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Phytotherapy: The Significance and Application of Selected Medicinal Plants in Modern Medicine

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ABSTRACT

Introduction: Phytotherapy, the field focused on utilizing medicinal plants for the prevention and treatment of diseases, plays a crucial role in a sustainable approach to healthcare. In the context of growing interest in natural therapies, attention is increasingly directed toward species such as *Urtica dioica* (common nettle), *Berberis vulgaris* (common barberry), and *Withania somnifera* (common ashwagandha). These plants, renowned for their richness in active compounds like flavonoids, alkaloids, lignans, and withanolides, offer a wide range of therapeutic effects.

This paper examines the role of these species in modern medicine, highlighting their importance in the treatment and prevention of chronic conditions such as diabetes, cardiovascular disorders, and cancer. It discusses their unique biochemical properties, mechanisms of action, and evidence of efficacy gathered through clinical studies. With advanced extraction techniques and phytochemical analysis, the pharmacological potential of these plants has been thoroughly explored, opening up new possibilities for integrating natural ingredients into holistic healthcare approaches. Phytotherapy based on these plants reflects not only their centuries-old tradition but also their growing importance in contemporary, sustainable medicine.

Aim of study: The aim of this scientific paper is to summarize the available knowledge on the significance and application of various medicinal plants used in modern medicine. Particular emphasis has been placed on their impact on metabolic syndrome, obesity, as well as the gastrointestinal, cardiovascular, and renal systems.

Material and methods: The literature available in PubMed, and the Google Scholar database was reviewed using the following keywords: „phytotherapy''; „herbal therapy''; „botanical characteristics"; „medicinal plants"; „utrica dioica"; „berberine"; „barberis vulgaris"; **"**withania somnifera"

Keywords: ,phytotherapy, herbal therapy, botanical characteristics, medicinal plants, utrica dioica, berberine, berberis vulgaris, withania somnifera

Urtica dioica

Botanical Characteristics

Urtica dioica, commonly known as stinging nettle, is a nitrophilous perennial herbaceous plant that can reach a height of 1 to 2 meters, depending on soil conditions [1,3]. This species is distinguished by the presence of fine, stinging hairs on the surfaces of its stems and leaves, which are elongated, serrated, and exhibit a characteristic fibrous structure. The stem, which has a quadrangular cross-section and is branched, contains numerous bioactive substances responsible for its broad spectrum of pharmacological properties, including antioxidant, antibacterial, anti-inflammatory, and analgesic effects [1,2]. The flowers are small, ranging in color from reddish-brown to greenish-white, predominantly unisexual, and appear in spike-like clusters on the axis of the upper leaves; the male flowers possess 4-5 long sepals, while the female flowers have 4 short sepals and a superior ovary [3]. The leaves of Urtica dioica are dark green, opposite, serrated, elongated, or ovate with a cordate base, and are covered in stinging hairs that serve as the plant's natural defense mechanism [3,4].

Chemical composition

Stinging nettle (Urtica dioica) serves as a source of numerous bioactive compounds that enhance its therapeutic effects, making it a valuable plant in modern phytotherapy [5,6,7]. Phytochemical studies of Urtica dioica have identified the presence of multiple bioactive substances, including flavonoids, phenolic acids, and lignans, which play a crucial role in its medicinal properties. This plant demonstrates a broad spectrum of biological activities, including antioxidant, anti-inflammatory, and antimicrobial effects. Moreover, these compounds may support the body's defense mechanisms, positioning stinging nettle as a promising component in the treatment and prevention of various diseases [6]. Flavonoids present in Urtica dioica extracts exhibit potent antioxidant properties, contributing to cellular protection against oxidative stress. Additionally, these bioactive molecules may significantly influence the modulation of inflammatory processes, rendering them potential candidates for therapeutic applications in oncology [5]. Urtica dioica is also a rich source of essential vitamins that support bodily functions. It contains substantial levels of vitamin C, a powerful antioxidant that safeguards cells from oxidative damage and facilitates collagen synthesis, thereby promoting the health of the skin and blood vessels. Vitamin K also found in stinging nettle, is vital for the proper coagulation process and supports bone health by regulating calcium metabolism. Furthermore, B vitamins, such as B2 (riboflavin) and B3 (niacin), contribute to maintaining optimal energy metabolism and support tissue regeneration and nervous system function [6,7]. Phenolic acids in Urtica dioica display strong antioxidant capacities, protecting

cells from oxidative stress and promoting regenerative processes in the body. Additionally, these bioactive compounds can modulate inflammatory responses, making them valuable in the prevention and treatment of chronic conditions. Lignans, another class of compounds found in stinging nettle, exhibit phytoestrogenic activity, which may aid in hormonal balance and positively impact cardiovascular health. These properties underscore stinging nettle's potential as an important component in modern phytotherapy [5,6,7].

