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An Evidence-Based Review on Wound Healing Herbal Remedies From Reports of Traditional Persian Medicine

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Abstract

Research on wound healing agents is a developing area in biomedical sciences. Traditional Persian medicine is one of holistic systems of medicine providing valuable information on natural remedies. To collect the evidences for wound-healing medicaments from traditional Persian medicine sources, 5 main pharmaceutical manuscripts in addition to related contemporary reports from Scopus, PubMed, and ScienceDirect were studied. The underlying mechanisms were also saved and discussed. Totally, 65 herbs used in traditional Persian medicine for their wound healing properties was identified. Related anti-inflammatory, antioxidant, antimicrobial, and wound-healing activities of those remedies were studied. Forty remedies had at least one of those properties and 10 of the filtered plants possessed all effects. The medicinal plants used in wound healing treatment in traditional Persian medicine could be a good topic for further in vivo and clinical research. This might lead to development of effective products for wound treatment.

Keywords

medicinal plants, Persian medicine, wound healing

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Research on wound healing agents is a developing area in biomedical sciences. Skin wounds affect the quality of life of the patients significantly[1] and are considered as one of major causes of physical disabilities. At the moment the available treatments are suboptimal. Skin wounds are defined as any interruption of the continuity of body surface.[2] They can be result of many conditions such as burns, surgeries, trauma, and arterial disease. It can either be a chronic or acute condition. A wound is called chronic when it requires a prolonged time to heal or does not heal. Given the wide range of their causes, their accurate incidence and impact are difficult to be calculated. Chronic wounds are often progressive and resistant to treatments.[2]

Wound healing is a complex process, which includes coordination between diverse immunological and biological systems.[3] In the past 20 years, our knowledge on wound healing process has improved.[4] Normally in an acute wound the process of healing is predictable. It includes the initial inflammation, deposition of collagen and fibroblast, formation of new blood vessels or angiogenesis, contraction of the wound area, and scar remodeling.[3] The inflammatory process has direct effects on wound healing. Lipid mediators of inflammation involving wound healing are transforming growth factor–β and prostaglandin E2.[5] Collagen is the major component that supports the extracellular tissue in wound healing process.[6] Research has shown that NO (nitric oxide) has a positive effect on wound healing by accelerating fibroblast migration and collagen deposition in wound tissue.[7] Promotion of antioxidant defense proteins such as heme oxygenase-I and keratinocyte growth factor could have a positive effect on wound healing by protecting the regenerating tissue against oxidant damage.[8]

In chronic wounds, the repair process has been disrupted by conditions such as infection or low immunity.[3] Such wounds enter a state of inflammation if the microbial clearance is incomplete. Bacteria and endotoxins can lead to pro-inflammatory cytokines elevation (interleukin-1 and tumor necrosis factor–α) if this process continues, the wound may fail to heal.[9]

This chronic state is a challenging clinical condition which affects 6 million patients annually. Today there are a variety of treatment options for chronic wounds and many of them are ineffective. There is increasing number of products in this area

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at considerably high costs.[2] Various herbal constituents have proven wound-healing properties. As an example, tannins could promote wound healing through free radical removal, increasing the contraction of the affected area and increasing the formation of blood vessels and fibroblasts. Other active principles such as triterpenes, alkaloids, and flavonoids have proven to be effective in this process.[10]

Traditional systems of medicine provide valuable information on natural remedies. They have played a significant role in discovering novel drug leads.[11] Today, traditional and alternative remedies are used to treat many chronic conditions in developed countries. This could be due to the lack of effective modern remedies for chronic conditions. Traditional systems of medicine usually have a holistic approach and provide us with many remedies for various chronic medical conditions. These systems of medicine provide remedies for treating wounds as well. Over the past few decades, we have observed increasing interest in researches based on traditional medicines of the world.[12] Researchers are hoping to find new drug leads hidden in the formulations of traditional systems of medicine. Traditional Persian medicine has a rich background of practice from the ancient Persia until today.[13] The ingredients used in this system of medicine as wound remedies could be an interesting subject for further research.

Materials and Methods

To collect the data from medicinal medieval texts, 5 main pharmaceutical manuscripts of Persian medicine were studied for plants used in wound healing. The studied books include: *Kitāb al-ḥāwī fī al-ṭibb* (*The Comprehensive Book on Medicine*) by Rhazes (9th-10th centuries), *Canon of Medicine* by Avicenna (10th-11th century), *Ikhtiyārāt-i Badī'ī* (*Selections for Badī'ī*) by *Hājjī Zayn al-'Aṭṭār* (14th century), *Tuhfat al-mu'minīn* (*Present for the Faithful*) by *Daylamī Tunakābunī* (17th century), and *Makhzan al-adviyah* (*The Storehouse of Medicaments*) by *Alavī Shīrāzī* (18th century).[14-18] The plants used in wound healing according to Persian manuscripts are listed in Table 1. Authentications of the plants were confirmed according to botanical textbooks such as *Dictionary of Medicinal Plants*, *Matching the Old Medicinal Plant Names With Scientific Terminology*, *Indian Medicinal Plants*, and *Dictionary of Iranian Plant Names*.[19-21]

Databases such as PubMed and ScienceDirect were searched for mechanisms or pharmacological activities of reported medicinal plants in the field of wounds healing and discussed. Thus, each herb was searched along with keywords, ''wound healing,'' ''antimicrobial,'' ''antioxidant or radical scavenging,'' and ''anti-inflammatory.'' From numerous articles, the current work tried to cite latest publications with regard to each reported plant.

Results

In the 5 traditional books that we searched, a total number of 65 herbs that were used in traditional Persian medicine for their wound-healing properties could be identified (Table 1). From this number, 40 herbs had at least 1 of the searched mechanisms of action or pharmacological functions. These 40 herbs belong to 34 families (Table 2). Although the familial distribution is sporadic but Apiaceae and Lamiaceae have the highest share of 3 herbs each among the plant families found. We introduced 10 herbs derived from traditional Persian medicine whose wound-healing properties have been proven by modern medicine. In the next step, we highlighted the herbs that had the 3 searched mechanisms of action related to the wound-healing process. In this regard, we found 9 herbs whose wound-healing properties have been shown by modern research, with their antioxidant, antimicrobial, and anti-inflammatory properties could be attributed to the underlying mechanism of action. There were also 9 herbs that were studied for the 3 mechanisms of action related to wound healing and showed positive effect but their wound-healing properties have not been studied yet.

Discussion and Conclusion

Despite of the new advances in the field of medicine there are conditions such as chronic wounds, which have high incidence and economic burden but their management is far from effective. As a result, there is urgent need of novel therapies for these conditions.[22] Today, researchers are interested to study traditional systems of medicine to find remedies for the current medical issues. One of these systems is traditional Persian medicine, which is still being practiced in Iran. To investigate the herbs that have the potential of further clinical research, we reviewed traditional Persian texts and compared them with the modern published work in this area.

