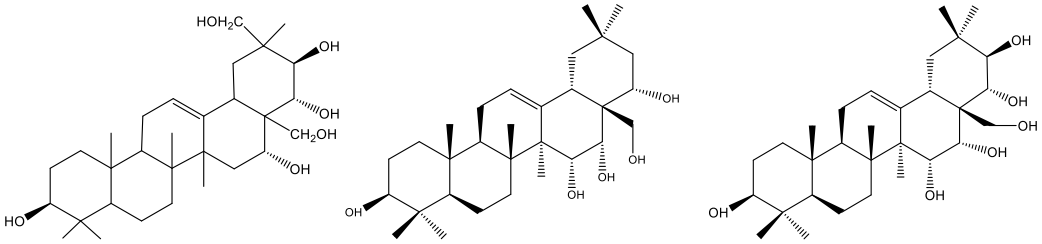
The fruit extracts derived from *Sorbus aucuparia* L. have demonstrated antioxidant [202] and antitumor activity [195]. The antioxidant activity is attributed to the presence of flavonoids, vitamins C and E [198], and anthocyanins [201,203] within their composition. Moreover, the authors of [201] have reported additional pharmacological effects of the fruit extracts, including antitumor, antiproliferative, antiviral, antibacterial, antifungal, and anti-inflammatory effects.

Within the field of dermatology, Rowan berries are recognized as a valuable multivitamin raw material for the treatment of allergic diseases and other skin ailments, owing to their wound-healing properties [204].

Eryngium planum* L. Seler family – *Apiaceae

The subgenera of *Eryngium* are predominantly distributed throughout Europe, Africa, and Asia, with certain subgenera exhibiting a widespread presence in Australia [205,206]. In Kazakhstan, Eryngium is found growing in the steppe regions of Northern Kazakhstan, as well as in the Dzungarian and Zailiyskiy Alatau mountain ranges [207].

The aerial parts of *Eryngium* species are characterized by the presence of saponins, flavonoids, and essential oils, while the underground parts contain triterpene saponins, monoterpene glycosides, phenolic compounds such as flavonoids and phenolic acids, coumarin derivatives, terpene aldehyde esters, essential oils, and oligosaccharides [208,209]. The isolation of eringinol (14) from the aboveground parts of the plant was reported later [210]. Further studies on the phytochemical constituents of the plant were conducted on leaves and roots, leading to the isolation of various aglycones containing acetic, tigloic, butyric, and isovaleric acids at positions C16, C21, C22, or C28 [210,211]. Additionally, A1-barrigenol (15) and R1-barrigenol (16), a type of aglycone containing dimethylacrylic, angelic, and/or tigloic acids as acid fragments, were named eryngiumgenine AD and isolated from the roots of *E. planum* [209].



(14) **(15)** **(16)**

E. planum has a significant role in European and Asian traditional medicine for treating various inflammatory diseases. The plant's aboveground parts are bioactive primarily due to the presence of polyphenols and saponins [212–214]. It has demonstrated potential for use in gastrointestinal diseases and exhibits antibacterial, analgesic, anthelmintic, anticonvulsant, and anticancer properties, highlighting its crucial importance in ethnopharmacology [215]. The aerial part of the plant collected during flowering is used for therapeutic purposes.

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According to the results obtained from HPLC-MS analysis, flavonoids, particularly rutin and isoquercetin, are the major constituents of *E. planum* extracts [216]. Rutin is known to possess skin toning properties and to prevent the appearance of skin conditions such as rosacea and erythema. The anti-inflammatory effects of *E. planum* extracts may be attributed to the synergistic activity of ursolic acid and polyphenols such as rutin, chlorogenic acid, rosmarinic acid, genistin, and daidzein, which have been previously studied for their anti-inflammatory properties [217–220]. Notably, ursolic acid, which is abundant in concentrated extracts of the plant, exhibits antioxidant, antimicrobial, anti-inflammatory, and hypoglycemic activities [221].

Eryngium planum L. has potential applications in dermatology, particularly for the treatment of atrophic and purulent skin wounds when applied topically [222].

Ribes Nigrum* L. Saxifrage family – *Saxifragaceae

Ribes Nigrum L. is a diminutive perennial shrub indigenous to Central Europe and North Asia that has been widely cultivated globally, including in the United States [223]. Furthermore, it is known to thrive in the territory of Kazakhstan [224].

Fresh blackcurrant fruits are known to contain a diverse range of functional and biologically active compounds, including soluble sugars, flavonoids, organic acids, vitamins, polyamino acids, macro- and microelements, and unsaturated fatty acids [225,226]. Additionally, blackcurrants are a rich source of vitamin C [227]. Anthocyanins, a group of biologically active compounds, are prominently found in blackcurrant berries, as well as in its seeds and leaves [228]. Notably, blackcurrant seed oil is a valuable source of gamma-linolenic acid (γ-C18:3), stearidonic acid (C18:4), tocochromanols (primarily γ-tocopherol and α-tocopherol), and sitosterol [225].

The fruits, leaves, and shoots of *Ribes nigrum*, both in fresh and dried form, have been traditionally used as a multivitamin and general tonic for hypovitaminosis and beriberi, as well as for enhancing the immune system. In folk medicine, the leaves of *Ribes nigrum* have been used for treating various conditions, including kidney stones, gout, cystitis, urethritis, osteochondrosis, rheumatism, muscle and joint pain, exudative diathesis, eczema, and furunculosis [229]. Additionally, *Ribes nigrum* is also used in homeopathy [230]. In a study [231], a wide range of pharmacological actions of *Ribes nigrum* extract, rich in anthocyanins, has been indicated. Extracts containing more than 20% anthocyanins have been found to exhibit antioxidant, anti-inflammatory, phytoestrogenic activity, anti-postprandial hyperglycemic and anti-diabetic effects, and cardioprotective effects. Furthermore, the anthocyanin-rich fraction of black currant peel extract has been found to exhibit a strong cytotoxic effect on human liver cancer cells, and to have a positive effect on vision and eye health.

In the field of dermatology, blackcurrant leaves have been utilized for treating skin lesions resulting from atopic dermatitis, allergic itchy dermatoses (e.g., eczema, neurodermatitis, pruritus), while leaves and fruits have been used for managing psoriasis, scleroderma, lichen planus, vasculitis, and acne vulgaris [223,232]. *Ribes nigrum* may prove beneficial in treating various skin conditions, such as atopic dermatitis, psoriasis, and acne, owing to its higher anthocyanin content [233]. The antioxidant activity of blackcurrant, attributed to the presence of flavonoids and vitamin C, has been observed to modulate cancer and inflammation signaling pathways and absorb ultraviolet radiation [226]. Vitamin C has been shown to increase the transport protein under exposure to ultraviolet light. Furthermore, the presence of fatty acids in blackcurrant endows it with therapeutic potential for skin ailments [234].

