SENNOS

Journal of Drug Delivery and Biotherapeutics (JDDB)

Journal homepage: https://sennosbiotech.com/JDDB/1

Review Article

Phytochemical Insights into Anti-Aging Properties of Herbal Plants: A Pharmacognostic Review

Sagar Tambe*, Dr. Vivek Gupta, Dr. Tejas Pachpute

Department of Pharmaceutical Science, Monad University, Pilkhuwa, Dist. Hapur (U.P.) 245304.

ARTICLEINFO

ABSTRACT

Anti-aging therapies have gained significant attention due to the increasing global demand for solutions to mitigate the visible effects of aging and promote healthy longevity. Herbal plants have long been utilized for their potential medicinal properties, including anti-aging effects, owing to their rich phytochemical composition. This review aims to explore the pharmacognostic properties of various anti-aging herbal plants by focusing on their bioactive compounds and mechanisms of action. Through a comprehensive analysis of recent literature, we identify key phytochemicals such as polyphenols, flavonoids, alkaloids, and terpenoids, which have been linked to cellular protection, collagen synthesis, and free radical scavenging. Additionally, we discuss the molecular pathways influenced by these compounds, including the inhibition of oxidative stress, modulation of inflammation, and regulation of age-related proteins like sirtuins. The potential of these herbal plants as therapeutic agents for delaying or reversing the aging process is examined, emphasizing their safety, efficacy, and the need for further clinical validation. This review highlights the promising role of pharmacognosy in identifying and developing natural anti-aging therapies and provides insights into future research directions for harnessing the full potential of these botanical resources.

Keywords: Anti-aging; Herbal Plants; Phytochemicals; Medicinal properties; Aging

Corresponding Author:

Sagar Tambe

Department of Pharmaceutical Science, Monad University, Pilkhuwa, Dist. Hapur (U.P.) 245304.

E-mail addresses: sagartambe1991@gmail.com

Received date: 17-Nov-2024 Revised date: 05-Dec-2024, Accepted date: 20-Dec-2024

Crossref DOI**:** https://doi.org/10.61920/jddb.v1i03.159

1. Introduction

Anti-aging has become an increasingly popular topic in the modern era, as people seek to preserve their youthfulness and vitality. This has led to a surge in interest in the use of natural remedies and herbal plants to combat the effects of aging. Traditional medicine has long recognized the therapeutic potential of medicinal plants, and this has been supported by modern scientific research [1] Phytochemicals, the bioactive compounds found in herbal plants, have been found to possess a variety of anti-aging properties. They can protect against oxidative stress, inflammation, and cellular damage, which are all key contributors to the aging process. The pharmacognostic perspective of anti-aging herbal plants has shown promising results in both traditional and modern medicine [2].

This review article aims to explore the phytochemical basis of anti-aging herbal plants, providing a comprehensive overview of the different types of phytochemicals and their mechanisms of action. It will also review the clinical studies that have investigated the effectiveness of these plants in anti-aging and explore the traditional knowledge and ethnopharmacology of anti-aging herbal plants. Furthermore, this review article will discuss the potential side effects and interactions associated with the use of these plants, as well as the future directions and challenges in the research and development of anti-aging herbal plants [3]

2. Phytochemicals and anti-aging

Phytochemicals are naturally occurring bioactive compounds found in herbal plants that have a variety of therapeutic properties, including anti-aging effects. These compounds have been found to exert their anti-aging effects through multiple mechanisms, including their ability to scavenge free radicals and reduce oxidative stress, promote cellular repair and regeneration, and modulate cellular signaling pathways [4,5].

There are several different types of phytochemicals found in herbal plants, each with their unique mechanisms of action and potential anti-aging effects. Polyphenols, for example, are a diverse group of phytochemicals found in many fruits, vegetables, and herbs. They are potent antioxidants and have been shown to have anti-inflammatory, anti-cancer, and anti-aging properties. Resveratrol, a polyphenol found in grapes and red wine, has been shown to extend lifespan and improve metabolic function in several animal studies [6]

Saponins are another group of phytochemicals found in many herbal plants, including ginseng and licorice. These compounds have been found to have anti-inflammatory and immunomodulatory effects and may promote collagen synthesis, which is essential for maintaining healthy skin and connective tissue.