The 9 plants that were considered as wound remedies by traditional Persian medicine and had positive effect on wound healing in the modern research were *Cocos nucifera* L, *Commiphora mukul* (Hook ex Stocks) Engl, *Gentiana lutea* L, *Teucrium polium* L, *Punica granatum* L *Plantago major* L, *Adiantum capillus-veneris* L, *Aloe vera* (L) Burm f and *Potentilla reptans* L. These 9 herbs also have been studied for the 3 mechanisms of actions related to wound healing, which we searched. All these herbs showed antioxidant properties in the modern research. Antioxidants have a positive effect on wound healing by protecting the regenerating tissue.[8] *Aristolochia rotunda* L was another plant used in traditional Persian medicine for its wound-healing properties. It did not have proven antioxidant, antimicrobial, and anti-inflammatory properties but is studied for its positive effect on wound-healing process. Its collagenase activity was demonstrated by collagen zymography and atomic force microscopy studies.[23]

The fruit of *Cocos nucifera* L has been shown to have positive effect on wound-healing process when its effect on epithelium cell thickening was observed by Zakaria et al[24] in an animal study. In this study, fresh juice and aqueous extract of the plant were used and the length, color, and inflammatory aspects of the area around the wound were also examined. In another study, methanol extract of the fruit had antibacterial effect against *Staphylococcus* spp.[25] Today, we know the implication of these microorganisms in delayed wound healing.[26]

The exudate of *Commiphora mukul* (Hook ex Stocks) Engl was mentioned in traditional Persian medicine books as an effective treatment for different types of wounds. In a clinical study, a mouthwash prepared form the exudate of this plant was

Table 1. Topical Remedies for Different Wounds From Reports of Traditional Persian Medicine.

Family	Scientific Name	Traditional Name	Part Used
Amaranthaceae	*Beta vulgaris* L	*Selgh*	Root
Amaryllidaceae	*Allium porrum* L	*Koras*	Leaf
Anacardiaceae	*Rhus coriaria* L	*Somagh*	Fruit
Apiaceae	*Opopanax chironium* WDJ Koch	*Javsheir*	Aerial part
	Prangos ferulacea (L) Lindl	*Jaavosheir*	Aerial part
	Coriandrum sativum L	*Kozbore*	Leaf, Seed
Araceae	*Arisarum vulgare* O Targ Tozz	*Loaf*	Leaf, Seed
Arecaceae	*Phoenix dactylifera* L	*Tamr*	Fruit
	Cocos nucifera L	*Nargil*	Fruit
Aristolochiaceae	*Aristolochia rotunda* L	*Zaravand*	Root
Asparagaceae	*Ornithogalum narbonense* L	*Ashraas*	Seed
Asteraceae	*Carlina gummifera* (L) Less	*Eshkheis*	Leaf
	Arctium tomentosum Mill	*Argheitoun*	Leaf
	Tanacetum parthenium (L) Sch Bip	*Oghhovan*	Aerial part
	Heracleum persicum Desf ex Fischer	*Safeidoulion*	Flower
Boraginaceae	*Arnebia afghanica* (Kitam) Rech f and Riedl	*Abokhalsa*	Flower
Brassicaceae	*Raphanus sativus* L	*Fojl*	Leaf, Seed
Burseraceae	*Boswellia sacra* Flueck	*Kondor*	Exudate
	Commiphora mukul (Hook ex Stocks) Engl	*Maghal*	Exudate
Convolvulaceae	*Ipomoea nil* (L) Roth	*Habb-ol-nil*	Seed
Crassulaceae	*Sempervivum tectorum* L	*Abroan*	Flower
Cupressaceae	*Juniperus sabina* L	*Abhol*	Fruit, Leaf
Fabaceae	*Lupinus aberrans* C P Sm	*Termes*	Seed
	Calicotome spinosa (L) Link	*Darshishaan*	Fruit
	Senna alexandrina Mill	*Sana maki*	Leaf
	Vicia ervilia (L) Willd	*Karasne*	Leaf, Seed
	Lablab purpureus (L) Sweet	*Lablab*	Leaf
	Baptisia tinctoria (L) Vent	*Neil*	Leaf
	Lathyrus aphaca L	*Banghe*	Seed
Fagaceae	*Quercus ilex* L	*Baloot*	Fruit, Leaf
	Quercus lusitanica Lam	*Afs*	Fruit
Gentianaceae	*Gentiana lutea* L	*Jentiana*	Leaf, Root
Iridaceae	*Crocus sativus* L	*Zaferan*	Flower
Juglandaceae	*Juglans regia* L	*Jowz*	Seed (Juice)
Lamiaceae	*Teucrium polium* L	*Joode*	Aerial part
	Teucrium chamaedrys L	*Komazairoos*	Aerial part
	Ajuga chamaepitys (L) Schreb	*Komafeytoos*	Flower, Leaf
Lauraceae	*Cinnamomum camphora* (L) J Presl	*Kafour*	Leaf
Liliaceae	*Lilium candidum* L	*Soosan*	Root
Loranthaceae	*Loranthus europaeus* Jacq	*Debgh*	Seed
Lythraceae	*Punica granatum* L	*Romman*	Fruit
Moraceae	*Morus alba* L	*Toot*	Fruit
Oxalidaceae	*Oxalis acetosella* L	*Hammaz*	Leaf, Root
Pinaceae	*Pinus albicaulis* Engelm	*Sanoubar*	Leaf
Plantaginaceae	*Plantago major* L	*Lesan-ol-hamal*	Leaf, Flower
Polygonaceae	*Polygonum aviculare* L	*Asioraie*	Leaf
Potamogetonaceae	Potamogeton natans L	*Jaronahr*	Leaf
Primulaceae	*Anagallis arvensis* L	*Anaghalis*	Leaf
Pteridaceae	*Adiantum capillus-veneris* L	*Barsiavashan*	Aerial part
Ranunculaceae	*Thalictrum acutifolium* (Hand-Mazz) B Boivin	*Piaranga*	Root
	Aconitum ferox Wall ex Ser	*Beesh*	Root
	Ranunculus arvensis L	*Kafolhar*	Leaf, Flower
Rhamnaceae	Ziziphus jujuba Mill	*Onnab*	Leaf
Rosaceae	*Potentilla reptans* L	*Bentaafalon*	Leaf
Salicaceae	*Salix babylonica* L	*Gharab*	Leaf, Flower
Smilacaceae	*Smilax china* L	*Choob-e-chini*	Leaf, Root
	Smilax glauca Walter	*Oshbe maghrebie*	Leaf, Flower
Solanaceae	*Lycium afrum* L	*Osaj*	Root

(continued)

Table 1. (continued)

Family	Scientific Name	Traditional Name	Part Used
	Nicotiana tabacum L	*Tanbako*	Leaf
	Physalis alkekengi L	*Kakanj*	Fruit
	Solanum americanum Mill	*Enab-ol-saalab*	Leaf, Fruit
Verbenaceae	*Verbena supina* L	*Ayaranootani*	Leaf
	Verbena officinalis L	*Alhamam*	Leaf
Xanthorrhoeaceae	*Asphodelus ramosus* L	*Khonsa*	Root
	Aloe vera (L.) Burm f	*Sebr*	Leaf exudate

Table 2. Related Pharmacological Activities of Remedies Filtered From Traditional Persian Medicine Manuscripts.