Glycyrrhiza glabra* L. Legume family – *Fabaceae

Glycyrrhiza glabra L., commonly known as licorice, fragrant wood or mulaiti, is a small perennial plant that is native to Eurasia, North Africa and West Asia [235]. This plant is found ubiquitously in Kazakhstan [236,237]. The genus Glycyrrhiza is extensively distributed across the globe and encompasses over 30 species.

The root of *Glycyrrhiza glabra L.* is a significant medicinal component due to the presence of various isolated compounds. These include triterpene saponins such as the sweet saponin glycyrrhizin, flavonoids such as liquirtin which is the primary flavonoid glycoside, rhamnoliquirilin,

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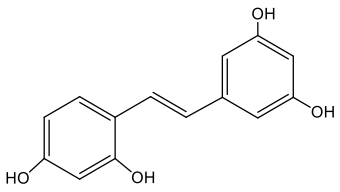
liquiritigenin, prenillicoflavon A, glucoliquiritin apioside, 1-methoxyphaseolin, shinpterocarpin, shinflavanone, lycopyranocoumarin, glisoflavone, lycoarylcoumarin, coumarin-GU-12, isoflavonoids, and chaconne. Among these, glycyrrhizic acid is the primary biologically active component, and it is known to be 60 times sweeter than sugar cane [235,238].

Licorice root has been employed as a therapeutic agent by both ancient and modern medical practitioners. Its oral administration has demonstrated efficacy in the treatment of various disorders including gastric, duodenal and esophageal ulcers, inflammation, laxatives, mouth ulcers, antispasmodic, antitussive, sedative, and expectorant. The herb's constituents make it a promising candidate for managing respiratory conditions such as asthma, acute and chronic bronchitis, and chronic cough. Furthermore, it has demonstrated potential in treating Addison's disease. Topical application of licorice extracts has also been effective in treating inflammatory skin conditions, mouth ulcers, and maintaining oral hygiene [238–240]. Glycyrrhizin, one of the major bioactive components of licorice, is widely utilized in the commercial production of non-food sweeteners and flavors for candies and pharmaceuticals [240].

Numerous clinical and experimental studies have demonstrated that this substance possesses several pharmacological properties that are highly advantageous, including anti-inflammatory, antiviral, antimicrobial, antioxidant, anticancer, immunomodulatory, hepatoprotective, and cardioprotective effects [238].

The ethanolic extract derived from the root of *Glycyrrhiza glabra* L. exhibited noteworthy antibacterial activity against Propionibacterium acne and Pseudomonas aeruginosa. This property has led to the use of *Glycyrrhiza glabra* L. in dermatology for treating skin diseases, such as dermatosis and acne [241].

Multiple studies have demonstrated the efficacy of *Glycyrrhiza glabra* L. in treating various skin conditions such as hyperpigmentation, eczema, and psoriasis. The therapeutic effects can be attributed to the presence of flavonoid compounds like oxyresveratrol (17), glabridin (18), and liquiritin (19) [242]. *Glycyrrhiza glabra* L. also contains Licochalcone A (20), which has anti-inflammatory and antimicrobial properties and has been found to be effective in treating acne, inflammatory skin diseases, and other skin ailments [243–245].



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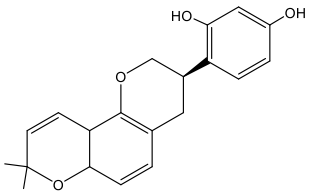

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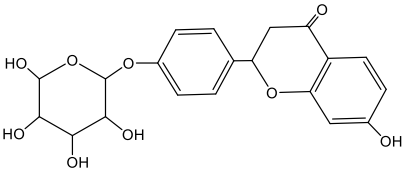

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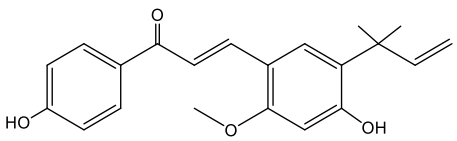

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Ononis spinosa* L. Legume family – *Fabaceae

Ononis spinosa L. has a wide distribution across Africa, Asia, and Europe. It is found in countries such as Algeria, Libya, Morocco, Tunisia, Afghanistan, Iran, Iraq, Palestine, Jordan, Lebanon, Syria, Turkey, Armenia, Azerbaijan, India, Denmark, Norway, Sweden, Great Britain, Austria, Belgium, Czechoslovakia, Germany, Hungary, the Netherlands, Poland, Switzerland, Estonia, Lithuania, Moldova, the European part of the Russian Federation, Albania, Bulgaria, Greece, Italy, Romania, France, Portugal, and Spain [246].

The root of *O. spinosa* is a reservoir of isoflavonoids, pterocarpans, and dihydroisoflavonoids, comprising formononetin, calicosin, pseudobaptigenin, medicarpin, maakiain, onogenin, and sativanon, with metabolites present in the form of glucosides, glucoside malonates, glucoside acetates, and free aglycones [247,248].

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The roots, leaves, and flowers of *O. spinosa* have been utilized in folk medicine for their antitussive, laxative, and diuretic properties. Infusions of the plant have been employed to treat dropsy, urinary tract infections, inflammation, and rheumatism, while external applications have been used to promote wound healing and alleviate skin conditions such as eczema. In Iraq, the roots were valued for their diuretic, blood purifying, laxative, and expectorant qualities [246]. Additionally, ash derived from burned samples of *O. spinosa* has demonstrated activity against various Candida species [249].

Pharmacological investigations have demonstrated that *O. spinosa* exhibits noteworthy hepatoprotective and antitumor properties [250], and may be considered a potential therapeutic agent for the management of urinary tract infections and bladder stones [247].

O. spinosa has been utilized in dermatology for its efficacy in treating skin ailments such as dermatitis (eczema) and pruritus, while also possessing wound-healing properties beneficial in the treatment of burns [251].

Gnaphalium uliginosum* L. Aster family – *Asteraceae

Gnaphalium uliginosum L. is a member of the Compositae family, a group of flowering plants, and is commonly referred to as swamp cudweed or swamp cudweed. It has a wide distribution, including in Kazakhstan. [252,253].

Gnaphalium uliginosum L. is known to harbor a limited array of chemical constituents, comprising of approximately 125 compounds such as flavonoids, sesquiterpenes, diterpenes, triterpenes, phytosterols, anthraquinones, caffeylquinic and caffeylglucaric acids, flavonols, and carotenoids [254,255].