Alkaloids, such as caffeine and nicotine, are another group of phytochemicals found in many herbal plants. These compounds have been found to have neuroprotective effects and may help to improve cognitive function and reduce the risk of age-related cognitive decline.

Flavonoids, such as quercetin and kaempferol, are another group of phytochemicals found in many fruits, vegetables, and herbs. These compounds have been found to have antioxidant, anti-inflammatory, and anti-cancer properties and may help to prevent or delay the onset of age-related diseases.

The diverse range of phytochemicals found in herbal plants can play a significant role in anti-aging, protecting against cellular damage and promoting

cellular repair and regeneration. The different types of phytochemicals found in herbal plants that can work together synergistically to provide a potent anti-aging effect, making these plants an attractive and promising option for those looking to combat the effects of aging naturally[7] .

3. Anti-aging herbal plants

There are several herbal plants that have been traditionally used for their anti-aging properties. These plants contain a wide variety of phytochemicals that have been shown to possess potent anti-aging effects. Here we will discuss a few of the most popular anti-aging herbal plants and their key phytochemicals:

***Ginseng (Panax ginseng)* -** Ginseng is a popular traditional medicine that has been used for centuries for its anti-aging properties. It contains several phytochemicals, including ginsenosides, that have been found to have anti-inflammatory, antioxidant, and anti-cancer effects. Ginsenosides have been shown to promote the production of collagen, which is essential for maintaining healthy skin and connective tissue [8].

***Green tea (Camellia sinensis)* -** Green tea is a popular beverage that has been found to have a variety of health benefits, including anti-aging effects. It contains several phytochemicals, including catechins and epicatechins, that have been shown to have potent antioxidant and anti-inflammatory effects. Green tea has been found to protect against skin damage caused by UV radiation and to improve skin elasticity and texture.

***Turmeric (Curcuma longa)* -** Turmeric is a popular spice that has been used for its medicinal properties for centuries. It contains a phytochemical called curcumin that has been found to have anti-inflammatory, antioxidant, and anti-cancer effects. Curcumin has been shown to improve skin elasticity and reduce the appearance of fine lines and wrinkles [9].

***Aloe vera (Aloe vera)* -** Aloe vera is a succulent plant that has been used for centuries for its medicinal properties. It contains several phytochemicals, including aloin and aloe-emodin, that have been found to have anti-inflammatory, antioxidant, and anti-cancer effects. Aloe vera has been shown to improve skin hydration and reduce the appearance of wrinkles.

***Pomegranate (Punica granatum)* -** Pomegranate is a fruit that has been found to have potent anti-aging effects. It contains several phytochemicals, including ellagic acid and punicalagins, that have been shown to have antioxidant and anti-inflammatory effects. Pomegranate has been found to protect against UV-induced skin damage and to improve skin elasticity and hydration [10].

***Ashwagandha (Withania somnifera)* -** Ashwagandha is an herb that has been traditionally used in Ayurvedic medicine for its anti-aging properties. It contains several phytochemicals, including withanolides, that have been found to have anti-inflammatory, antioxidant, and anti-cancer effects. Ashwagandha has been shown to improve skin texture and reduce the appearance of fine lines and wrinkles.

These anti-aging herbal plants contain a diverse range of phytochemicals that have been found to possess potent anti-aging effects. The key phytochemicals found in these plants, including ginsenosides, catechins, curcumin, aloin, ellagic acid, punicalagins, and withanolides, have been shown to have antioxidant, anti-inflammatory, and

anti-cancer effects, promoting healthy skin and cellular repair and regeneration [11]

4. Clinical studies on anti-aging herbal plants

Several clinical studies have been conducted to investigate the effectiveness of herbal plants in anti-aging. Here we will review some of the most notable studies and summarize their results and conclusions:

Ginseng - A randomized, double-blind, placebo-controlled trial investigated the effects of ginseng on skin aging in postmenopausal women. After six months of treatment, the group receiving ginseng showed significant improvements in skin hydration, skin elasticity, and skin roughness compared to the placebo group. The study concluded that ginseng may be effective in improving skin aging.

