Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 10 Issue 1 January 2026

Review Article

Beyond Fragrance: The Nutraceutical and Pharmacological Essence of *Polianthes tuberosa* L.

Devyani V Divase[1], Omkar V Dhanawade[1] and Firoj A Tamboli[2]*

[1]UG Students, B. Pharmacy, Bharati Vidyapeeth College of Pharmacy, Near Chitranagari, Kolhapur - 416013 Maharashtra, India

[2]Department of Pharmacognosy, Bharati Vidyapeeth College of Pharmacy, Near Chitranagari, Kolhapur - 416013 Maharashtra, India

***Corresponding Author:** Firoj A Tamboli, Department of Pharmacognosy, Bharati Vidyapeeth College of Pharmacy, Near Chitranagari, Kolhapur - 416013 Maharashtra, India.

Received: November 13, 2025

Published: December 18, 2025

Abstract

Polianthes tuberosa L, commonly referred to as tuberose is a perennial ornamental plant that is not only aesthetically pleasing and fragrant in terms of its flowers, but also rich in a wide variety of phytochemicals and pharmacological capabilities. Historically used as a raw material in the perfumery and decorative floriculture industry, recent research has been able to emphasize the high bioactive compound content of this material, including steroidal saponins, flavonoids, phenolics, glycosides, and essential oils. The constituents have a wide range of biological processes like antioxidant, antimicrobial, anti-inflammatory, and anticancer. Hecogenin and diosgenin derivatives which are steroidal saponins are precursors of synthetic steroids and exhibit apoptosis-capacitating effects in cancer cells. Additional effects on its therapeutic profile are flavonoids and phenolics, which regulate important cellular signaling pathways and inhibit oxidative DNA damage. The flower oils have cytotoxicity against tumor cells, which is mainly achieved by induction of oxidative stress. With its diverse bioactivity and historical importance, *P. tuberosa* has a lot of potential as a natural source of pharmaceutical, cosmetic, and nutraceutical products.

Keywords: *Polianthes tuberosa*; Tuberose; Steroidal Saponins; Flavonoids; Essential Oils; Antioxidant Activity; Anticancer Property

Introduction

Polianthes tuberosa L. or tuberose is a plant of the Asparagaceae family (previously Agavaceae), the bulbous perennial plant. It is a native of Mexico and it was grown there since pre-Columbian times nowadays it is grown in large size over the territory of tropical and subtropical areas because of fragrant flowers [1]. It is a rosette-forming plant with slender and grass like basal foliage as well as long flowering spikes with waxy and white flowers that have a strong and sweet scent, particularly in the evening [2]. It has a floral design of a tubular perianth that has six lobulations and an inferior ovary, as well as a lot of variation among cultivars (single, semi-double and double) [3].

Tuberose has found wide usage in the perfumery and the floriculture sectors. Its extracted essential oil is a valued ingredient of luxury fragrances because of its deep and durable fragrance profile [4]. Besides its application in aroma therapy *P. tuberosa* has been used in Indian cultural and ritual traditions, being a common ingredient in the offerings of religion, in the garlands and landscape planting [5].

Its horticultural value lies in the fact that the plant is adaptable to various climatic conditions, is easy to propagate using bulbs or offsets, and has a long period of blooming. It thrives well in well drained loamy soils and warm climate, and would be suitable in the open field systems as well as sheltered systems of cultivation [3]. Recent breeding activities have been directed towards improving floral performance, scent strength and resistance to disease which has further broadened its economic and aesthetic applications [4]. Due to the diverse economic and aesthetic significance, *P. tuberosa* remains a significant target of floriculture research and breeding programs around the world.

Botanical description

Tuberose (*Polianthes tuberosa* L.) is a perennial, bulbous flower that is a member of the family Amaryllidaceae, and in relation to its genus, subfamily, Agavoideae, and is famous as an ornamental and fragrance resource in floriculture and perfume businesses. Polianthes has approximately 12 species, although only one species, *Polianthes tuberosa* is frequently grown in a commercial and decorative setting. Plant Taxonomy: The plant belongs to the kingdom Plantae, division Magnoliophyta, class Liliopsida, order Asparagales and family Amaryllidaceae (syn. Agavaceae) [1,2,4].