Marshweed, also known as *Gnaphalium uliginosum* L., has been used in traditional medicine to alleviate a variety of conditions, including gastric disorders, edema, wounds, prostatitis, lumbago, neuritis, and angina pectoris. Additionally, it has been utilized for its antihypertensive, diuretic, antipyretic, and antimalarial properties [252].

Pharmacological investigations on *Gnaphalium uliginosum* L. extracts have revealed various beneficial effects, such as antioxidant [256], antibacterial, antifungal, antitussive, expectorant, antifidant, cytotoxic, and hepatoprotective activities [257]. Additionally, this plant exhibits anti-inflammatory, antidiabetic, and antihypouricemic properties [252]. *Gnaphalium uliginosum* L. is employed in medical practice as a hypotensive and wound-healing agent for treating hypertension, gastric ulcer, and difficult-to-heal wounds [255]. Furthermore, oil extracts derived from this plant are useful for managing laryngitis, catarrh of the upper respiratory tract, and tonsillitis [258].

In the field of dermatology, the extract derived from *Gnaphalium uliginosum* L. has been employed to address conditions such as eczema and skin cancer [259,260].

Onopordum acanthium* L. Aster family – *Asteraceae

Onopordum acanthium L. is a widely distributed species of plants found across Africa (Algeria), Asia (Afghanistan, Iran, Iraq, Turkey, Armenia, Azerbaijan, Georgia, Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, China, India, Pakistan), throughout Europe, Australia, New Zealand, and North and South America (Argentina, Chile, Uruguay) [261,262].

O. acanthium is a plant species that contains various phytochemical compounds, including saponins, alkaloids, sesquiterpene lactones, flavonoids, triterpenes, sterols, nitrogen-containing compounds, phenolic acids, coumarins, inulin, soluble sugars, proteins, and oils [262]. The fatty acid composition of the plant includes palmitic, stearic, oleic, and linoleic acids [263,264]. Additionally, phenolic, triterpene, and steroid compounds were detected in the aerial parts of *O. acanthium*, while the roots were found to contain sesquiterpene lactones and polyacetylenes [265].

In traditional medicine, various preparations of *O. acanthium,* including its powder, juice, and decoction of the aerial part, have been utilized as diuretics. This plant is known to stimulate the central nervous system and has demonstrated cardiotonic and hemostatic properties. Infusions of the leaves and inflorescences have also been employed to reduce swelling of various etiologies [265]. Furthermore, the extract derived from this plant has exhibited bactericidal, cardiotonic, and

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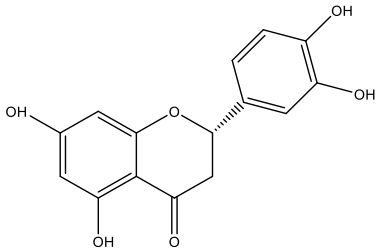
antitumor effects [266,267]. The extracts and isolated compounds from this plant have demonstrated a range of activities including anti-inflammatory, anti-radical, anti-proliferative, and antibacterial effects [265]. Additional activities noted for this plant include antioxidant and anti-inflammatory effects [268], as well as diuretic, dermatological, tonic, sedative, anticonvulsant, cardiotonic, hemostatic, and bactericidal effects, all without causing any side effects.

Eriodictyol (21) and quercetin (22) have been identified in the flowers of the plant, both of which possess potent antioxidant properties. Eriodictyol, in particular, has been found to protect skin cells from damage induced by UV radiation by inhibiting the MAPK signaling pathway, thereby exhibiting anti-aging effects. Quercetin, on the other hand, has been shown to support the body during periods of biological stress, including inflammation, allergies, itching, and weakened immunity [269].



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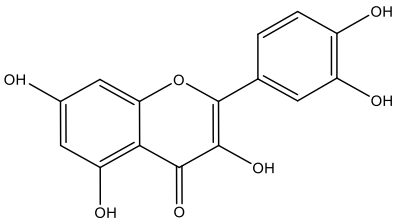

(22)

The antitumor activity of extracts obtained from a combination of flowers and fruits, leaves, and roots of *O. acanthium* against A431 culture (epithelial carcinoma of the skin) was examined by the authors of [270]. Aqueous, n-hexane, chloroform, and water-methanol extracts were utilized in the study. The results revealed that the chloroform extract of leaves and roots displayed the highest activity.

O. acanthium extracts find applications in dermatology beyond skin cancer, such as in the treatment of furunculosis, purulent wounds, and lupus [271].

Thymus serpyllum* L. Lamiaceae family – *Lamiaceae

Thymus serpyllum L., commonly known as creeping thyme, Bogorodskaya grass, and thyme, is widely distributed in countries bordering the Mediterranean, parts of Central Europe, and Asia [272]. The plant is found in the forest and forest-steppe zones of the European part of Russia, as well as in Western and Eastern Siberia, the Urals, Transbaikalia, and central regions of Kazakhstan, including the Ulytau mountains [273].

The plant is a valuable source of essential oil and pharmacologically active polyphenolic compounds, as reported in literature [274]. Thymol is the major component of the essential oil, comprising up to 42% of the oil, alongside other constituents such as carvacrol, n-cymol, α-terpineol, and borneol. Additionally, tannins, bitterness, gum, triterpene compounds including ursolic and oleanolic acids, flavonoids, and a significant amount of mineral salts have been detected in the herb. The mature seeds of the plant have also been found to contain 33.6% fatty oil [272,275]. Thyme also exhibits a high content of flavonoid phenolic and carotenoid antioxidants, such as zeaxanthin, lutein, apigenin, naringenin, and luteolin (9) (see above), as reported previously [276].

Thymus serpyllum L., a medicinal herb with rich essential oil and pharmacologically active polyphenolic compounds, has a long-standing history of being used in official and folk medicine to treat various ailments. The herb, collected during the flowering period, is used as a medicinal raw material after being threshed and dried in the shade or dryers at a temperature of 35-40°C. Thyme preparations have demonstrated expectorant, antimicrobial, and antifungal properties. Thyme is also used to treat a range of ailments, including sore throat, stomatitis, periodontal disease, asthma, headaches, laryngitis, and digestive system disorders [274,277]. Thyme extract has been shown to possess antitumor and antioxidant activity. Additionally, thyme is used as an alexiteric, emmenagogue, analgesic, and sedative, and in the form of ointments and lotions for rheumatism and skin diseases [273,278–280].