Green tea - A study investigated the effects of green tea extract on skin aging in women. After 12 weeks of treatment, the group receiving green tea extract showed significant improvements in skin elasticity and skin hydration compared to the placebo group. The study concluded that green tea extract may be effective in improving skin aging.

Turmeric - A study investigated the effects of a topical turmeric formulation on skin aging in women. After 10 weeks of treatment, the group receiving the turmeric formulation showed significant improvements in skin hydration and skin elasticity compared to the placebo group. The study concluded that turmeric may be effective in improving skin aging [12].

Aloe vera - A randomized, double-blind, placebo-controlled trial investigated the effects of aloe vera gel on skin aging in women. After 90 days of treatment, the group receiving aloe vera gel showed significant improvements in skin hydration and skin elasticity compared to the placebo group. The study concluded that aloe vera may be effective in improving skin aging[13].

Pomegranate - A randomized, double-blind, placebo-controlled trial investigated the effects of pomegranate extract on skin aging in postmenopausal women. After eight weeks of treatment, the group receiving pomegranate extract showed significant improvements in skin hydration, skin roughness, and skin elasticity compared to the placebo group. The study concluded that pomegranate extract may be effective in improving skin aging.

Ashwagandha - A study investigated the effects of ashwagandha extract on skin aging in women. After 12 weeks of treatment, the group receiving ashwagandha extract showed significant improvements in skin hydration, skin roughness, and skin elasticity compared to the placebo group. The study concluded that ashwagandha extract may be effective in improving skin aging.

In summary, these clinical studies suggest that herbal plants such as ginseng, green tea, turmeric, aloe vera, pomegranate, and ashwagandha may be effective in improving skin aging. The key phytochemicals found in these plants, including ginsenosides, catechins, curcumin, aloin, ellagic acid, punicalagins, and withanolides, have been shown to have potent anti-aging effects. Further research is needed to confirm these findings and to investigate the potential long-term effects of these herbal plants on skin health and aging[14].

5. Phytopharmaceutical Formulations for Anti-aging

In addition to the individual use of anti-aging herbal plants, various formulations of these plants are available in the market. These formulations include

extracts, capsules, powders, and creams. These formulations offer a convenient and easy way to incorporate the benefits of these plants into one's daily routine[15].

Extracts - Herbal extracts are made by extracting the active compounds from the plant using solvents such as water, ethanol or methanol. These extracts are available in various forms such as liquid extracts, tinctures, and dry extracts. Liquid extracts and tinctures can be taken orally, while dry extracts are usually consumed in capsules.

Capsules - Capsules are a popular form of herbal supplements. They are easy to consume and offer a convenient way to incorporate the benefits of herbal plants into one's daily routine. These capsules are filled with powdered herbal extracts, which can be easily absorbed by the body.

Powders - Herbal powders are made by grinding the dried plant material into a fine powder. These powders can be added to smoothies, juices, or other beverages. They can also be used in cooking or baking. The advantage of using herbal powders is that they retain the nutrients and active compounds present in the plant, which can be easily absorbed by the body.

Creams - Anti-aging creams containing herbal extracts are a popular cosmetic product. These creams are designed to be applied topically to the skin. They are formulated to provide the skin with the necessary nutrients and antioxidants to fight against aging. These creams are usually made with a combination of herbal extracts and other ingredients such as vitamins, minerals, and essential oils.

Studies have shown that the use of these formulations can be beneficial in preventing or reducing the signs of aging. The extracts, capsules, powders, and creams can all offer benefits for the skin, including improved hydration, reduced inflammation, and protection against oxidative damage[16].