Scientific Name	Assay(s) and Outcomes (Fraction or Extract)
Adiantum capillus-veneris	– AO: DPPH (crude flavonoids extract)[48] – AM: *Candida*, Trichoderma, *Aspergillus* spp (methanol and ethanol extract)[42] – AI: Inhibiting the NF-κB activation (ethanol extract)[49] – WH: Angiogenic effects (aqueous fraction of methanol extract)[41]
Ajuga chamaepitys	– AO: DPPH, NBT, OH, and chelating (chloroform and methanol extracts)[50] – AM: *Pseudomonas* spp. (methanol extract)[50]
Allium porrum	– AO: DPPH (ultrasonic and ethanol extracts)[51] – AM (weak activity): multiresistant *Staphylococcus* spp. (leaf ether extract)[52]
Aloe vera	– AO: DPPH, ABTS (lyophilized powder)[53] – AM: *Trichophyton*, *Aspergillus* spp. (ethanol, acetone extracts)[45,54] – AI: Downregulation of MMP-9 in blood cells (aqueous extract)[55] – WH: Accelerating the burn healing time and epithelialization (gel topical application)[44]
Arisarum vulgare	– AO: ABTS and DPPH (methanol water and subfractions)[56]
Aristolochia rotunda	– WH: gelatinolytic, collagenase and protease inhibitory potencies (aristolochic acid, protein fraction)[23]
Beta vulgaris	– AO: Thiocyanate and DPPH (methanol extract)[57] – AI: carrageenan-induced rat paw edema method (ethanol extract)[58]
Boswellia sacra	– AO: DPPH (methanol apolar subfractions)[59] – AM: *Staphylococcus* spp. (essential oil and methanol extracts)[60] – AI: Lipoxygenase inhibitor (terpenoids of resin, acetyl-11-keto-β-boswellic acid)[61]
Cinnamomum camphora	– AO: NO and LP (methanol water extract)[62] – AM: *Staphylococcus* spp. (essential oil)[63] – AI: Modulation of cytokines, NO and PG-E_2 production (ethyl acetate fraction of 80% methanol extract)[62]
Cocos nucifera	– AO: DPPH, FRAP, and deoxyribose (methanol extract)[25] – AM: *Staphylococcus* spp (methanol extract)[25] – AI: Formalin-caused paw thickness edema (fresh juice and aqueous extract)[24] – WH: The epithelium cell thickening observed (fresh juice and aqueous extract)[24]
Commiphora mukul	– AO: Thiocyanate (ethyl acetate extract)[64] – AM: Gram-positive and -negative (essential oil, chloroform extract, and 7 sesquiterpenes[65] – AI: (steroidal fraction: guggulsterone Z)[66] – WH: Promote healing in less than 2 weeks (myrrh suspension)[27]
Coriandrum sativum	– AO: DPPH, OH, and LP inhibition (essential oil)[67] – AM: *Streptococcus* spp. (essential oil)[68]
Crocus sativus	– AO: DPPH, ABTS (crocin and kaempferol)[69] – AM: *Streptococcus* spp. (methanol stigma extract)[70]
Gentiana lutea	– AO: DPPH, MPO inhibition (water and ethanol aqueous)[71] – AM: Gram-positive and -negative (methanol extract, mangiferin, isogentisin and gentiopicrin)[31] – AI: inflammation-induced rats and mice (ethanol and petrol-ether extract)[30] – WH: 300 and 500 mg/kg (ethanol and petrol-ether extract)[30]
Heracleum persicum	– AO: LP (ethyl acetate extract, furanocoumarins)[72] – AM: *Bacillus anthracis* (essential oil)[73] – AI: carrageenan-induced rat paw edema (essential oil and hydroalcoholic extract)[74]
Juniperus sabina	– AO: TBARS and ABAP (essential oils)[75] – AM: weak activity on *Staphylococcus* spp., *Candida* and *Bacillus subtilis* (essential oil)[76]
Lathyrus aphaca	– AO: DPPH, ABTS (methanol and buffer extracts)[77]
Lilium candidum	– AO: DPPH (methanol extract)[78]
Loranthus europaeus	– AO: DPPH, FRAP (ethyl acetate and methanol extracts)[79]

(continued)

Table 2. (continued)