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Owing to its sedative and diuretic properties, formulations containing *Thymus serpyllum* L. can be employed for pruritic dermatoses [281]. Bulgarian herbalists advocate creeping thyme as a constituent of medicinal concoctions for treating eczema, neurodermatitis, urticaria, and as an external remedy to eliminate wrinkles [282].

Achillea millefolium* L. Aster family – *Asteraceae

Achillea millefolium L., commonly known as common yarrow, belongs to the Asteraceae family (Asteraceae Dumort.). The plant was referred to as "venus eyelashes" during the Middle Ages due to its leaves' feathery appearance, while the whole plant was known as "soldier's grass" for its use in treating wounds. There are over 100 different species of *Achillea millefolium* L., which are found in various regions worldwide, including North America, Europe, Asia, Australia, New Zealand, and the Middle East [283–286]. The plant is widespread in Kazakhstan and serves as a valuable source of nectar for honeybees [287].

The main components of *A. millefolium* are essential oils and phenolic compounds, monoterpenes, sesquiterpenes, lactones [288], amino acids, fatty acids, salicylic and succinic acids, ascorbic acid, folic acid, caffeic acid, and flavonoids [289]. The composition of the essential oil includes sesquiterpenoids: Achilles, acetylbalquinolide, caryophyllene, proazulene; monoterpenoids: camphor (11), thujol (10), (see above), cineole, pinene, borneol. In addition, alkaloids (the main of which is akhilein), flavonoids, including flavone glycosides apigenin (13) and luteolin (9) (see above) were found in the yarrow herb; tannins (α-phyloquinone), vitamins K, C, A, B; amines: choline, stakhidrin; esters (bornyl acetate, myrtenyl acetate), caryophyllene, organic acids (acetic, formic, malic, isovaleric, aconitic, coffee, chlorogenic), polyins (pontic epoxide, matrixar ester), cyclic alcohol viburnite (20%), menthol, geraniol [290–294]. Yarrow also contains sterols (mainly β-sitosterol, as well as stigmasterol, campesterol, cholesterol, taraxasterol and pseudotaraxasterol), coumarins, the biogenic amine betaine, inulin and other polysaccharides, which contain monosaccharides such as rhamnose, arabinose, xylose, mannose, glucose, galactose, ribose [295].

The bitter taste of *A. millefolium* can be attributed to the presence of sesquiterpene lactones in its essential oil. The quantity of essential oil produced by the plant is largely dependent on the growth stage. During the early stage of growth, the content of essential oil is 0.13%, which increases to 0.34% during flowering. The ratio of monoterpenes to sesquiterpenes also changes during the growing season, with an increase in the former and a decrease in the latter. Notably, the levels of α-pinene, β-pinene, and α-thujone show a marked increase, whereas those of sabinene, borneol, and bornyl acetate decrease [293,294].

In traditional medicine, yarrow has been employed to alleviate a variety of ailments including respiratory conditions (such as asthma and bronchitis), gastrointestinal disorders (including dyspepsia and hepatobiliary disorders), skin inflammation, and headaches. The aerial part of the plant, including leaves, stems, and inflorescences, is typically collected during the flowering phase for use as medicinal raw material. Yarrow is often administered as infusions, extracts, and potions to treat bleeding, flatulence, and gastrointestinal diseases such as gastritis, gastric ulcer, and duodenal ulcer. It is also consumed as a tea to stimulate appetite [286,289,296].

A. millefolium possesses various therapeutic properties such as disinfectant, anti-inflammatory, antispasmodic, anthelmintic, antibacterial, antioxidant and antimicrobial effects [297]. Additionally, the herb has demonstrated antiulcer and anticancer activities [298], while the experimental findings suggest that yarrow may stimulate thrombocytopoiesis, leading to an increase in the number of platelets in the blood [299].

Yarrow has long been utilized in traditional medicine as an effective treatment for various skin ailments, including acne, eczema, neurodermatitis, and urticaria. Moreover, yarrow is incorporated into medicinal preparations for vasculitis. Its therapeutic effects can be administered orally to prevent the recurrence of eczema [296,300–302].

Equisetum arvense* L. Horsetail family – *Equisetaceae

Equisetum arvense L., a herbaceous plant belonging to the Equisetaceae family, is widely distributed in North America, Europe, and Asia, including the territory of Kazakhstan [303,304].

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Equisetum arvense L. contains more than 210 natural compounds distributed in various organs. These compounds include alkaloids, carbohydrates, proteins and amino acids, phytosterols, saponins, sterols, ascorbic acid, silicic acid, phenolic compounds, and their glycosides, tannins, flavonoids (such as apigenin, genquanin, luteolin, kaempferol, quercetin), triterpenoids, volatile oils, and other bioactive substances [305,306].

Equisetum arvense, a plant species from the Equisetaceae family, has been utilized in traditional medicine for its therapeutic properties. Its applications include the treatment of tuberculosis, renal and bladder catarrh, as well as a hemostatic agent to address excessive menstruation, nasal, pulmonary, and gastric bleeding, among others [307].

The water-alcohol extract of *Equisetum arvense* L. has demonstrated various biological activities including antioxidant [308], anti-inflammatory, antibacterial, and antimicrobial effects [309]. Studies have also reported its antiproliferative activity [310], as well as antifungal, vasodilating, hepatoprotective [311], neuro- and cardioprotective, cytotoxic, and anti-cellulite properties [312,313]. Additionally, *Equisetum arvense* L. has been traditionally used for its analgesic effects on rheumatism and frostbite, as well as its anti-inflammatory properties, which can improve blood circulation. This plant has been employed as a bath agent for skin diseases and incorporated into cosmetic products as a rejuvenating, moisturizing, anti-wrinkle, anti-acne, antiperspirant, and conditioning agent [314].

Equisetum arvense L. is recognized for its high content of silicon, a compound that is associated with promoting skin health. Silicon aids in maintaining skin firmness and elasticity, while its mild exfoliating properties help to eliminate dead skin cells and enhance skin texture [315,316]. The antioxidant potential of *Equisetum arvense L.* has been attributed to the presence of flavonoids such as quercetin, kaempferol, and isorhamnetin [317].

Humulus lupulus* L. Hemp family – *Cannabaceae

Humulus lupulus L., commonly known as hops, is a plant species that is widely distributed in temperate regions worldwide [318,319].