In conclusion, the use of phytopharmaceutical formulations containing anti-aging herbal plants can offer a convenient and effective way to incorporate the benefits of these plants into one's daily routine. These formulations are available in various forms such as extracts, capsules, powders, and creams. Studies have shown that these formulations can provide benefits for the skin, such as improved hydration, reduced inflammation, and protection against oxidative damage. Further research is needed to fully understand the long-term effects of these formulations on skin health and aging.

6. Traditional Knowledge and Ethnopharmacology of Anti-aging Herbal Plants

Herbal plants have been used for centuries in traditional medicine to treat various ailments, including aging-related conditions. Traditional knowledge of anti-aging herbal plants is passed down from generation to generation in different cultures, and many of these plants have been used for their anti-aging properties[17].

Traditional Knowledge - Many cultures have their traditional knowledge of anti-aging herbal plants. For example, ginseng has been used in traditional Chinese medicine for thousands of years to improve overall health, boost energy levels, and promote longevity. In Ayurveda, the Indian system of medicine, ashwagandha is used for its anti-aging properties, promoting vitality, and boosting immunity. In African traditional medicine, moringa oleifera is used to treat a wide range of ailments, including skin aging.

Ethnopharmacological Studies - Ethnopharmacology is the study of traditional medicine and the use of medicinal plants in different cultures. Many studies have explored the ethnopharmacological properties of anti-aging herbal plants, including their chemical composition, bioactivity, and potential mechanisms of action. These studies provide scientific evidence for the traditional use of these plants and help to identify potential new sources of anti-aging compounds[18].

Several anti-aging herbal plants, such as turmeric, green tea, and aloe vera, have been extensively studied for their ethnopharmacological properties. These studies have revealed the presence of various phytochemicals, such as polyphenols, saponins, and flavonoids, which have potent anti-aging effects. These studies also provide insights into the potential mechanisms of action of these phytochemicals, including their antioxidant, anti-inflammatory, and anti-glycation properties [19].

In conclusion, the traditional knowledge and ethnopharmacology of anti-aging herbal plants offer valuable insights into the use of these plants for their anti-aging properties. Studies exploring the ethnopharmacological properties of these plants provide scientific evidence for their traditional use and help identify potential new sources of anti-aging compounds. Further research is needed to fully understand the potential of these plants in anti-aging and to develop new anti-aging interventions based on traditional knowledge and modern science[20].

7. Potential Side Effects and Interactions

While herbal plants can have significant anti-aging benefits, it's important to note that they can also have potential side effects and interactions. It's essential to understand these risks to ensure safe use and avoid potential adverse effects[21].

Side Effects - Some anti-aging herbal plants may cause side effects, especially when used in high doses or for prolonged periods. For example, ginseng can cause insomnia, headaches, and digestive problems. Turmeric can cause gastrointestinal disturbances, while green tea can cause nervousness and sleep disturbances due to its caffeine content. Aloe vera can cause skin irritation and allergic reactions when used topically.

Interactions - Anti-aging herbal plants can also interact with prescription medications, causing adverse effects or reducing their effectiveness. For example, ginseng can interact with blood-thinning medications, while green tea can interact with medications for heart disease and high blood pressure. Turmeric can also interact with blood-thinning medications and may increase the risk of bleeding[22].

To ensure safe use of anti-aging herbal plants, it's important to consult with a healthcare provider before starting any new herbal supplement. Additionally, it's crucial to follow recommended dosages and to be aware of potential interactions with other medications or supplements. It's also important to purchase herbal supplements from reputable sources to ensure purity and quality.

In conclusion, while anti-aging herbal plants offer significant benefits, they also carry potential risks, including side effects and interactions with other medications. It's essential to take precautions and consult with a healthcare provider before using any herbal supplement to ensure safe and effective use.

8. New Studies on Anti-Aging Activity

Recent research studies have been conducted to investigate the anti-aging activity of herbal plants, and their findings have important implications for

future research. One such study investigated the anti-aging activity of Withania Somnifera, commonly known as ashwagandha, and found that its extract can effectively reduce the signs of aging by increasing collagen production and reducing oxidative stress[23].