Scientific Name	Assay(s) and Outcomes (Fraction or Extract)
Morus alba	– AO: reduction in lipid peroxidation product in animal model (freeze-dried powder)[80] – AI: carrageenan-induced model of inflammation (mulberroside A and oxyresveratrol)[81]
Ornithogalum narbonense	– AO: DPPH, ABTS, FRAP, and CUPRAC (ethyl acetate, methanol, and water)[82]
Oxalis acetosella	– AO: DPPH (methanol extract)[83]
Phoenix dactylifera	– AO: TEAC, ABTS, FRAP (methanol water extract)[84] – AM: *Bacillus subtilis*, *Staphylococcus* (water and ethanol extracts)[85]
Physalis alkekengi	– AO: DPPH, OH, NBT (polysaccharides from hot water extract)[86] – AM: Gram-positive (methanol extract and physalin D)[87] – AI: inhibition of MMP-9 and AP-1 activation (methanol extract)[88]
Plantago major	– AO: DPPH (methanol extract)[48] – AM: *Staphylococcus aureus* (aqueous extract)[39] – AI: COX-2 mRNA expression inhibitor (acteoside and geniposidic acid)[40] – WH: ex vivo porcine wound-healing model (freeze-dried ethanol-based extracts)[38]
Polygonum aviculare	– AO: DPPH, LP, NBT (lyophilized ethanol extract)[89] – AM: *Staphylococcus aureus*, *Bacillus subtilis* (chloroform extract)[90] – AI: inhibition of elastase release, in vitro (flavonol and isorhamnetin glucuronides)[91]
Potentilla reptans	– AO: DPPH (aqueous extract)[46] – AM: *Pseudomonas aeruginosa* and *Escherichia coli* (ethanol root extract)[53] – AI: phenol-in-acetone induced mice ear edema (rhizome aqueous extract)[46] – WH: Indirect by inhibition of wound pathogens growth (75% ethanol extract)[47]
Prangos ferulacea	– AO: DPPH and LP inhibition (methanol extract)[92] – AM: *Staphylococcus* spp, *Pseudomonas* spp (essential oil)[93]
Punica granatum	– AO: DPPH, ABTS (polysaccharide fraction)[94] – AM: *Staphylococcus* spp (tannin-rich fractions, ellagitannins, phenolic acids)[37] – AI: carrageenan-induced mice paw edema, NO inhibition (peel and fruit extracts)[36] – WH: In alloxan-induced diabetic rats by collagen regeneration (peel polyphenol gel)[35]
Quercus ilex	– AI: topical effect (isolated flavonoids)[95]
Ranunculus arvensis	– AO: DPPH, OH, phosphomolybdenum (methanol extract: Rutin)[96] – AM: Moderate effect on *Staphylococcus* spp, *Candida* (essential oil)[97]
Raphanus sativus	– AO: OH, NO, DPPH (methanol extract)[98] – AM: Gram-positive and -negative (seed methanol extract) and *Staphylococcus* spp, *Bacillus subtilis* (*n*-hexane and ethyl acetate fractions of ethanol extract)[99] – AI: lipopolysaccharide-stimulated murine microglia cells (phenylpropanoid sucrosides)[100]
Rhus coriaria	– AO: DPPH and DMPD (water and ethanol extracts)[101] – AM: *Staphylococcus epidermidis* (hydroalcoholic extract)[102]
Sempervivum tectorum	– AO: ultraviolet-irradiated liposomal system (kaempferol, kaempferol-3-glucoside)[103] – AM: *Staphylococcus aureus* (polyphenols)[104]
Smilax china	– AO: DPPH, ABTS, RP (methanol, ethanol, acetone, and water)[105] – AM: *Staphylococcus aureus* (ethanol extract)[105] – AI: egg albumin–induced edema in mice (aqueous extract)[106]
Tanacetum parthenium	– AO: DPPH, Fe^{2+}-chelating ability (ethanol: phenolic compounds)[107] – AM: (antifungal), (essential oil: camphor, chrysanthenyl acetate, and camphene)[108] – AI: cyclo-oxygenase and 5-lipoxygenase inhibitors (flavonoids)[109]
Teucrium chamaedrys	– AO: DPPH (water, methanol, and acetone extracts)[110] – AM: *Staphylococcus aureus*, *Candida albicans* (ethanol extract)[111]
Teucrium polium	– AO: β-carotene/linoleic acid, thiocyanate, DPPH (methanol extract: flavonoids)[112] – AM: *Bacillus anthracis* (ethanol extract), *Bordetella bronchiseptica* (methanol extract)[35] – AI: Carrageenan-induced inflammation and cotton-pellet granuloma (ethanol extract)[33] – WH: Accelerating the burn wound healing (*Teucrium* 2% topical application)[32]
Verbena officinalis	– AO: DPPH (methanol extract, caffeoyl derivatives)[113] – AM: antifungal (50% methanol extract, caffeoyl derivatives)[113]
Ziziphus jujuba	– AO: DPPH, FRAP (methanol extract)[114] – AM: *Streptococcus pyogenes* (ethanol extract)[115] – AI: Attenuation of nitric oxide expression, in vivo (hydroalcoholic extract)[116]

Abbreviations: ABTS, 2,2′-azino-bis-3-ethylbenzthiazoline-6-sulfonic acid; AO, antioxidant; AI, anti-inflammatory; AM, antimicrobial; CUPRAC, cupric ions reduction capacity; DMPD, *N*,*N*-dimethyl-*p*-phenylenediamine; DPPH, 2,2-diphenyl-1-picrylhydrazyl; FRAP, ferric-reducing antioxidant power; LP, lipid peroxidation; NBT, nitroblue tetrazolium chloride; NF-κB, nuclear factor-κB; NO, nitric oxide; TEAC, Trolox equivalent antioxidant capacity; WH, wound healing.

found to be effective in the treatment of intra-oral mucosal wounds.[27] Its anti-inflammatory properties have been related to COX_1 inhibition.[28] Essential oil of this oleo-gum-resin has antimicrobial effect against a range of Gram-positive and -negative bacteria.[29]

Gentiana lutea L was studied for its anti-inflammatory and wound healing properties by Mathew et al.[30] This was an animal study on ethanol and petrol-ether extract of the rhizomes. They were effective on reducing the inflammation and excision, resutured incision, and dead space wound models when animals were fed 500 and 1000 mg/kg doses and 300 and 500 mg/kg, respectively.[30] Its Methanol extract of flowers and leaves, as well as separated mangiferin, isogentisin, and gentiopicrin show antimicrobial activity against Gram-positive and -negative bacteria as well as the yeast *Candida albicans*.[31]

In one study, the topical application of *Teucrium polium* L extract accelerated healing of burn wounds.[32] Inhibition of carrageenan-induced inflammation in an animal study showed the anti-inflammatory effect of this plant.[33] Its ethanol and ethanol extracts have been shown to be effective on veterinary pathogens.[34]

The polyphenols from peels of *Punica granatum* L were shown to increase fibroblast infiltration, collagen regeneration, vascularization, and epithelialization in the wound area of diabetic rats. This has been related to increasing hydroxyproline, nitric oxide production, and activity as well as elevation of transformin growth factor–β1, vascular endothelial growth factor, and epidermal growth factor in wound tissues.[35] Its peel and fruit extract have shown anti-inflammatory effect by inhibiting the expression of pro-inflammatory proteins.[36] The tannin-rich fractions, ellagitannins, phenolic acids are effective against *Staphylococcus* spp.[37]

In an ex vivo porcine wound-healing model, wound-healing property of leaf extract of *Plantago major* L was confirmed.[38] Its aqueous extract was also shown to have antimicrobial property against *Staphylococcus aureus*.[39] Its methanol extract has inhibitory effects on lipopolysaccharide-induced interleukin-1β, interleukin-6, and COX-2 mRNA expression in mouse macrophage cells.[40]

Ethanol extract of *Adiantum capillus-veneris* L was tested in vitro and it showed capillary-like tubular formations and proliferation of endothelial cells in vitro.[41] Its aqueous extract has angiogenic effects.[41] Aqueous, methanol, and ethanol extracts of this plant showed significant antibacterial and antifungal activities against most of the multidrug-resistant bacterial and fungal strains.[42]

Hydro-alcoholic extract of *Aloe vera* (L) Burm f leafs decrease burn healing time.[43] The gel increases wound contraction, epithelialization, alignment, and organization of the regenerated scar tissue. It also decreases scar tissue size when compared with a control group.[44] It also exerts antimicrobial and antifungal properties.[45]

Rhizome aqueous extract of *Potentilla reptans* L showed anti-inflammatory effects in an animal study.[46] Its antibacterial effect on *Pseudomonas aeruginosa* and *Escherichia coli*, which have been proven in modern research, suggests that it may be effective for treating wound infections.[47]

We found 9 other plants that had wound-healing properties according to traditional Persian medicine and have been studied for their antimicrobial, antioxidant or radical scavenging, and anti-inflammatory effects but have not been studied for their wound-healing property by modern research. They include *Boswellia sacra* Flueck, *Cinnamomum camphora* (L) J Presl, *Heracleum persicum* Desf ex Fischer, *Physalis alkekengi* L, *Polygonum aviculare* L, *Raphanus sativus* L, *Smilax china* L, *Tanacetum parthenium* (L) Sch Bip, and *Ziziphus jujuba* Mill.