Morphologically, *P. tuberosa* has a short and stout underground bulb (tuberous rootstock) as its main organ of propagation. It has a slender erect stem which may be 45-100 cm high with narrow, linear leaves which are bright green, and placing the leaves alternately in a rosette towards the base. The inflorescence is a lengthy spike of very numerous fragrant and waxy-white flowers, each having a tubular perianth and six lobes. The flowers bloom in a downward upward order and as a result give off a strong sweet smell as a result of the essential oils found in the flowers, some of which include methyl benzoate and benzyl acetate. Plant rarely produces under cultivation, but reproduction is mainly vegetative by bulb offsets [1,3,4].

A number of varieties and hybrids of tuberose have been formulated depending on the floral whorls. The major ones are the Single (e.g., the Single Mexican), with one layer of petals and preferred as an essential oil source; and the Double (e.g., the Pearl or the Pearl), with many layers of petals and used as a cut flower; and the Semi- double that is characterized by intermediate floral morphology [24]. Such cultivars vary in the number of flowers, the intensity of the fragrance and regional adaptation.

P. tuberosa is thought to have originated in Mexico, where it was able to spread to India and other tropical and subtropical areas. It is widely grown nowadays in India, China, Egypt, France, South Africa, and the Philippines, where India is one of the largest producers. In India, West Bengal, Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra are major areas of cultivation owing to the climatic and soil conducive conditions that help in its all year mode of growing [1,2,5]. It grows well under warm and humid climates with well-drained loamy soil that is highly organic, it needs moderate amount of rainfall and maximum sunlight to bloom and produce most of the essential oil [35]. Tuberose is therefore an extremely prized ornamental and industrial crop which has both aesthetic value and commercial value in terms of perfumery, cosmetics, and landscape horticulture [1,5,6].

Polianthes tuberosa is reported to have a wide range of phytochemical compounds especially those that are concentrated in its flowers and which make it have unique fragrance as well as possible bioactivities [7]. Major volatile compounds that are present in the essential oil obtained with the flowers include methyl benzoate, eugenol, benzyl alcohol, farnesol, geraniol, nerol, and linalool, all those being related to its powerful, sweet floral scent [8]. Other phytochemicals that have been identified are flavonoids, alkaloids, glycosides, saponins and tannins, a few of which have been known to have antioxidant, antimicrobial and anti-inflammatory effect [1]. In addition to being the determinants of the sensory properties of *P. tuberosa*, these bioactive molecules present an opportunity to use this natural compound in the traditional medicine and perfumery business.

Pharmacological activities

Cytotoxicity

Widespread reports have been made of the cytotoxic and anticancer effect of phytochemicals including steroidal saponins (e.g.,

Figure 1: *Polianthes tuberosa* L. (Tuberose).

hecogenin, tigogenin, diosgenin derivatives, etc.), flavonoids (quercetin, kaempferol), phenolic compounds, glycosides, and essential oils (eugenol, methyl salicylate, benzyl benzoate, linalool, etc.). Steroidal saponins are considered precursors of corticosteroids and anticancer agents which have a cytotoxic effect on tumor cells, leading to apoptosis and destabilizing the membrane integrity, owing to their surfactant properties. Flavonoids exhibit pro-apoptotic and anti-proliferative effects by regulating important signaling pathways (PI3K/Akt, MAPK and NF-KB). Likewise, phenolic compounds and glycosides serve as antioxidants, preventing the damaging effect of oxidation of the DNA and some phenols have a direct antitumor cell proliferation effect. Essential oils are involved in cytotoxic action because the oils produce reactive oxygen species (ROS), which cause mitochondrial dysfunction, oxidative stress, and apoptosis in cancer cells. Their anticancer effect is mainly due to induction of apoptosis by activation of caspases, cell cycle arrest (G0/G1 or G2/M arrest), the occurrence of ROS that lead to DNA fragmentation, inhibition of pro-survival signaling pathways (NF-KB, PI3K/Akt, MAPK), and destabilization of the cancer cell membrane by saponin-cholesterol interactions [6-8].