H. lupulus is a plant that contains a multitude of phytochemicals, with a high concentration found in the female inflorescences from which lupulin, a yellowish-brown granular powder, is obtained. Lupulin comprises bitter resins and essential oils, imparting the characteristic aroma and flavor of hops. The primary bitter acids found in hop resin are alpha acids (humulons) and beta acids (lupulones). The essential oils contain myrcene, linalool, and geraniol, which are the most important aromatic compounds. Additionally, lupulin contains polyphenols, such as kaempferol, quercetin, catechins, prenylnaringenin, hydroxycinnamic acid, and condensed tannins. Ferulic acid is the most representative compound in the phenolcarboxylic acid group. Hop seeds are rich in catechins (catechin, epicatechin), which are widely used in various industries, including pharmaceuticals, cosmetics, and nutraceuticals [318,320,321].

H. lupulus has a long history in traditional medicine, with records dating back to prehistoric times. It has been used to treat various ailments such as leprosy, toothache, fever, stomach issues, sleep disorders, and anxiety. Additionally, it has been utilized as a bowel function enhancer and to improve the pharmaceutical properties of certain drugs due to its antimicrobial and antifungal properties. Given the numerous health benefits of hop polyphenols, which include antioxidant and antimicrobial effects, they have the potential for therapeutic use [318,319].

Hop extract has been found to possess various pharmacological properties. For instance, it exhibits antitumor and anti-inflammatory effects, as evidenced by previous studies [322]. Moreover, the extract has been reported to possess antibacterial, anticollagenase, and antioxidant activity [323]. Additionally, hop extract has been found to possess antiallergic, antiviral, hepatoprotective, and antithrombogenic effects [320].

In dermatology, extracts of *H. lupulus* have been employed as an antipsoriatic medication [322]. Furthermore, they are used in the management of inflammatory skin disorders in adolescents, and hop cones are taken orally to address baldness, furunculosis, lichen, and scrofula [318,323].

Cichorium intybus* L. Aster family – *Asteraceae

Cichorium intybus L., a perennial herbaceous plant belonging to the Asteraceae family, is known by various common names such as roadside grass, blue flower, roadside cornflower, bride of the sun, and sun grass. Its recognizable feature is the inflorescences-baskets that exclusively comprise reed blue flowers. However, the said baskets only open during early morning hours or in cloudy weather. The term "chicory" is derived from the Latin word, meaning "entering the fields." Due to its therapeutic properties, this plant has earned the monikers "king root," "golden root," and "cure for a hundred diseases" [324].

C. intybus L. exhibits a wide geographical distribution encompassing Northern and Central Europe, Siberia, Turkey, Afghanistan, Northern and Central China, South America, South Africa, Ethiopia, Madagascar, India, Australia, and New Zealand. This herbaceous plant is capable of thriving throughout the territories of the Commonwealth of Independent States, with the exception of the Far North region [325].

The roots of *C. intybus* L. contain 56-65% inulin (in terms of dry matter), the maximum accumulation of which is observed in autumn. Intibin glycoside gives specific bitterness to chicory roots. Proteins, sugars, pectin, sesquiterpene lactones (germacranolides: lactucin, lactucopicrin and 8-deoxylactucin) were also found in the roots; guayanolides: cycriosides B and C, sonchuside C), tannins and resinous substances, choline, carotene, vitamins B, B2, PP and C, from mineral elements - sodium, potassium, calcium, manganese, phosphorus, iron. Chicory roots contain taraxasterol (1) (see above), phenolic acids (chlorogenic (6) (see above), isochlorogenic, neochlorogenic, caffeic and cicoric acids) [324,326]. In the flowers of Cichorium intybus L., chicory glycoside was found, in the seeds - inulin and protocatechin aldehyde [327,328], prebiotic fructooligosaccharides, sesquiterpene lactones, caffeic acid derivatives (chicory acid, chlorogenic acid, isochlorogenic acid, dicapheoyltartaric acid), proteins, hydroxycoumarins, flavonoids, alkaloids, steroids, terpenoids, oils, volatile compounds, vitamins [329,330]. Aliphatic compounds and their derivatives make up the main fraction; terpenoids are somewhat less common in the plant. Chicory leaves contain inulin, vitamins A, B1, B2 and C, macro- and microelements (Ca, K, Mg, Na, Fe, Cu, Mn, Zn), phenolic compounds and others [325].

The aerial and subterranean portions of *C. intybus* L. are extensively employed in traditional medicine, such as in Chinese and Mongolian practices, as an agent for modulating the immune system, promoting bile secretion, protecting the liver, and reducing blood glucose levels. The plant is documented in the Chinese Pharmacopoeia and is utilized in the formulation of homeopathic remedies in Germany. The extract of chicory herb is a constituent of the LIV-52 complex preparation from India [331].

Published literature indicates that *C. intybus* L. exhibits a diverse range of pharmacological activities, including antiseptic and astringent properties, choleretic and diuretic effects, and beneficial effects on the nervous and cardiovascular systems. Additionally, its infusion has been employed for normalizing heart rhythm. According to the literature, preparations derived from *C. intybus* L. are effective in treating a variety of conditions affecting the gallbladder, liver, kidneys, and urinary system. Additionally, chicory preparations have been shown to exhibit potential therapeutic benefits in managing obesity, liver diseases, atherosclerosis, hypoacid gastritis, tachycardia, arrhythmia, and nephritis. The milky juice of the plant contains bitter substances that have been found to stimulate peristalsis of the gastrointestinal tract, increase the secretion of gastric and intestinal juice, and promote regular bowel movements and appetite. According to published literature, *C. intybus* L. has been found to possess a notable therapeutic effect in managing diabetes mellitus and in preventing it (antidiabetic effect). This effect is attributed to the presence of inulin, a natural sugar substitute that eliminates toxins and non-nutrient substances from the body. Preparations based on *C. intybus* L. exhibit diverse pharmacological activities, including anti-inflammatory, antioxidant, antiviral, choleretic, diuretic, hepatoprotective, and antibacterial effects, making them beneficial in treating colitis, gastritis, and enteritis. Decoctions of *C. intybus* L. roots have been reported to be effective in the treatment of helminthic invasion, anemia, malaria, scurvy, eczema, and tumors of the spleen [325,327,332–337]. Furthermore, some research indicates that *C. intybus* L. may modulate immune responses [329]. Infusions of *C. intybus* L. flowers have been found to possess antiseptic, anti-

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inflammatory, moisturizing, and nourishing properties, which are beneficial in treating inflammation of the skin and eyes [331].

A decoction of *C. intybus* L. is commonly used topically (in the form of baths, applications, and lotions) for the management of various skin diseases, including but not limited to eczema, urticaria, psoriasis, seboroid dermatitis, neurodermatitis, atopic dermatitis, vitiligo, acne, and furunculosis. Additionally, the herb is recognized for its efficacy in the care of dry skin [325,331].