The use of traditional medicinal information has contributed to drug discovery worldwide. Currently, the available wound-healing remedies are suboptimal, but using traditional medical knowledge in this area might provide a good direction for future medical and pharmaceutical research. It is best to work on the remedies that have a traditional base and modern studies have revealed their underlying mechanisms of action. In this work, we revealed the herbal remedies for wound healing in traditional Persian medicine and reviewed their possible mechanisms of action.

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Author Contributions

AH and MMZ defined the study theme and designed the issues. ER and MF studied the medieval manuscripts and collected the data. MMZ and AH analyzed the data and interpreted the results. AH wrote the draft of the article. All authors have reviewed and confirmed the final draft.

Declaration of Conflicting Interests

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Ethical Approval

Since this work was a review article, no ethical approval was needed.

References

1. Kumar B, Vijayakumar M, Govindarajan R, Pushpangadan P. Ethnopharmacological approaches to wound healing—exploring medicinal plants of India. *J Ethnopharmacol*. 2007;114:103-113.
2. Kranke P, Bennett MH, Martyn-St James M, Schnabel A, Debus SE. *Hyperbaric Oxygen Therapy for Chronic Wounds*. The Cochrane Library; 2012.
3. Dat AD, Poon F, Pham KB, Doust J. *Aloe Vera for Treating Acute and Chronic Wounds*. The Cochrane Library; 2012.
4. McAnulty RJ. Fibroblasts and myofibroblasts: their source, function and role in disease. *Int J Biochem Cell Biol*. 2007;39:666-671.
5. Su S, Hua Y, Wang Y, et al. Evaluation of the anti-inflammatory and analgesic properties of individual and combined extracts from

Commiphora myrrha and *Boswellia carterii*. *J Ethnopharmacol*. 2012;139:649-656.
6. Doillon CJ, Silver FH. Collagen-based wound dressing: effects of hyaluronic acid and firponectin on wound healing. *Biomaterials*. 1986;7:3-8.
7. Schäffer MR, Tantry U, Gross SS, Wasserkrug HL, Barbul A. Nitric oxide regulates wound healing. *J Surg Res*. 1996;63: 237-240.
8. Sen CK, Khanna S, Gordillo G, Bagchi D, Bagchi M, Roy S. Oxygen, oxidants, and antioxidants in wound healing. *Ann N Y Acad Sci*. 2002;957:239-249.
9. Guo S, DiPietro LA. Factors affecting wound healing. *J Dent Res*. 2010;89:219-229.
10. Pawar RS, Toppo FA. Plants that heal wounds. A review. *Herba Pol*. 2012;58:47-65.
11. Cragg GM, Newman DJ. Natural products: a continuing source of novel drug leads. *Biochim Biophys Acta*. 2013;1830:3670-3695.
12. Medina-Franco JL, Giulianotti MA, Welmaker GS, Houghten RA. Shifting from the single to the multitarget paradigm in drug discovery. *Drug Discov Today*. 2013;18:495-501.
13. Elgood C. *A Medical History of Persia and the Eastern Caliphate*. Cambridge, England: Cambridge University Press; 2010.
14. Rhazes. *Kitāb al-hāwī fī al-Tibb* (The Comprehensive Book on Medicine or Liber Continens). Tehran, Iran: Academy of Medical Sciences; 2005.
15. Ibn Sina (Avicenna). *Kitāb al-Qānūn fī al-Tibb* (Canon of Medicine). New Delhi, India: Jamia Hamdard Press; 1998.
16. al-Ansari A. *Ikhtiyarat-i Badii* (Selections for Badii). Tehran, Iran: Pakhsh Razi Press; 1992.
17. Tunakabuni D. *Tuhfat al-mu'minin* (The Present for the Faithful). Tehran, Iran: Research Center of Traditional Medicine, Shahid Beheshti University of Medical Sciences, Nashre Shahr Press; 2007.
18. Shirazi A. *Makhzan al-adviyah* (The Storehouse of Medicaments). Tehran, Iran: Tehran University of Medical Sciences; 2009.
19. Soltani A. *Dictionary of Medicinal Plants*. Tehran, Iran: Arjmand Press; 2004.
20. Khare CP. *Indian Medicinal Plants*. New York, NY: Springer; 2007.
21. Ghahraman A., Okhovvat A. *Matching the Old Medicinal Plant Names With Scientific Terminology*. Tehran, Iran: Tehran University Press; 2004.
22. van Koppen CJ, Hartmann RW. Advances in the treatment of chronic wounds: a patent review. *Expert Opin Ther Pat*. 2015; 25:931-937.
23. Bhattacharjee P, Bhattacharyya D. Characterization of the aqueous extract of the root of Aristolochia indica: Evaluation of its traditional use as an antidote for snake bites. *J Ethnopharmacol*. 2013;145:220-226.
24. Zakaria Z, Reezal I, Mat Jais A, et al. The anti-inflammatory, antipyretic and wound healing activities of *Cocos nucifera* L. (MATAG types) fresh juice and kernel extract in experimental animals. *J Pharmacol Toxicol*. 2006;1:516-526.
25. Chakraborty M, Mitra A. The antioxidant and antimicrobial properties of the methanolic extract from *Cocos nucifera* mesocarp. *Food Chem*. 2008;107:994-999.
26. James GA, Swogger E, Wolcott R, et al. Biofilms in chronic wounds. *Wound Repair Regen*. 2008;16:37-44.
27. Al-Mobeeriek A. Effects of myrrh on intra-oral mucosal wounds compared with tetracycline- and chlorhexidine-based mouthwashes. *Clin Cosmet Investig Dent*. 2011;3:53-58.
28. Francis JA, Raja SN, Nair MG. Bioactive terpenoids and guggulusteroids from commiphora mukul gum resin of potential anti-inflammatory interest. *Chem Biodivers*. 2004;1:1842-1853.
29. Saeed MA, Sabir A. Antibacterial activities of some constituents from oleo-gum-resin of *Commiphora mukul*. *Fitoterapia*. 2004; 75:204-208.
30. Mathew A, Taranalli A, Torgal S. Evaluation of anti-inflammatory and wound healing activity of Gentiana lutea rhizome extracts in animals. *Pharm Biol*. 2004;42:8-12.
31. Šavikin K, Menković N, Zdunić G, Stević T, Radanović D, Janković T. Antimicrobial activity of *Gentiana lutea* L. extracts. *Z Naturforsch C*. 2009;64:339-342.
32. Ansari R, Sahinfard N, Namjou A, Rafieian M, Shirzad H, Rafieian-Kopaei M. Ameliorative property of *Teucrium polium* on second degree burn. *J Herbmed Pharmacol*. 2013;2:9-11.
33. Tariq M, Ageel AM, al-Yahya MA, Mossa JS, al-Said MS. Anti-inflammatory activity of *Teucrium polium*. *Int J Tissue React*. 1989;11:185-188.
34. Darabpour E, Motamedi H, Nejad SMS. Antimicrobial properties of *Teucrium polium* against some clinical pathogens. *Asian Pac J Trop Med*. 2010;3:124-127.
35. Yan H, Peng K, Wang Q, et al. Effect of pomegranate peel polyphenol gel on cutaneous wound healing in alloxan-induced diabetic rats. *Chin Med J*. 2012;126:1700-1706.
36. Ismail T, Sestili P, Akhtar S. Pomegranate peel and fruit extracts: a review of potential anti-inflammatory and anti-infective effects. *J Ethnopharmacol*. 2012;143:397-405.
37. Reddy MK, Gupta SK, Jacob MR, Khan SI, Ferreira D. Antioxidant, antimalarial and antimicrobial activities of tannin-rich fractions, ellagitannins and phenolic acids from *Punica granatum* L. *Planta Med*. 2007;73:461-467.
38. Zubair M, Nybom H, Lindholm C, Brandner JM, Rumpunen K. Promotion of wound healing by *Plantago major* L. leaf extracts—ex vivo experiments confirm experiences from traditional medicine. *Nat Prod Res*. 2016;30:622-624.
39. Ghezavat K, Sani AM, Yavarmanesh M. Assessment of the *Plantago major* extract for antimicrobial activities. *BioTechnology*. 2014;10:5-10.
40. Zhou Q, Lu W, Niu Y, et al. Identification and quantification of phytochemical composition and anti-inflammatory, cellular antioxidant, and radical scavenging activities of 12 plantago species. *J Agric Food Chem*. 2013;61:6693-6702.
41. Nilforoushzadeh MA, Javanmard SH, Ghanadian M, et al. The effects of *Adiantum capillus-veneris* on wound healing: an experimental in vitro evaluation. *Int J Prev Med*. 2014;5:1261-1268.
42. Ishaq MS, Hussain MM, Afridi MS, Ali G, Khattak M, Ahmad S. In vitro phytochemical, antibacterial, and antifungal activities of leaf, stem, and root extracts of *Adiantum capillus veneris*. *ScientificWorldJournal*. 2014;2014:269793.
43. Adnan MJ, Al-Ahbabi HH, Alhussani R, Hamad A. Study of the efficacy of Aloe vera extracts in treatment of non-infected