Medicinal properties

Stinging nettle (Urtica dioica) is a plant renowned for its versatile therapeutic properties, which have been utilized in traditional medicine for centuries. Modern research confirms its efficacy in alleviating inflammation, supporting urinary tract health, and mitigating allergy symptoms. It also promotes skin and hair health, making it a valuable component in dermatological and cosmetic preparations. Furthermore, stinging nettle can aid in managing rheumatism, reducing blood sugar levels, and enhancing overall immunity, establishing its significance in preventive healthcare [3,4].

Stinging nettle exhibits potent anti-inflammatory effects, making it beneficial in the treatment of conditions such as arthritis and chronic muscle pain. Its mechanism of action involves inhibiting enzymes like COX-1 and COX-2, which are responsible for inflammatory processes, thereby reducing the production of inflammatory mediators. Additionally, nettle limits the release of cytokines and other pro-inflammatory factors, highlighting its utility in both acute and chronic inflammatory conditions [6,7].

Extracts from stinging nettle demonstrate promising anti-cancer properties, attributed to its bioactive compounds with antioxidant and immunomodulatory activities. These substances inhibit cancer cell proliferation by regulating signaling pathways associated with apoptosis and the cell cycle. Moreover, nettle reduces oxidative stress, a critical factor in the initiation and progression of cancers, and shows potential in suppressing angiogenesis, thereby impeding tumor growth by limiting nutrient supply. These features establish nettle as a potential adjuvant in cancer therapy [4,5]. Studies indicate that nettle compounds may inhibit enzymes such as 5-α-reductase and aromatase, which play pivotal roles in the progression of prostate cancer by regulating hormonal levels. Additionally, nettle is being explored for its potential in managing breast cancer by inhibiting cancer cell proliferation and reducing angiogenesis. Evidence also suggests its capacity to mitigate oxidative stress and enhance immune responses in gastrointestinal cancers, underlining its potential in supportive oncology treatments, though further clinical studies are warranted [5,6].

In vivo studies have demonstrated that aqueous extracts of stinging nettle leaves possess antidiabetic properties, aiding in blood glucose regulation. Experiments on diabetic mice revealed that nettle reduces glucose absorption in the intestines, contributing to lowered blood sugar levels. Furthermore, nettle has been observed to stimulate insulin secretion, a finding confirmed in studies on both healthy and diabetic rats after intraperitoneal administration of aqueous extracts. These attributes position nettle as a promising agent in diabetes management [6].

Stinging nettle supports the treatment of urinary tract infections through its anti-inflammatory and diuretic properties. By promoting increased urine output, it facilitates the removal of bacteria from the urinary tract, aiding in detoxification. Additionally, its bioactive compounds alleviate inflammation of the mucosal linings in the urinary system, accelerating tissue regeneration and reducing discomfort associated with infections. These properties make nettle a widely utilized natural aid in managing urinary tract infections [6,7,8].

Extracts of stinging nettle exhibit anti-allergic effects, making them an effective remedy for allergic rhinitis. The bioactive compounds in nettle act on key receptors and enzymes involved in allergic responses, reducing the release of histamine and other inflammatory mediators. Clinical trials have demonstrated that nettle root extracts can alleviate allergy symptoms such as nasal congestion, sneezing, and itching by modulating immune responses. Additionally, nettle supports immune system balance, helping to decrease hypersensitivity to environmental allergens. These properties highlight nettle's potential as a supportive treatment for allergies [9,10].