Bidens tripartita* L. Aster family – *Asteraceae

Bidens tripartita L. is widely distributed in the European part of the CIS, Transcaucasia, Siberia, Central Asia (excluding Turkmenistan), and the southern region of the Far East. Its range also extends to North Africa and North America [338]. In Kazakhstan, this species is ubiquitous across its regions.

B. tripartita L. is a plant that is rich in various biologically active compounds, including essential oil, chlorophylls, flavonoids, cinnamic acid derivatives, tannins with a high polyphenol fraction content, polysaccharides, carotenoids, ascorbic acid, coumarins, chalcones, and minerals such as Zn, Sr, Se, and Mn. Flavonoids found in the plant include luteolin (9), butein, sulphuretin, sulphurein, cynaroside, auron, (+)-catechin, (-)-epicatechin, rutin, myricetin, 7-hydroxyflavone, esculetin, and umbelliferone, among others. These compounds have been identified in the plant's grass and have been shown to possess various pharmacological properties [339–345].

In traditional medicine, water infusion and decoction of *B. tripartita* L. have been utilized for a considerable time period in combination with baths for the treatment of scrofula, rickets, exudative diathesis, and various pustular skin diseases such as acne and boils, as well as for the management of gout, arthritis, and articular rheumatism. They are also recommended for improving appetite and digestion, and for the treatment of liver and spleen disorders, colds, bronchitis, and diabetes mellitus [346,347]. Additionally, it is used as a diuretic, diaphoretic, and anti-inflammatory agent for urinary tract and kidney-related problems [339].

Preparations derived from *B. tripartita* L. exhibit a range of therapeutic effects, including anti-inflammatory, hemostatic, antiseptic, sedative, and wound-healing properties. Additionally, these preparations have been found to lower blood pressure and increase the amplitude of heart contractions [348,349]. The anti-allergic, anti-inflammatory, diuretic, and antispasmodic effects of the alcohol extract of *B. tripartita* L. have also been confirmed [350,351]. Furthermore, the herb's diethyl ether extract has been shown to possess antimicrobial and antifungal activity [339], which supports the herb's traditional use in treating skin diseases and mucocutaneous candidiasis caused by these microorganisms. The methanolic extract of *B. tripartita* L. exhibits antioxidant activity against cancer cells and has the ability to inhibit key enzymes, such as α-amylase and α-glucosidase. In addition, evidence suggests that the herb has antidiabetic activity, as well as antihyperglycemic and antioxidant effects [352].

The broad pharmacological effects of the series plant are attributed to its abundant content of various biologically active substances. Manganese ions in the plant's enzyme systems are believed to impact hematopoiesis, blood coagulation, endocrine gland activity, liver cell function, blood vessel and bile duct tone, and may prevent intravascular thrombus formation while enhancing the series' antimicrobial properties [348,349]. Flavonoids in the plant are responsible for its antiallergic and diuretic effects by affecting metabolic processes. Tannins, which possess pronounced antimicrobial properties, are thought to be responsible for the plant's antimicrobial and anti-inflammatory properties. The presence of vitamin C can activate the function of the endocrine glands, improve metabolism, strengthen the immune system, and help treat viral infections. The essential oils present in the plant are effective in destroying pathogenic microflora and fungi, while zinc may improve appetite and digestion [346,347].

The extract derived from the sequence plant has been employed in the treatment of numerous skin conditions, including psoriasis, seborrhea, urticaria, diathesis, acne, pimples, wounds, and ulcers, as well as small cracks. This plant's beneficial effects on the skin can be attributed to the presence of tannins, which can also aid in alleviating excessive sweating of the armpits and legs. Accordingly, the sequence is commonly used to prepare baths, lotions, and rubdowns for microbial eczema of the feet and epidermophytosis [342,346,347,353]. The mask derived from the sequence has

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been shown to eliminate oily sheen, tone the skin, and have a rejuvenating effect. Additionally, wiping the face with a decoction of the string has been demonstrated to reduce acne [348,349]. In cases of diathesis, the addition of a string infusion (from 10-30 g of grass) to a bath has been recommended [354].

The preparations derived from the tripartite series possess a range of pharmacological properties, including anti-inflammatory, sedative, desensitizing, and antibacterial effects. These preparations find applications in the treatment of various conditions, such as diathesis, gout, rickets, arthritis, acne, and boils. Though their use as a diuretic and diaphoretic is infrequent, the sequence has been experimentally found to lower blood pressure and slightly increase heart contraction amplitude. Furthermore, oil extracts from the herb are recommended for their tissue-regenerating effects on difficult-to-heal wounds. The sequence is also included in antiscrofulous collections [346,347].

Vaccinium myrtillus* L. Cowberry family – *Vacciniaceae

Vaccinium myrtillus L. is a plant species that is predominantly found in forested areas in Northern Europe and North America [355], as well as in Europe, Asia, and North America [356]. Its distribution in Kazakhstan is limited to the southwestern region of Altai, situated in Eastern Kazakhstan [357].

The fruits of *Vaccinium myrtillus* L. are a rich source of bioactive compounds such as phenolic acids (chlorogenic acid (6) being the most common), flavonoids (with isoquercetin being the predominant one), and resveratrol in the leaf extract [355,358]. In addition, they contain polyphenols, phenolic acids, and anthocyanins [359,360]. Moreover, they are a rich source of trace elements and other phytochemicals such as organic acids, sugars, vitamins, fibers, and phenolic compounds (both anthocyanins and non-anthocyanins), glycosides (arbutin and myrtilin), peryl alcohol, resins, triterpene alcohol, pyrocatechin and pyrogallic tannins, free hydroquinone, ascorbic acid, carotene, and organic acids (quinic, citric, lactic, malic, succinic, oxalic). They also contain retinol acetate, thiamine bromide, and pectin [361].

According to traditional medicinal practices, *Vaccinium myrtillus* L. flowers are utilized as ointments to treat a wide array of skin-related ailments, including but not limited to ulcers, eczema, burns, bruises, rashes, varicose veins, and acne [355]. Moreover, this plant has demonstrated blood glucose-lowering effects and has been shown to possess antioxidant, anti-inflammatory, and lipid-lowering properties, indicating its potential efficacy in treating chronic inflammatory conditions, including those linked to aging such as cancer and cardiovascular disease [362].

Blueberries are regarded as a valuable source of antioxidants, which have attributed to their utilization in managing numerous ailments (e.g., inflammation, cardiovascular disease, cancer, diabetes, and aging-related diseases) linked to augmented oxidative stress [355,359,360].