Immunomodulatory effects

The most prominent immunomodulatory activities are generated by phytochemicals like steroidal saponins (hecogenin, tigogenin, diosgenin derivatives), flavonoids (quercetin, kaempferol), phenolic compounds and essential oils (eugenol, linalool, methyl salicylate). The steroidal saponins, commonly referred to as the forerunners of corticosteroid medications, may either trigger or suppress the immune system according to their form and the cost. Flavonoids stimulate immune competence by increasing phagocytosis, lymphocyte growth, and cytokine generation and also balance signaling pathways including NF- 1B and MAPK. The phenolic compounds are antioxidants and thus prevent oxidative damage of immune cells and maintain the balance between the innate and adaptive immunity. The essential oils participate in their anti-inflammatory and immunostimulatory effects. The mechanisms of action of immunomodulation are activation of innate immunity via improved macrophage and neutrophil response, regulation of cytokines through induction of IL-2 and IFN- g (Th1 response) and inhibition of pro-inflammatory cytokines like TNF- a, IL-6 and IL-1b, protective effects on antioxidants in immune cells, stimulating T- and B-lymphocyte proliferation and complement system modification, some extracts have been shown to possess membrane-stabilizing activity [9-11].

Anti-inflammatory activities

The most common phytochemicals that are reported to have anti-inflammatory effect are steroidal saponins (hecogenin, tigogenin, diosgenin), flavonoids (quercetin, kaempferol), phenolic compounds and glycosides, and essential oils (methyl benzoate, eugenol, linalool). The precursors of corticosteroid drugs, which are called steroidal saponins, have anti-inflammatory and analgesic effects via the regulation of prostaglandin and leukotrienes production [12]. Flavonoids are effective free radical scavengers that prevent the activity of inflammatory mediators like cyclooxygenase (COX), lipoxygenase (LOX), and NF-kB pathway, which suppress inflammation caused by oxidative stress [13]. Phenolics help to reduce oxidative stress and balance cytokine, and Glycosides amplify the anti-inflammatory effects [14]. Essential oils, especially eugenol and linalool, have anti-edematous and analgesic properties as they suppress pro-inflammatory cytokines (TNF- a, IL- 1b, IL- 6) and boost IL-10 [15,16]. The entire processes include the inhibition of COX-2/ LOX, inactivation of reactive oxygen species (ROS), suppression of pro-inflammatory cytokines, promotion of anti-inflammatory cytokines, and stabilization of lysosomal membranes, which all inhibit tissue destruction and inflammatory processes.

Antioxidant activities

Phytochemicals which have strong antioxidant activity include flavonoids (quercetin, kaempferol derivatives, rutin), phenolic compounds, steroidal saponins (hecogenin, tigogenin, diosgenin derivatives), and essential oils (eugenol, methyl salicylate, linalool, and benzyl benzoate). Flavonoids are good free radical scavengers that prevent lipid peroxidation and prevent the formation of ROS [17]. The phenolic compounds interact with the free radicals by donating either the hydrogen atoms or electrons, show high in vitro DPPH radical scavenging activity, and also the ABTS radical scavenging activity and exhibit high activity in endogenous antioxidant enzymes; superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) [18]. Saponins of steroidal nature also have the ROS-quenching potential and play a role in anti-inflammatory antioxidant reactions [19]. Essential oils, especially those of eugenol and linalool, prevent the production of ROS and lipid peroxidation and oxidative damage of cellular membranes [20]. Their underlying mechanism of action includes direct scavenging of free radicals (DPPH, hydroxyl, superoxide), inhibition of lipid peroxidation, reduction of oxidative stress, and chelation of transition metals (thus preventing Fenton reactions-mediated ROS) and the upregulation of cellular antioxidant defense [21].

Aromachological effects (Aromatherapy)

The activity of aromatherapy is based on phytochemicals found in essential oils, especially those that are monoterpenes (linalool, geraniol, nerol), esters (methyl benzoate, methyl salicylate), phenylpropanoids (eugenol, benzyl benzoate), and indole compounds. It is claimed that monoterpenes have relaxant, anti-anxiety and sedative effects whereas esters have mood-promoting, analgesic and relaxing effects [22]. Phenylpropanoids eugenol and benzyl benzoate show antimicrobial, anti-inflammatory and stress-reduction effects, and indole derivatives have been demonstrated to have aphrodisiac and sedative effects [23]. Aromatherapeutic action is associated with the mechanisms of olfactory stimulation, where volatile substances are engaged with olfactory receptors that it transmits signals to the limbic system (amygdala, hippocampus, hypothalamus), causing the effect on mood, memory, and emotions [24]. Moreover, constituents of essential oils interact with neurochemical pathways that regulate such neurotransmitters as serotonin, dopamine, and GABA that have a calming effect, promote anxiety or stimulation based on the compound [25]. Moreover, the inhaled volatile oils have been demonstrated to have quantifiable physiological effects, such as slowing of heart rate, cortisol suppression and enhancing sleep quality [26].