Berberis vulgaris

Botanical Characteristics

Berberis vulgaris L. (family Berberidaceae), commonly known as barberry, is widely recognized in Europe and has been traditionally utilized in folk medicine. Various parts of this plant, including its roots, bark, leaves, and fruits, have been utilized for their medicinal properties [11]. Barberry is a spiny, deciduous shrub that can reach a height of up to 4 meters. It is native to large parts of Europe, as well as regions of northwestern Africa and western Asia, and has successfully naturalized in northern Europe and North America [13]. The *Berberis* genus comprises spiny shrubs, which can be either deciduous or evergreen and are distinguished by their yellow wood and flowers. These plants exhibit dimorphic growth, featuring both long and short shoots. The long shoots bear modified leaves that do not participate in photosynthesis but instead develop into three-spined thorns. In contrast, the short shoots produce functional

leaves, which range from 1 to 10 cm in length and can be either simple with smooth edges or serrated with spiny margins. The flowers of *Berberis* can appear singly or in racemes within a single inflorescence. These flowers, typically yellow or orange, measure between 3 and 6 mm in length and consist of six sepals and six petals arranged in alternating whorls, often displaying a similar coloration. The fruits of this genus are small berries, ranging from 5 to 15 mm in size, which transition to either red or blue as they mature [12].

Chemical composition

Over the past two decades, extensive research has highlighted the pharmacological and therapeutic potential of *B. vulgaris* and its isoquinoline alkaloids, particularly berberine. Phytochemical analyses have identified isoquinoline alkaloids, including berberine, berbamine, and palmatine, as the primary bioactive constituents of this species. Among them, berberine is the most extensively investigated protoberberine alkaloid due to its diverse biological activities [11].

Medicinal properties

The lipid-lowering effects and improvement of insulin resistance are among the most extensively investigated properties of berberine in numerous randomized clinical trials [11,12]. Additionally, clinical studies have explored its potential therapeutic applications in cardiovascular diseases, oncology, gastrointestinal disorders, central nervous system conditions, endocrine dysfunctions, and other health concerns. Berberine exhibits low toxicity when administered at standard doses and has demonstrated clinical benefits with minimal adverse effects. The most commonly reported side effects are mild gastrointestinal disturbances in some patients. [14,15]

The hypoglycemic properties of berberine were first documented in 1988 during its therapeutic application for diarrhea management in diabetic patients in China. This observation led to further investigations into its potential role in glucose metabolism regulation and its efficacy as an antidiabetic agent [16].

Berberine has been shown to significantly reduce glycated hemoglobin (HbA1c) levels in patients with diabetes, with its efficacy in lowering HbA1c being comparable to that of metformin, a commonly prescribed oral hypoglycemic agent. In monotherapy, both berberine and metformin improved glycemic parameters, including HbA1c, fasting blood glucose (FBG), and postprandial blood glucose (PBG)[17,18]. However, their effects on lipid metabolism differed. Berberine demonstrated a significant reduction in serum triglycerides and total cholesterol levels. While reductions in high-density lipoprotein cholesterol (HDL-C) and low-

density lipoprotein cholesterol (LDL-C) were also observed, these changes did not reach statistical significance. Further research is required to determine whether berberine exerts a definitive lowering effect on HDL-C. In contrast, metformin exhibited minimal impact on lipid parameters [18,19].

The development of novel derivatives and formulations of berberine represents a significant challenge for researchers due to its inherently low bioavailability and suboptimal pharmacokinetic properties, which continue to hinder its potential therapeutic applications. Consequently, the design of new formulations and structurally modified derivatives that retain comparable biological activity while overcoming these pharmacological limitations has become a primary focus of scientific inquiry [21]. Current research efforts are directed toward the synthesis of berberine-based compounds that exhibit enhanced potency at lower concentrations and improved pharmacokinetic profiles. Recent studies emphasize the crucial correlation between berberine's structural characteristics and its biological activity, shedding light on strategies for optimizing its therapeutic efficacy [20].

Withania somnifera

Botanical Characteristics

Withania somnifera (W. Somnifera), Dunal (Solanaceae), also named as ''Winter cherry'' or ''Indian Ginseng''[22]. It is a perennial shrub that is evergreen, drought-tolerant, and woody. It typically reaches a height of around 2 meters and has a width of about 1 meter. The plant is native to the arid regions of tropical and subtropical areas, such as the Canary Islands, the Mediterranean, parts of Africa, China, South Asia (including India and Sri Lanka), and the Middle East [23]. The plant is primarily used for medicinal purposes, with freshly dried roots being the main therapeutic component, though its leaves, flowers, seeds, and fruits are also utilized. It is widely employed in Ayurvedic and Unani medicine [22]. The plant features tomentose branches covered in short silver-gray hairs, with brownish, prostrate to erect stems. Its alternate, almost hairless leaves are green on top and densely hairy underneath. Small, green, bell-shaped flowers with a 5-lobed calyx and light yellow to yellow-green, campanulate corolla appear at the leaf nodes. The fruit is a spherical berry, 5–8 mm in diameter, turning orange-red when ripe and enclosed in a membranous calyx. The roots are stout, fleshy, with fibrous secondary branches, and emit a strong odor with a bitter, acrid taste [24].