Blueberry leaves have been found to possess hypoglycemic effects, attributed to the presence of myrtilin glycoside which mimics insulin and regulates pancreatic function. However, prolonged use of the leaves is not recommended due to potential toxic effects of hydroquinone. Dried blueberries are known for their astringent properties while fresh blueberries are known to have carminative, anti-inflammatory, diuretic, hemostatic, antibiotic, and vitamin properties, and can regulate metabolism and digestive activity. In traditional medicine, blueberries have been used to treat various ailments such as bile duct and bladder stones, coughs, scurvy, and pulmonary tuberculosis. They have also been used to treat gastroenterocolitis and diarrhea, particularly in children. Due to their high content of vitamin C, blueberries have been used for the treatment of scurvy, and externally for stomatitis and pharyngitis, which are accompanied by oral cavity wounds and ulcers [363,364].

In traditional medicine, blueberry leaves have been utilized to treat a range of health conditions that are associated with oxidative stress, including skin conditions. The high antioxidant potential of blueberry seed oil, which contains chlorogenic acid, isoquercetin, and resveratrol, as well as α-linolenic, linoleic, and oleic acids, has been well established. Furthermore, a plant extract of isoquercetin has been found to have a dose-dependent inhibitory effect on edema caused by allergic contact dermatitis [355,365].

Chelidonium majus* L. Poppy family – *Papaveraceae

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Chelidonium majus L., a plant species commonly known as greater celandine, is widely distributed across Asia, North America, and northwestern Africa [366].

The plant *C. majus* is known to contain a high concentration of isoquinoline alkaloids, with levels ranging from 0.27-2.25% in the aerial parts and 3-4% in the root. Over 70 compounds have been identified, including various alkaloids (such as chelidonin, chelerythrin, sanguinarine, berberine, protopine, allocryptopine, and koptisin), flavonoids (such as rutin, quercetin, and kaempferol), saponins, vitamins (such as vitamin A and C), mineral elements, a small amount of phytosterols (such as α-spinasterol and ergosterol), and aromatic and aliphatic acids (including chelidonic, caffeic, ferulic, polycoumaric, citric, malic, succinic, gentisic, p-hydroxybenzoic, and nicotinic acids) and their derivatives. Additionally, celandine contains polysaccharides, alcohols (1-hexocosanol, chelidoniol, and nonacosanol), choline, tyramine, histamine, and saponosides. It should be noted that a previous study provided the formulas of all organic components [367]. The content of most mineral elements in celandine ranged from 10 to 65%, with potassium (65%) and phosphorus (54%) being the most abundant [368–370].

C. majus has a long history of traditional use in Europe, Asia and Africa for various ailments, including those affecting the liver and bile ducts, as well as for the treatment of skin conditions such as warts, calluses, and eczema. Additionally, the plant has been used to treat stomach ulcers, tuberculosis, skin rashes, and oral infections. In traditional Chinese medicine and homeopathy, *C. majus* is used to alleviate congestion, pain, swelling, and jaundice [366,371].

Celandine extracts have been found to possess a broad spectrum of pharmacological activities including anti-inflammatory, antimicrobial, anticancer, antioxidant, hepatoprotective, natriuretic, and antidiuretic effects, corroborating some of the traditional medicinal uses of *C. majus* Additionally, the plant has demonstrated immunomodulatory, lipid-lowering, and radioprotective properties [367,368,371,372]. Moreover, the ethanolic extract of *C. majus* has been found to contain biologically active secondary metabolites with significant inhibitory effects against Alzheimer's disease [366].

The use of the milky juice of the celandine herb in folk medicine and homeopathy to treat viral warts has been documented for many years. This juice is rich in alkaloids, with chelidonin being the predominant compound (23). Studies have demonstrated the antimicrobial, immunomodulatory, cytostatic, and cytotoxic effects of celandine alkaloids, including their activity against keratinocytes. Compounds such as chelidonine (23), sanguinarine (24), chelerythrine, coptisine, and protopin have been found to exhibit cytotoxic activity. Sanguinarine (24) has been shown to be particularly effective at inhibiting keratinocyte growth, suggesting that celandine may have potential as an additional therapy for malignant skin diseases [370].

Rosa sinnamotea* L. Rose family – *Rosaceae

Rose hips have considerable economic importance and are widespread garden plants across Europe, Asia, North America, and the Middle East. The distribution of wild roses in diverse regions of Kazakhstan exhibits heterogeneity. In particular, a greater range of species diversity has been observed in forest and forest-steppe zones [373]. There is a total of 21 distinct species of wild rose that grow in Kazakhstan, with five of them being present in Central Kazakhstan, including *R. glabrifolia, R. laxa* Retz., *R. Acicularis* Lindl., *R. majalis* Herrm. *(R. cinnamomea* L.*), and R. pimpinellifolia* L. *(R. spinosissima* L.*)* [374].

The fruits of *Rosa Canina* are highly valued by the food and pharmaceutical industries due to their rich composition of biologically and physiologically active compounds. These include a wide range of vitamins (C, B, P, PP, E, K), flavonoids, carotenes, carbohydrates (mono- and oligosaccharides), organic acids (tartaric, citric), polyunsaturated fatty acids, trace elements, and others [375,376]. The essential oil derived from rosehips is primarily composed of alcohols, monoterpenes, and sesquiterpenes [377]. Dog rose seeds are also a valuable source of crude oil, comprising approximately 15% of their total weight. To extract oil from the seeds, various methods are employed such as pressing, solvent extraction, ultrasonic, microwave, sub- and supercritical fluid extraction. Rosehip oil is considered particularly valuable due to its essential fatty acid content, tocopherols, phytosterols (β-sitosterol), and phenols, which contribute to its functional properties. The primary essential fatty acids present in rosehip oil are linoleic, linolenic, and oleic acids, while

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the γ-tocopherol isomer of tocols is the most abundant in the oil. Among the numerous health benefits of rosehip oil, its anti-cancer effects are particularly noteworthy. Additionally, the therapeutic effect of rosehip oil on skin diseases makes it a preferred ingredient in cosmetics [378].

Rose hips have a well-established history in traditional medicine as a preventative and treatment measure for colds and other infections, as well as a diuretic and therapy for various inflammatory disorders. In modern medical practice, dog rose (*Rosa Canina* L.) is incorporated into compositions and complexes for the treatment of inflammatory ailments, including but not limited to rheumatoid arthritis, reactive arthritis, osteoarthritis, and other types of arthritis. It is also utilized to combat upper respiratory tract infections, for the management of psoriasis, and to prevent oxidative stress in the oral cavity, among other applications [375].

The distinctive phytochemical composition of rose hips has garnered significant interest as a promising source for functional foods, natural medicines, and cosmo-nutraceuticals. In present times, rose hips are employed as a constituent in probiotic products [377].