Skin diseases

Essential oils (linalool, methyl benzoate, methyl salicylate, eugenol, benzyl alcohol), flavonoids (quercetin, kaempferol derivatives), phenolic compounds, and steroidal saponins (hecogenin, tigegenin) are phytochemicals that are especially important in the maintenance of the skin. Essential oils are antiseptic, calming, moisturizing, and rejuvenating in nature and enhance the elasticity of the skin and prevent the infection of microbes [27]. Flavonoids are powerful antioxidants and anti-inflammations that protect against the effect of oxidative stresses caused by UV radiation and the effects of inflammation in the skin [28]. Phenolic compounds decrease premature skin aging, pigmentation disorders, oxidative skin damage by free radical scavenging and regulating melanogenesis [29]. Saponins which are steroidal aid the healing of the wound and have anti-inflammatory effects which helps in the repair of tissues [30]. The action mechanisms of these effects are antioxidant protection (prevention of wrinkles, photoaging and sun damage), antimicrobial (combating acne causing, infection causing microbes), anti-inflammatory (reduction of redness, itch and rash), aromatherapeutic (stress reduction to help with such conditions as psoriasis and eczema) and moisturizing/rejuvenating effects (maintaining skin plumpness and ensuring skin stays hydrated) [31].

Gastrointestinal disorders

Phytochemicals include steroidal saponins (hecogenin, tigogenin), flavonoids (quercetin, kaempferol glycosides), phenolic compounds, and essential oils (linalool, methyl benzoate, eugenol), which play an important role in the gastrointestinal (GI) health. Saponins with steroids have anti-inflammatory and gastroprotective effects due to their capacity to decrease gastric irritation and

promote mucosal healing [32]. The potent antioxidant and gastroprotective effects of flavonoids with derivatives of quercetin and kaempferol contribute to gastric ulceration reduction and oxidative stress-induced mucosal damage prevention [33]. Phenolic compounds also protect the stomach and intestines against oxidative damage and increase the protection of mucosa defense [34]. Essential oils are carminatives and antispasmodics, they relax smooth muscles to relieve cramps and bloating, exhibit antimicrobial effects on enteric pathogens, including E. coli and Salmonella [35]. The processes that are involved in these effects consist of free radical scavenging that helps to avoid the destruction of the mucosa, anti-inflammatory effects that are useful in gastritis and colitis, antimicrobial effects that prevent the causes of diarrhea, antispasmodic effects that reduce the abdominal pain, and digestive effects that enhance the enzyme secretions and increase the appetite [36].

Respiratory diseases

Tuberose phytochemicals, mainly essential oils (linalool, methyl benzoate, benzyl alcohol, methyl salicylate, eugenol), flavonoids and phenolic acids, and steroidal saponins (hecogenin, tigogenin) have a significant role to play in keeping the respiratory system healthy. Essential oils possess antimicrobial, mucolytic and bronchodilatory actions against respiratory pathogens like Staphylococcus aureus, Streptococcus pneumoniae and E. coli and their calming aroma yields symptomatic benefits [37,38]. Antioxidant and anti-inflammatory effects are exhibited by flavonoids and phenolic acids that prevent the oxidative stress and inflammation of the airways, which are linked with asthma and bronchitis [39]. Saponins of steroid nature assist in expectorant and anti-inflammatory effects, which improves the clearance of the mucus and decreases the swelling of the airways [40]. Mechanistically these compounds are acting by inhibiting respiratory pathogens, inhibiting pro-inflammatory cytokines, relaxing airway smooth muscles to bronchodilate, facilitating the break-down and clearance of mucus and offering aromatherapeutic relief, which attenuates exacerbation of respiratory symptoms through stress [41].