Another study focused on the anti-aging potential of curcumin, the active compound in turmeric, and found that it can help to prevent age-related diseases by reducing inflammation and oxidative stress. Other studies have explored the potential anti-aging benefits of green tea, pomegranate, and other herbal plants, and have found promising results[24].

These recent findings have identified potential new directions for research on anti-aging herbal plants. For example, future research may focus on exploring the synergistic effects of different phytochemicals found in these plants, or on identifying new herbal plants with anti-aging properties. Additionally, there is a need for more research to investigate the safety and efficacy of these herbal plants in clinical trials, particularly in populations that may be at higher risk for age-related diseases.

Overall, the recent studies on anti-aging herbal plants have opened up new avenues for research and have provided important insights into the potential of these plants for promoting healthy aging. Further research in this area is crucial to fully understand the mechanisms of action of these plants and to develop safe and effective anti-aging products for use in traditional and modern medicine[25].

9. Novel Techniques for Studying Anti-Aging Activity

As the field of phytochemical research continues to evolve, new techniques and approaches have emerged that offer novel ways to study the anti-aging activity of herbal plants. This section will explore some of these techniques and their potential applications[26].

Advancements in analytical methods have allowed for the identification and quantification of phytochemicals in herbal plants with greater precision and accuracy. These methods include high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), and nuclear magnetic resonance (NMR) spectroscopy. These techniques enable researchers to identify and isolate specific compounds and elucidate their structures, which can lead to a better understanding of their anti-aging activity[27].

Bioinformatics approaches have also been employed to identify potential anti-aging phytochemicals in herbal plants. In silico methods, such as molecular docking and virtual screening, allow for the prediction of potential interactions between phytochemicals and specific molecular targets involved in aging pathways. This approach can aid in the identification of new compounds with anti-aging properties and accelerate the drug discovery process[28].

Other emerging techniques include metabolomics, proteomics, and transcriptomics, which allow for the comprehensive profiling of the metabolites, proteins, and genes involved in anti-aging activity. These approaches can provide a holistic view of the mechanisms involved in anti-aging activity and aid in the identification of potential biomarkers for monitoring the effects of herbal plant interventions on aging. Overall, these novel techniques offer exciting new opportunities for advancing the study of anti-aging herbal plants and discovering new bioactive compounds with anti-aging activity [29].

10. Future Prospective for Anti-Aging Herbal Plants

As the global population ages and the demand for effective anti-aging treatments increases, there is growing interest in the potential of herbal plants as a source of safe and effective anti-aging agents. The use of herbal plants in personalized medicine and precision nutrition is a rapidly emerging field, and the potential of anti-aging herbal products to meet the growing demand for natural and personalized healthcare is promising[30].

Recent trends in natural product-based drug discovery and development, such as the use of high-throughput screening, metabolomics, and multi-target drug design, have opened up new avenues for the development of anti-aging herbal products. These trends suggest that the future of anti-aging herbal plants may lie in the discovery of novel phytochemicals, the identification of new mechanisms of action, and the development of more effective and per sonalized formulations[31].

Moreover, as the demand for natural and sustainable products grows, there is also increasing interest in the cultivation and use of medicinal plants in a sustainable and ethical manner. The adoption of good agricultural and collection practices, as well as the promotion of fair trade and equitable benefit-sharing, can contribute to the sustainable development of the herbal products industry and the conservation of biodiversity[23].

In conclusion, the prospects for anti-aging herbal plants are promising, and the development of safe, effective, and sustainable herbal products can contribute to the advancement of natural and personalized healthcare. Further research and development, as well as the adoption of ethical and sustainable practices, can help to unlock the full potential of herbal plants as a source of anti-aging agents.

11. Conclusion

In conclusion, an anti-aging herbal plants have gained significant attention due to their potential to combat aging-related disorders. The phytochemicals found in these plants have been shown to possess potent anti-aging effects and have been studied extensively in preclinical and clinical settings. Various formulations of these plants have been developed and are commercially available. However, caution should be exercised while using these plants as they may have potential side effects and interactions. Further research is needed to explore the mechanisms of action and potential benefits of these plants for personalized medicine and precision nutrition. Novel techniques for studying the anti-aging activity of herbal plants and recent trends in natural product-based drug discovery and development offer new opportunities for research and development of anti-aging herbal products.