The rose hip extract's antioxidant activity is predominantly attributable to its ascorbic acid and polyphenolic compounds. Moreover, the extract manifests antimutagenic and anticancer properties [376].

Rosa Canina L. finds common application in cosmetology, where it is frequently utilized in conjunction with other biologically active compounds or herbal extracts. However, there are instances where it is employed as a sole ingredient, such as in a French patent that employs an extract of dog rose as an active agent for combating seborrhea, along with a cosmetic skincare strategy aimed at mitigating excess sebum production and associated dermatological manifestations [375].

Orchis maculata* L. Orchid family – *Orchidaceae

Spotted orchis is indigenous to countries with a cold, temperate subtropical climate, particularly in Central and Southern Europe and Asia [379]. Its distribution within Kazakhstan is primarily concentrated in the East Kazakhstan region [380].

Spotted orchis comprises a mucilaginous substance that harbors a high molecular weight polysaccharide, which decomposes to manose; in addition to dextrin, starch, proteins, bitterness, pentoses, methylpentosans, sucrose, loroglossin glycoside, and essential oil [381–384]. Furthermore, the plant houses alkaloids, saponins, tannins, phenolic compounds (such as gallic acid, catechin, chlorogenic acid, and syringic acid), terpenes, sterols, flavonoids, and anthocyanins [385,386]. Orchis mascula flowers' ethanol extracts also encompass saponins, flavonoids, anthraquinone, terpenoids, tannins, cyanogenic glycosides, and cardiac glycosides [387]. These extracts exhibited a noteworthy antimicrobial effect against Salmonella paratyphi, Klebsiella oxytoca, or Staphylococcus aureus.

Orchis maculata L. contains anthocyanins and phenolic acids, which are potent antioxidants and have a nourishing impact. These compounds have the ability to inhibit collagenase, an enzyme that degrades collagen in the skin and hair. Catechin, for instance, acts on collagen and makes it resilient against the action of collagenase. Catechin also forms a complex with collagen, modifying its structure and making it resistant to enzyme degradation. Flavonoids, in general, contribute to scalp elasticity and nutrition, strengthen blood vessel walls, and enhance blood flow. Furthermore, polyphenols exhibit antimicrobial properties, which makes them a valuable ingredient in formulations used to treat mycoses [388]. The spotted orchis extract has been demonstrated to possess anti-inflammatory, antispasmodic, diuretic, enveloping, and immunomodulatory effects, as outlined in [381]. The enveloping effect can be attributed to the presence of loroglossin (25), a glycoside that protects inflamed tissues from excessive irritation [389].

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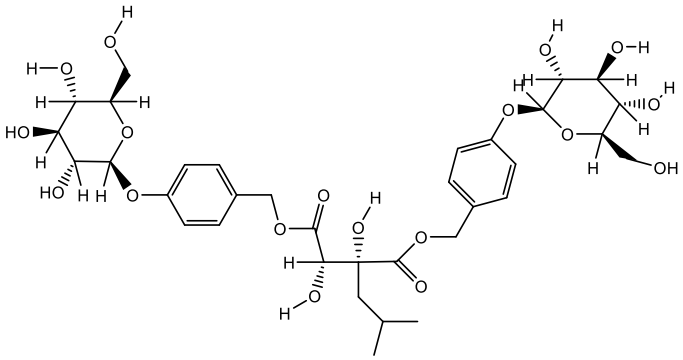


(25)

In dermatology, the oral use of *Orchis maculata* L. extract is prevalent in folk medicine for senile itching, skin tuberculosis, and other dermatoses accompanied by cachexia and chronic diseases of the respiratory and gastrointestinal tracts. The extract is also employed for the speedy healing of wounds and ulcers [382]. Additionally, cosmetic skincare products containing the extract and produced on an industrial scale are available [383].

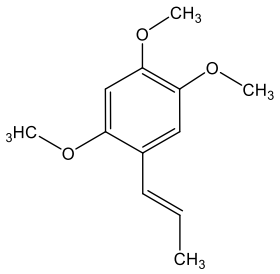
Acorus calamus* L. Aroid family – *Araseae

Calamus marsh is a perennial plant containing aromatic compounds and is widespread in Central Asia, India, and the Himalayas. Although its distribution has significantly decreased in Europe, it remains a common plant in the northern marshy regions with a temperate climate [390]. It is found in Asia, Europe, and North America and is known to grow in Central Kazakhstan along the banks of rivers, swamps, and lakes, sometimes forming substantial thickets.

Calamus marsh is rich in various chemical compounds, including bitter glycoside acorin, essential oil (which contains proazulene), gum, resins, ascorbic acid, tannins, starch, and mucus. The dried rhizome of Calamus marsh contains yellow aromatic volatile oils comprising of small amounts of sesquiterpenes and their alcohols; choline, flavone, acoradin, galangin, acolamon, and isocolamon. Furthermore, it contains cineol, limonene, terpineol, azulene, eugenol, camphene, cadinene, ethanol, galangin, magnesium, zinc, tannin, terpenes, menthol, and camphor [391].

Calamus root is recognized in traditional medicine as a therapeutic agent for a range of ailments, such as arthritis, neuralgia, diarrhea, dyspepsia, and hair loss [390,392].

The plant has been found to possess potent antioxidant, anti-inflammatory, antiulcer, antimicrobial, and wound healing properties. It is employed in dermatology for the treatment of pyoderma, acne vulgaris, alopecia, and eczema [393–395]. The advantageous effect on the skin can be attributed to the presence of β-azarone (26), a phenylpropanoid class chemical compound:



(26)

β-Azaron is known to play a role in the body's natural defense against ultraviolet rays, but it has also been found to have carcinogenic properties and induce liver tumors. Calamus marsh, which contains varying amounts of β-azarone depending on the variety, has been traditionally used in Asian medicine for its anti-inflammatory properties, which can help alleviate skin itching, swelling, and redness. Meanwhile, European varieties of Calamus marsh are known to contain sesquiterpenoids, which possess psychoactive properties and display beneficial medicinal effects [396–398].

3. Conclusions

In our work, we conducted a literature search, which allowed us to conclude that the medicinal plants of the Flora of the Republic of Kazakhstan are rich in medicinal plants, which are widely used in medicine to create dosage forms and preparations. Most of these plants have a complex of biologically active substances that give them high biological activity. Many plants are essential for the treatment of a wide range of ailments, including skin conditions, and can be used as natural alternative medicines. In general, our results confirm the importance and value of medicinal plants of the flora of Kazakhstan for scientific and medical research.

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