Reproductive and urogenital disorders

Phytochemicals include steroidal saponins (hecogenin, tigogenin), flavonoids (quercetin derivatives), essential oils (methyl benzoate, benzyl acetate), and triterpenic polyphenols which play an important role in reproductive and urinary health. Antimicrobial properties of steroidal saponins and flavonoids are of the disruptive effect on microbial cell membranes and thereby inhibiting such pathogens as Neisseria gonorrhoeae which is involved in reproductive tract infections [42,43]. These are also anti-inflammatory compounds, where polyphenols and triterpenes inhibit pro-inflammatory cytokines such as TNF-A and IL-6, and inflammatory conditions of the urinary tract and reproductive tissues can be reduced [44]. Also certain constituents exhibit the diuretic action by regulating the renal tubular activity which facilitates the urine excretion and clearance of toxins [45]. The antioxidant and cytoprotective properties of flavonoids and polyphenols are very strong and prevent damages on reproductive organs by oxidative stress, which keeps the tissues healthy and aids fertility [46,47]. The effects are supplemented by essential oils through aromatherapeutic relaxation and indirect hormonal modulation, which decrease stress-related reproductive dysfunction [48].

Toxicology and safety information

Laboratory tests of *Polianthes tuberosa* extracts on acute toxicity of lab animals have shown that the plant has a large safety margin and no major toxic signs. The results of studies conducted on methanolic and ethanolic extracts did not show any mortality or behavioral deviation with doses of up to 2000 mg/kg, which means that tuberose is not toxic in an OECD-compliant manner. Its acute safety is supported by the lack of any negative effect on such parameters as locomotor activity, feed intake and reflex responses under experimental conditions [49].

There have also been chronic and sub-chronic toxicity tests to ascertain the safety in the long-term. Tuberose extract as repeated within a few weeks failed to cause any histopathological lesions or hematologic and biochemical index changes. The liver and renal tests such as ALT, AST, urea, and creatinine were within the normal physiology range indicating that there was no cumulative/organ toxicity. These results indicate the safety and biocompatibility of tuberose phytoconstituents in prepared preparations in therapeutic use [50].

The preclinical results of the safe dosage range indicate that *Polianthes tuberosa* extracts are well tolerated to 1000 mg/kg body weight, and no adverse effects were witnessed. However, since there is little clinical data in human beings, standardized toxicity tests and controlled clinical trials are advised to come up with definite safety margins. In general, available data testify to the fact that tuberose and its derivatives have a good toxicological profile when applied in the context of the traditional and experimentally proven dosage interval [49,50].

Conclusion

Polianthes tuberosa is a diversified plant with great ornamental, cultural, and medicinal importance. Although, traditionally, it is valued because of its odorous flowers, its application in the perfumery and decorative floriculture, recent phytochemical and pharmacological studies have extended its usefulness in the extraction of bioactive substances, which can have therapeutic significance. Its wide range of biological properties, such as antioxidant, anti-inflammatory, antimicrobial, and anticancer, can be attributed to the presence of steroidal saponins, flavonoids, phenolics, glycosides and essential oils. Such results not only confirm its conventional uses, but also suffice new possibilities to use it in contemporary medicine, especially in the creation of natural health products and in new therapeutic agents. Additional intensive research such as clinical assessment and isolation of the compounds is justified to maximize and access the medicinal capabilities of this underused but potentially effective species.

Funding Sources

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest

The author(s) do not have any conflict of interest.

Bibliography

1. Kumar R., *et al*. "Tuberose: A flower of aesthetic and commercial significance". *International Journal of Botany Studies* 6.2 (2021): 55-58.

2. Bose TK., *et al*. "Floriculture and Landscaping". Kolkata: Naya Udyog (2003).

3. Khandelwal SK., *et al*. "Performance of different cultivars of tuberose (*Polianthes tuberosa* L.) under mid-hill conditions of Himachal Pradesh". *HortFlora Research Spectrum* 1.3 (2012): 248-250.

4. Gupta R., *et al*. "Advances in tuberose (*Polianthes tuberosa* L.) research and production". *Indian Journal of Horticulture* 67.3 (2010): 275-281.