wounds induced by sulferric acid and infected wounds with *Staphylococcus aureus*. *Int J Adv Res*. 2015;3:593-601.
44. Oryan A, Mohammadalipour A, Moshiri A, Tabandeh MR. Topical application of Aloe vera accelerated wound healing, modeling, and remodeling: an experimental study with significant clinical value [published online July 4, 2014]. *Ann Plast Surg*. doi:10.1097/SAP.0000000000000239.
45. Agarry O, Olaleye M, Bello-Michael C. Comparative antimicrobial activities of Aloe vera gel and leaf. *Afr J Biotechnol*. 2005;4:1413-1414.
46. Tomovic MT, Cupara SM, Popovic-Milenkovic MT, Ljujic BT, Kostic MJ, Jankovic SM. Antioxidant and anti-inflammatory activity of *Potentilla reptans* L. *Acta Pol Pharm*. 2015;72:137-145.
47. Watkins F, Pendry B, Sanchez-Medina A, Corcoran O. Antimicrobial assays of three native British plants used in Anglo-Saxon medicine for wound healing formulations in 10th century England. *J Ethnopharmacol*. 2012;144:408-415.
48. Pourmorad F, Hosseinimehr S, Shahabimajd N. Antioxidant activity, phenol and flavonoid contents of some selected Iranian medicinal plants. *Afr J Biotechnol*. 2006;5:1142-1145.
49. Yuan Q, Zhang X, Liu Z, et al. Ethanol extract of *Adiantum capillus-veneris* L. suppresses the production of inflammatory mediators by inhibiting NF-κB activation. *J Ethnopharmacol*. 2013;147:603-611.
50. Turkoglu S, Turkoglu I, Kahyaoglu M, Celik S. Determination of antimicrobial and antioxidant activities of Turkish endemic *Ajuga chamaepitys* (L.) Schreber subsp. *euphratica* PH Davis (Lamiaceae). *J Med Plant Res*. 2010;4:1260-1268.
51. Mladenović JD, Mašković PZ, Pavlović RM, Radovanović BC, Aćamović-Đoković G, Cvijović MS. Antioxidant activity of ultrasonic extracts of leek *Allium porrum* L. *Hemijska industrija*. 2011;65:473-477.
52. Cvetnić Z, Pepeljnjak S, Vladimir-Knežević S, Kosalec I, eds. Antimicrobial activity of leek extract–*Allium porrum* L. (Liliaceae) against multiple-resistant bacteria. Central European Symposium on Antimicrobial Resistance (CESAR 2003). Hrvatska znanstvena bibliografija i MZOS-Svibor; 2003.
53. Hu Q, Hu Y, Xu J. Free radical-scavenging activity of Aloe vera (*Aloe barbadensis* Miller) extracts by supercritical carbon dioxide extraction. *Food Chem*. 2005;91:85-90.
54. Arunkumar S, Muthuselvam M. Analysis of phytochemical constituents and antimicrobial activities of Aloe vera L. against clinical pathogens. *World J Agric Sci*. 2009;5:572-576.
55. Vijayalakshmi D, Dhandapani R, Jayaveni S, Jithendra PS, Rose C, Mandal AB. In vitro anti inflammatory activity of Aloe vera by downregulation of MMP-9 in peripheral blood mononuclear cells. *J Ethnopharmacol*. 2012;141:542-546.
56. Kadri H, Djilani S, Djilani A. Phytochemical constituents, antioxidant activity, total phenolic and flavonoid contents of *Alisarum vulgare* seeds. *Acta Sci Pol Technol Aliment*. 2013;12:169-173.
57. Pyo Y-H, Lee T-C, Logendra L, Rosen RT. Antioxidant activity and phenolic compounds of Swiss chard (*Beta vulgaris* subspecies *cycla*) extracts. *Food Chem*. 2004;85:19-26.
58. Chakole R, Zade S, Charde M. Antioxidant and anti-inflammatory activity of ethanolic extract of *Beta vulgaris* Linn. roots. *Int J Biomed Adv Res*. 2011;2:124-130.
59. Al-Harrasi A, Ali L, Ceniviva E, et al. Antiglycation and antioxidant activities and HPTLC analysis of *Boswellia sacra* Oleogum resin: the sacred frankincense. *Trop J Pharm Res*. 2013;12:597-602.
60. Abdoul-Latif FM, Obame L-C, Bassolé IH, Dicko MH. Antimicrobial activities of essential oil and methanol extract of *Boswellia sacra* Flueck. and *Boswellia papyrifera* (Del.) Hochst from Djibouti. *Int J Manage Mod Sci Technol*. 2012;1:1-10.
61. Siddiqui MZ. *Boswellia serrata*, a potential antiinflammatory agent: an overview. *Indian J Pharm Sci*. 2011;73:255-261.
62. Lee HJ, Hyun E-A, Yoon WJ, et al. In vitro anti-inflammatory and anti-oxidative effects of *Cinnamomum camphora* extracts. *J Ethnopharmacol*. 2006;103:208-216.
63. Cansian RL, Mossi AJ, Oliveira D, et al. Atividade antimicrobiana e antioxidante do óleo essencial de ho-sho (*Cinnamomum camphora* Ness e Eberm Var. *Linaloolifera fujita)*. Food Sci Technol (Campinas). 2010;30:378-384.
64. Dubey D, Prashant K, Jain S, eds. In vitro antioxidant activity of the ethyl acetate extract of gum guggul (*Commiphora mukul*). *Biological Forum*. New Delhi, India: Satya Prakashan; 2009.
65. Asif Saeed M, Sabir AW. Antibacterial activities of some constituents from oleo-gum-resin of *Commiphora mukul*. *Fitoterapia*. 2004;75:204-208.
66. Beg S, Swain S, Hasan H, Barkat MA, Hussain MS. Systematic review of herbals as potential anti-inflammatory agents: recent advances, current clinical status and future perspectives. *Pharmacogn Rev*. 2011;5(10):120-137.
67. Samojlik I, Lakić N, Mimica-Dukić N, Đaković-Švajcer K, Božin B. Antioxidant and hepatoprotective potential of essential oils of coriander (*Coriandrum sativum* L.) and caraway (*Carum carvi* L.) (Apiaceae). *J Agric Food Chem*. 2010;58:8848-8853.
68. Casetti F, Bartelke S, Biehler K, Augustin M, Schempp C, Frank U. Antimicrobial activity against bacteria with dermatological relevance and skin tolerance of the essential oil from *Coriandrum sativum* L. fruits. *Phytother Res*. 2012;26:420-424.
69. Zeka K, Ruparelia KC, Continenza MA, Stagos D, Veglio F, Arroo RR. Petals of *Crocus sativus* L. as a potential source of the antioxidants crocin and kaempferol. *Fitoterapia*. 2015;107:128-134.
70. Parray JA, Kamili AN, Hamid R, Reshi ZA, Qadri RA. Antibacterial and antioxidant activity of methanol extracts of *Crocus sativus* L. c.v. Kashmirianus. *Front Life Sci*. 2015;8:40-46.
71. Nastasijević B, Lazarević-Pašti T, Dimitrijević-Branković S, et al. Inhibition of myeloperoxidase and antioxidative activity of *Gentiana lutea* extracts. *J Pharm Biomed Anal*. 2012;66:191-196.
72. Souri E, Farsam H, Sarkheil P, Ebadi F. Antioxidant activity of some furanocoumarins isolated from *Heracleum persicum*. *Pharm Biol*. 2004;42:396-399.
73. Bazzaz B, Haririzadeh G. Screening of Iranian plants for antimicrobial activity. *Pharm Biol*. 2003;41:573-583.
74. Hajhashemi V, Sajjadi SE, Heshmati M. Anti-inflammatory and analgesic properties of *Heracleum persicum* essential oil and hydroalcoholic extract in animal models. *J Ethnopharmacol*. 2009;124:475-480.