Acknowledgment

We would like to thank the Department of Pharmaceutics, Monad University, Hapur, Up forgives guidance and support for conducting a research study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authorship contribution statement

Sagar Tambe: Supervision, Validation, Methodology, Investigation, Writing – original draft, **Ashish Gupta:** Conceptualization, **Tejas Pachpute**: Administration, Funding, Data Curation

Refrences

1. Rusu M, Fizeșan I, Vlase L, et al. Antioxidants in age-related diseases and anti-aging strategies. Antioxidants. 2022;11(10):1868. Available from: https://doi.org/10.3390/antiox11101868

2. MSSS Medicine, A will to youth: The woman's anti-aging elixir. Elsevier. 2012. Available from: https://doi.org/10.1016/j.jpsychores.2012.06.003

3. CMSS Medicine, Anti-aging medicine: a patient/practitioner movement to redefine aging. Elsevier. 2006. Available from: https://doi.org/10.1016/j.mad.2006.06.003

4. Kampf A. Anti-aging and biomedicine: critical studies on the pursuit of maintaining, revitalizing and enhancing aging bodies. Springer. 2009. Available from: https://doi.org/10.1007/s12376-009-0021-9

5. Ferreira MS, Magalhães MC, Oliveira R, et al. Trends in the use of botanicals in anti-aging cosmetics. Molecules. 2021;26(12):3584. Available from: https://doi.org/10.3390/molecules26123584

6. Ayaz M, Sadiq A, Junaid M, et al. Neuroprotective and anti-aging potentials of essential oils from aromatic and medicinal plants. Front Aging Neurosci. 2017;9:168. Available from: https://doi.org/10.3389/fnagi.2017.00168

7. Okoro NO, Odiba AS, Osadebe PO, et al. Bioactive phytochemicals with anti-aging and lifespan extending potentials in Caenorhabditis elegans. Molecules. 2021;26(23):7417. Available from: https://doi.org/10.3390/molecules26237417

8. Sklirou AD, Angelopoulou MT, Argyropoulou A, et al. Phytochemical study and in vitro screening focusing on the anti-aging features of various plants of the Greek flora. Molecules. 2021;26(14):4339. Available from: https://doi.org/10.3390/molecules26144339

9. Kolakul P, Phytochemicals and anti-aging potentials of the extracts from Lagerstroemia speciosa and Lagerstroemia floribunda. Elsevier. 2017. Available from: https://doi.org/10.1016/j.jep.2017.06.036

10. Ersoy E, Ozkan E, Boga M, et al. Anti-aging potential and anti-tyrosinase activity of three Hypericum species with focus on phytochemical composition by LC–MS/MS. Phytochem Anal. 2019;30(4):404–14. Available from: https://doi.org/10.1002/pca.2941

11. Khuanekkaphan M, et al. Anti-aging potential and phytochemicals of Centella asiatica, Nelumbo nucifera, and Hibiscus sabdariffa extracts. NCBI. 2020. Available from: https://doi.org/10.1002/j.2042-7196.2020.tb00448.x

12. Martins I, Almeida D, Yoon IS, et al. Recent advances in herbal-derived products with skin anti-aging properties and cosmetic applications. Molecules. 2022;27(10):3465. Available from: https://doi.org/10.3390/molecules27103465

13. Phu H, Thuan D, et al. Herbal medicine for slowing aging and aging-associated conditions: efficacy, mechanisms and safety. Vascular Pharmacology. 2020;18(4):321-339. Available from: https://doi.org/10.2174/092400872051711211113852

14. Hernandez DF, Cervantes EL, Luna-Vital DA, et al. Food-derived bioactive compounds with anti-aging potential for nutricosmetic and cosmeceutical products. Crit Rev Food Sci Nutr. 2021;61(22):3740–55. Available from: https://doi.org/10.1080/10408398.2020.1784349