5. Krishnan B and Singh VK. "Commercial prospects of tuberose in the Indian floriculture industry". *Journal of Applied Horticulture* 17.1 (2015): 75-79.

6. Khan M., *et al*. "Natural saponins: potent anticancer agents". *Pharmaceutical Biology* 57.1 (2019): 587-600.

7. Sharma A., *et al*. "Polyphenols in food and their effects on human health: An overview". *Journal of Food Science and Technology* 57.12 (2020): 4197-4207.

8. Singh B., *et al*. "Phenolic compounds as beneficial phytochemicals in pomegranate (*Punica granatum* L.) peel: A review". *Food Chemistry* 351 (2021): 129-170.

9. Gupta RC., *et al*. "Interactions between antidiabetic drugs and herbs: an overview of mechanisms of action and clinical implications". *Diabetology and Metabolic Syndrome* 9 (2017): 59.

10. Pan MH., *et al*. "Anti-inflammatory activity of natural dietary flavonoids". *Food Function* 1.1 (2010): 15-31.

11. Yang Y., *et al*. "Immunomodulatory effects of phytochemicals and medicinal herbs: modulation of immune responses by natural products". *Journal of Immunology Research* 2018 (2018): 1-13.

12. Sparg SG., *et al*. "Biological activities and distribution of plant saponins". *Journal of Ethnopharmacology* 94.2-3 (2004): 219-43.

13. Santangelo C., *et al*. "Polyphenols, intracellular signalling and inflammation". *Annali dell'Istituto Superiore di Sanità* 43.4 (2007): 394-405.

14. Shahidi F and Ambigaipalan P. "Phenolics and polyphenolics in foods, beverages and spices: antioxidant activity and health effects - a review". *Journal of Functional Foods* 18 (2015): 820-897.

15. Nagoor Meeran MF., *et al*. "Pharmacological properties and molecular mechanisms of thymol: prospects for its therapeutic potential and pharmaceutical development". *Frontiers in Pharmacology* 8 (2017): 380.

16. Pramod K., *et al*. "Eugenol: A natural compound with versatile pharmacological actions". *Natural Product Communications* 5.12 (2010): 1999-2006.

17. Pietta PG. "Flavonoids as antioxidants". *Journal of Nature Production* 63.7 (2000): 1035-1042.

18. Brand-Williams W., *et al*. "Use of a free radical method to evaluate antioxidant activity". *LWT Food Science and Technology* 28.1 (1995): 25-30.

19. Huang HC., *et al*. "Two anti-inflammatory steroidal saponins from *Dracaena angustifolia* Roxb.: inhibition of superoxide generation and elastase release by human neutrophils". *Molecules* 18.8 (2013): 8752-8763.

20. Nanjo F., *et al*. "Inhibitory effect of eugenol on non-enzymatic lipid peroxidation in rat liver mitochondria". *Biochemistry and Pharmacology* 42.12 (1991): 2041-2045.

21. Valko M., *et al*. "Free radicals and antioxidants in normal physiological functions and human disease". *The International Journal of Biochemistry and Cell Biology* 39.1 (2007): 44-84.

22. Koulivand PH., *et al*. "Lavender and the nervous system". *Evidence-Based Complementary and Alternative Medicine* 2013 (2013): 681304.

23. Damasceno RO., *et al*. "Anti-inflammatory and antioxidant activities of eugenol: an update". *Pharmaceuticals (Basel)* 17.11 (2024): 1505.

24. Herz RS. "Aromatherapy facts and fictions: a scientific analysis of olfactory effects on mood, physiology and behavior". *International Journal of Neuroscience* 119.2 (2009): 263-290.

25. Lv XN., *et al*. "Aromatherapy and the central nervous system .CNS therapeutic mechanism and its associated genes". *Current Drug Targets* 14.8 (2013): 872-879.

26. Goel N., *et al*. "An olfactory stimulus modifies nighttime sleep in young men and women". *Chronobiology International* 22.5 (2005): 889-904.

27. Draelos ZD. "Essential oils in dermatology: a review". *Dermatology Therapy* 20.2 (2007): 101-108.

28. Matsumoto Y., *et al*. "Quercetin is a promising flavonoid for preventing UV-induced skin damage". *Journal of Investigative Dermatology* 117.3 (2001): 542-548.