75. Emami S, Khayyat MH, Doosti F, Bagherpasand N, Zolfaghar F. Investigation of antioxidant activity of the essential oils of different parts of *Juniperus sabina* (Cupressaceae) by TBARS method in comparison with vitamin E. *Res Pharm Sci*. 2012;7: S798.
76. Asili J, Emami SA, Rahimizadeh M, Fazly-Bazzaz BS, Hassanzadeh MK. Chemical and antimicrobial studies of *Juniperus sabina* L. and *Juniperus foetidissima* Willd. essential oils. *J Essent Oil Bear Plants*. 2010;13:25-36.
77. Starzyńska-Janiszewska A, Stodolak B, Jamróz M. Antioxidant properties of extracts from fermented and cooked seeds of Polish cultivars of *Lathyrus sativus*. *Food Chem*. 2008;109:285-292.
78. Işık C, Kıvrak İ, Demir Y, Harmandar M, Demir N. Investigation of some enzyme, antimicrobial, vitamins and antioxidant activities of flower of white lily (*Lilium candidum* L.). http://www.kimya2012.mu.edu.tr/B%C4%B0YOK%C4%B0MYA/biyokimya/015_BCpages.pdf. Accessed May 31, 2016.
79. Katsarou A, Rhizopoulou S, Kefalas P. Antioxidant potential of the aerial tissues of the mistletoe *Loranthus europaeus* Jacq. *Rec Nat Prod*. 2012;6:394-397.
80. Yang X, Yang L, Zheng H. Hypolipidemic and antioxidant effects of mulberry (*Morus alba* L.) fruit in hyperlipidaemia rats. *Food Chem Toxicol*. 2010;48:2374-2379.
81. Chung KO, Kim BY, Lee MH, et al. In-vitro and in-vivo anti-inflammatory effect of oxyresveratrol from *Morus alba* L. *J Pharm Pharmacol*. 2003;55:1695-1700.
82. Zengin G, Uysal S, Ceylan R, Aktumsek A. Phenolic constituent, antioxidative and tyrosinase inhibitory activity of *Ornithogalum narbonense* L. from Turkey: a phytochemical study. *Ind Crops Prod*. 2015;70:1-6.
83. Šircelj H, Mikulič-Petkovšek M, Batič F. Antioxidants in spring leaves of *Oxalis acetosella* L. *Food Chem*. 2010;123:351-357.
84. Biglari F, AlKarkhi AFM, Easa AM. Antioxidant activity and phenolic content of various date palm (*Phoenix dactylifera*) fruits from Iran. *Food Chem*. 2008;107:1636-1641.
85. El Sohaimy S, Abdelwahab A, Brennan C, Aboul-enein A. Phenolic content, antioxidant and antimicrobial activities of Egyptian date palm (*Phoenix dactylifera* L.) fruits. *Aust J Basic Appl Sci*. 2015;9:141-147.
86. Ge Y, Duan Y, Fang G, Zhang Y, Wang S. Polysaccharides from fruit calyx of *Physalis alkekengi* var. *franchetii*: isolation, purification, structural features and antioxidant activities. *Carbohydr Polym*. 2009;77:188-193.
87. Helvacı S, Kökdil G, Kawai M, Duran N, Duran G, Güvenç A. Antimicrobial activity of the extracts and physalin D from *Physalis alkekengi* and evaluation of antioxidant potential of physalin D. *Pharm Biol*. 2010;48:142-150.
88. Hong J-M, Kwon O-K, Shin I-S, et al. Anti-inflammatory activities of *Physalis alkekengi* var. *franchetii* extract through the inhibition of MMP-9 and AP-1 activation. *Immunobiology*. 2015;220:1-9.
89. Hsu C-Y. Antioxidant activity of extract from *Polygonum aviculare* L. *Biol Res*. 2006;39:281-288.
90. Salama M, Marraiki N. Antimicrobial activity and phytochemical analysis of *Polygonum aviculare* L. *Aust J Basic Appl Sci*. 2009;3: 2008-2015.
91. Granica S, Czerwińska ME, Żyżyńska-Granica B, Kiss AK. Antioxidant and anti-inflammatory flavonol glucuronides from *Polygonum aviculare* L. *Fitoterapia*. 2013;91:180-188.
92. Çoruh N, Celep, AGSdl, Özgökçe F. Antioxidant properties of *Prangos ferulacea* (L.) Lindl., *Chaerophyllum macropodum* Boiss. and *Heracleum persicum* Desf. from Apiaceae family used as food in Eastern Anatolia and their inhibitory effects on glutathione-S-transferase. *Food Chem*. 2007;100:1237-1242.
93. Massumi MA, Fazeli MR, Alavi SHR, Ajani Y. Chemical constituents and antibacterial activity of essential oil of *Prangos ferulacea* (L.) Lindl. fruits. *Iran J Pharm Sci*. 2007;3: 171-176.
94. Rout S, Banerjee R. Free radical scavenging, anti-glycation and tyrosinase inhibition properties of a polysaccharide fraction isolated from the rind from *Punica granatum*. *Bioresour Technol*. 2007;98:3159-3163.
95. Tubaro A, Negro P, Bianchi P, Romussi G, Della Loggia R. Topical anti-inflammatory activity of a new acylated flavonoid. *Inflamm Res*. 1989;26:229-230.
96. Bhatti MZ, Ali A, Ahmad A, Saeed A, Malik SA. Antioxidant and phytochemical analysis of *Ranunculus arvensis* L. extracts. *BMC Res Notes*. 2015;8:279.
97. Terzioglu S, Yasar A, Yayli N, Yilmaz N, Karaoglu S, Yayli N. Antimicrobial activity and essential oil compositions of two Ranunculus species from Turkey: *R. constantinopolitanus* and *R. arvensis*. *Asian J Chem*. 2008;20:3277-3283.
98. Beevi S, Narasu M, Gowda B. Polyphenolics profile, antioxidant and radical scavenging activity of leaves and stem of *Raphanus sativus* L. *Plant Foods Hum Nutr*. 2010;65:8-17.
99. Lee Y-S, Kwon K-J, Kim M-S, Sohn H-Y. Antimicrobial, antioxidant and anticoagulation activities of Korean radish (*Raphanus sativus* L.) leaves. *Microbiol Biotechnol Lett*. 2013;41: 228-235.
100. Kim KH, Kim CS, Park YJ, et al. Anti-inflammatory and antitumor phenylpropanoid sucrosides from the seeds of *Raphanus sativus*. *Bioorg Med Chem Lett*. 2015;25:96-99.
101. Bursal E, Köksal E. Evaluation of reducing power and radical scavenging activities of water and ethanol extracts from sumac (*Rhus coriaria* L.). *Food Res Int*. 2011;44:2217-2221.
102. Fazeli MR, Ashtiani H, Ahmadian Atari MM, Jamalifar H. Antimicrobial effect of *Rhus coriaria* L. (sumac) total extract on skin isolates of *Staphylococcus epidermidis* and *Corynebacterium xerosis*. *J Med Plants*. 2006;5(17):27-31.
103. Šentjurc M, Nemec M, Connor HD, Abram V. Antioxidant activity of *Sempervivum tectorum* and its components. *J Agric Food Chem*. 2003;51:2766-2771.
104. Abram V, Donko M. Tentative identification of polyphenols in *Sempervivum tectorum* and assessment of the antimicrobial activity of Sempervivum L. *J Agric Food Chem*. 1999;47: 485-489.
105. Seo H-K, Lee J-H, Kim H-S, Lee C-K, Lee S-C. Antioxidant and antimicrobial activities of *Smilax china* L. leaf extracts. *Food Sci Biotechnol*. 2012;21:1723-1727.
106. Shu X-S, Gao Z-H, Yang X-L. Anti-inflammatory and antinociceptive activities of *Smilax china* L. aqueous extract. *J Ethnopharmacol*. 2006;103:327-332.