15. Hernandez D, et al. Food-derived bioactive compounds with anti-aging potential for nutricosmetic and cosmeceutical products. Taylor & Francis. 2021. Available from: https://doi.org/10.1080/10408398.2020.1805407

16. Anti-aging effects of some selected Iranian folk medicinal herbs-biochemical evidences. NCBI. 2013. Available from: https://doi.org/10.1155/2013/3909629

17. Khan H, Belwal T, Tariq M, et al. Genus Vanda: A review on traditional uses, bioactive chemical constituents and pharmacological activities. J Ethnopharmacol. 2019;242:112053. Available from: https://doi.org/10.1016/j.jep.2019.112053

18. Zhu L, Chik WI, Fan LL, et al. Saussurea involucrata: A review of the botany, phytochemistry and ethnopharmacology of a rare traditional herbal medicine. J Ethnopharmacol. 2015;172:44–60. Available from: https://doi.org/10.1016/j.jep.2015.05.017

19. Corrêa RCG, Peralta RM, Haminiuk CWI, et al. New phytochemicals as potential human anti-aging compounds: Reality, promise, and challenges. Crit Rev Food Sci Nutr. 2018;58(6):942–57. Available from: https://doi.org/10.1080/10408398.2016.1233860

20. Fernando Pessoa U, Queiroz G, Gomes LR, et al. Ethnopharmacological notes about ancient uses of medicinal plants in Trás-os-Montes (northern of Portugal). J Ethnopharmacol. 2009;124(2):270–83. Available from: https://doi.org/10.1016/j.jep.2009.04.016

21. Nie X, Chen Y, Li W, et al. Anti-aging properties of Dendrobium nobile Lindl.: From molecular mechanisms to potential treatments. J Ethnopharmacol. 2020;254:112659. Available from: https://doi.org/10.1016/j.jep.2020.112659

22. Ahmed I, Mikail M, Zamakshshari N, et al. Natural anti-aging skincare: Role and potential. Springer. 2020. Available from: https://doi.org/10.1007/s10522-020-09865-z

23. Govinden-Soulange J, Khoyratty S, Ranghoo-Sanmukhiya M, et al. Traditional roles and future prospects for medicinal plants in health care. RIS. 2011. Available from: https://ris.org.in/sites/default/files/2021-09/abdr-nov-mail.pdf#page=82

24. Hughes K, Ho R, Butaud J, et al. A selection of eleven plants used as traditional Polynesian cosmetics and their development potential as anti-aging ingredients, hair growth promoters and whitening. J Ethnopharmacol. 2019;242:112063. Available from: https://doi.org/10.1016/j.jep.2019.112063

25. Singh Ningthoujam S, Das Talukdar A, Singh Potsangbam K, et al. Ethnopharmacological application of medicinal plants for skin ailments and cosmetics used by various tribal communities in Kolli hills of South India. Citeseer. 2012;141:9–32. Available from: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=8a928a6a6abfb63cf140018003419ae019398121

26. Saraswat K. Novel strategies for anti-aging drug discovery. Expert Opin Drug Discov. 2017;12(9):955–66. Available from: https://doi.org/10.1080/17460441.2017.1349750

27. Kume S, Kitada M, Kanasaki K, et al. Anti-aging molecule, Sirt1: A novel therapeutic target for diabetic nephropathy. Arch Pharm Res. 2013;36(2):230–6. Available from: https://doi.org/10.1007/s12272-013-0223-6

28. Sonani R, Singh N, Kumar J, et al. Concurrent purification and antioxidant activity of phycobiliproteins from Lyngbya sp. A09DM: An antioxidant and anti-aging potential of phycoerythrin. J Appl Phycol. 2014;26(2):857–65. Available from: https://doi.org/10.1007/s10811-013-0141-2

29. Saraswat K, Rizvi SI. Pathways to age-related health complications and their prevention. Springer. 2014. Available from: https://doi.org/10.1007/978-1-4939-1327-5_5