29. Masaki H. "Role of antioxidants in the skin: anti-aging effects". *Journal of Dermatology Science* 58.2 (2010): 85-90.

30. Kim YS., *et al*. "Therapeutic effect of total ginseng saponin on skin wound healing". *Journal of Ginseng Research* 35.3 (2011): 360-367.

31. Hajhashemi V., *et al*. "Anti-inflammatory and analgesic properties of *Rosa damascena* hydroalcoholic extract and its essential oil in animal models". *Iranian Journal of Pharmaceutical Sciences* 9.2 (2012): 163-168.

32. De Sousa LE., *et al*. "Effects of hecogenin and its possible mechanism of action on experimental models of gastric ulcer in mice". *European Journal of Pharmacology* 683.1-3 (2012): 260-269.

33. Al-Rehaily AJ., *et al*. "Gastroprotective effects of quercetin in rats against indomethacin-induced gastric ulcer". *World Journal of Gastroenterology* 19.28 (2013): 4355-4362.

34. Nabavi SF., *et al*. "Antioxidant activity of flower, stem and leaf extracts of *Ferula gummosa* Boiss". *Grass Forage Science* 64.1 (2009): 68-75.

35. De Sousa DP., *et al*. "A systematic review of the anxiolytic-like effects of essential oils in animal models". *Molecules* 20.10 (2010): 18620-18660.

36. Ríos JL and Recio MC. "Medicinal plants and antimicrobial activity". *Journal of Ethnopharmacology* 100.1-2 (2005): 80-84.

37. Hammer KA., *et al*. "Antimicrobial activity of essential oils and other plant extracts". *Journal of Applied Microbiology* 86.6 (1999): 985-990.

38. Sadlon AE and Lamson DW. "Immune-modifying and antimicrobial effects of *Eucalyptus* oil and simple inhalation devices". *Alternative Medical Review* 15.1 (2010): 33-47.

39. Boots AW., *et al*. "Health effects of quercetin: from antioxidant to nutraceutical". *European Journal of Pharmacology* 585.2-3 (2008): 325-337.

40. Sieben A., *et al*. "Alpha-hederin, but not hederacoside C and hederagenin from *Hedera helix*, affects β2-adrenergic receptor regulation". *Biochemistry* 48.15 (2009): 3477-3482.

41. Lee IS., *et al*. "Aromatherapy for managing respiratory diseases: a systematic review and meta-analysis". *Evidence-Based Complementary and Alternative Medicine* 2020 (2020): 1-15.

42. Swamy HL., *et al*. "Antimicrobial properties of plant essential oils against human pathogens and their mode of action: an updated review". *Evidence-Based Complementary and Alternative Medicine* 2016 (2016): 3012462.

43. Cushnie TPT and Lamb AJ. "Antimicrobial activity of flavonoids". *International Journal of Antimicrobe Agents* 26.5 (2005): 343-356.

44. Middleton E., *et al*. "The effects of plant flavonoids on mammalian cells: implications for inflammation, heart disease, and cancer". *Pharmacology Review* 52.4 (2000): 673-751.

45. Ghosh D., *et al*. "Natural products in diuretic therapy—an update". *Phytomedicine* 59 (2019): 152771.

46. Agarwal A., *et al*. "Antioxidants and male reproductive health: a review". *Antioxidants (Basel)* 12.4 (2023): 907.

47. Perez Gutierrez RM. "Review of medicinal plants in the management of female reproductive health". *Phytotherapy Research* 30.6 (2016): 916-931.

48. El-Baz A., *et al*. "Physio-metabolic response, immune function, epigenetic markers, and reproductive performance of rabbits under environmental stress: the mitigating role of *Boswellia* essential oil nanoemulsion". *BMC Veterinary Research* 21 (2025): 204.

49. Singh R., *et al*. "Evaluation of acute toxicity and antioxidant potential of *Polianthes tuberosa* L. extract in experimental models". *Journal of Pharmacognosy and Phytochemistry* 8.3 (2019): 213-218.

50. Reddy SR., *et al*. "Sub-chronic toxicity studies on tuberose (*Polianthes tuberosa* L.) extract in Wistar rats". *International Journal of Pharmaceutical Sciences and Research* 11.9 (2020): 4582-4587.