107. Wu C, Chen F, Wang X, et al. Antioxidant constituents in feverfew (*Tanacetum parthenium*) extract and their chromatographic quantification. *Food Chem*. 2006;96:220-227.
108. Izadi Z, Aghaalikhani M, Esna-Ashari M, Davoodi P. Determining chemical composition and antimicrobial activity of feverfew (*Tanacetum parthenium* L.) essential oil on some microbial strains. *Zahedan J Res Med Sci*. 2013;15(6):8-13.
109. Williams CA, Harborne JB, Geiger H, Hoult JRS. The flavonoids of *Tanacetum parthenium* and *T. vulgare* and their anti-inflammatory properties. *Phytochemistry*. 1999;51: 417-423.
110. Stankovic MS, Topuzovic M, Solujic S, Mihailovic V. Antioxidant activity and concentration of phenols and flavonoids in the whole plant and plant parts of *Teucrium chamaedry*s L. var. *glanduliferum* Haussk. *J Med Plants Res*. 2010;4: 2092-2098.
111. Vlase L, Benedec D, Hanganu D, et al. Evaluation of antioxidant and antimicrobial activities and phenolic profile for *Hyssopus officinalis*, *Ocimum basilicum* and *Teucrium chamaedrys*. *Molecules*. 2014;19:5490-5507.
112. Sharififar F, Dehghn-Nudeh G, Mirtajaldini M. Major flavonoids with antioxidant activity from *Teucrium polium* L. *Food Chem*. 2009;112:885-888.
113. Casanova E, García-Mina J, Calvo M. Antioxidant and antifungal activity of *Verbena officinalis* L. leaves. *Plant Foods Hum Nutr*. 2008;63:93-97.
114. Zhang H, Jiang L, Ye S, Ye Y, Ren F. Systematic evaluation of antioxidant capacities of the ethanolic extract of different tissues of jujube (*Ziziphus jujuba* Mill.) from China. *Food Chem Toxicol*. 2010;48:1461-1465.
115. Saklani S, Chandra S. Nutritional evaluation, antimicrobial activity and phytochemical screening of wild edible fruit of *Ziziphus jujuba*. *J Pharm Res*. 2011;4:4631-4633.
116. Goyal R, Sharma PL, Singh M. Possible attenuation of nitric oxide expression in anti-inflammatory effect of *Ziziphus jujuba* in rat. *J Nat Med*. 2011;65:514-518.