Origin of the name

The species name "somnifera" is derived from the Latin word meaning "sleep-inducer," due to its remarkable anti-stress properties. The common name "Ashwagandha" comes from the

Sanskrit words "ashwa," meaning horse, and "gandha," meaning smell, referring to the distinct "wet horse" scent of its roots. It is also known as Indian ginseng because of its similar pharmacological effects and traditional use, like Korean ginseng tea [24].

Chemical composition

Withania somnifera has been used for medicinal purposes for thousands of years, stretching back to around 6,000 years ago. Its primary bioactive compounds include withanolides (such as Withaferin A, Withanolide A, and Withanone), sitoindosides, Withanosides, and various alkaloids, all believed to offer potential therapeutic benefits. The plant produces natural bioactive substances rich in phenols, steroids, and flavonoids, which are known for their good biocompatibility, bioavailability, and low toxicity [25]. The pharmacological properties of Withania somnifera are well-established, with the roots being the most commonly used in Ayurvedic medicine. The stems and leaves also contain valuable bioactive compounds like steroidal lactones, alkaloids, and phenolic acids. Metabolomic studies show that the plant's metabolite profile varies based on the part of the plant, its developmental stage, season of collection, and geographical location. Withanolide levels differ depending on the morpho/chemotypes of the species [26]. Plenty of phytochemicals mentioned before have been extracted from Withania somnifera using methods such as column chromatography, thin-layer chromatography (TLC), and high-performance liquid chromatography (HPLC). These methods involve analyzing methanolic extracts from different parts of the plant, like leaves and twigs.

Medicinal properties

There are many recent scientific research focusing on the medicinal properties of WS. Its bioactive compounds are tested, because of its unique properties like: exhibiting neuroprotective, immunomodulatory, adaptogenic, anti-stress, and bone health, and the plant has shown promising anti-cancer properties [29].

The Randomized Controlled Trial proved that the standardized Withania somnifera extract of leaves and roots used in chronically stressed people can safely and effectively reduce stress parameters. The results were both confirmed in validated questionnaires, but also using stress-related biomarkers in a dose-dependent manner. Moreover, the authors claim that the study subjects tolerance to the drug was very well, and patients did not report side effects of its use [27].

Scientists also tested Withania somnifera extract in women during perimenopause. Their study proved that Ashwagandha root extract may offer a safe and effective solution for alleviating mild to moderate menopausal symptoms during perimenopause in women. It was also linked to

a significant increase in serum estradiol and a notable decrease in serum FSH and LH levels compared to the placebo. No significant difference was observed in serum testosterone levels between the groups with WS extract and placebo [28].

As written before WS is reached in phytoconstituents like alkaloids, steroids, flavonoids, phenolics, nitrogen-containing compounds, and trace elements. Withanolides, the primary alkaloids in the plant, contribute to its anticancer properties due to their high oxygen content. The plant has shown strong effectiveness against various cancers, including colon, breast, lung, prostate, skin, blood, liver, and kidney cancers. Additionally, clinical studies have shown that active compounds like Withaferin-A and Withanolide-D have minimal toxicity [30].

Another research focuses on ashwagandha root extract supplementation in people who work out. The results show that supplementing with WS root extract for eight weeks, combined with resistance training, effectively enhances muscle strength, growth, and endurance in both men and women. WS root extract may serve as a safe, effective, and affordable option for athletes looking to boost muscle endurance [31].

Conclusions

Urtica dioica (common nettle), Berberis vulgaris (common barberry), and Withania somnifera (common ashwagandha) are examples of plants with significant importance in modern phytotherapy, attributed to their rich content of bioactive compounds and extensive therapeutic applications. Common nettle exhibits anti-inflammatory, antidiabetic, and anticancer properties, aiding in the management of diabetes, allergies, and urinary tract infections. Common barberry, with berberine as its key bioactive component, demonstrates lipid-lowering, antidiabetic, and cardioprotective effects, while also supporting the treatment of cancer. Ashwagandha, known for its high content of withanolides, sitoindosides, and alkaloids, showcases adaptogenic, neuroprotective, and anticancer activities, enhancing both mental and physical health.

These three plants play a crucial role in modern medical practices, offering natural and effective therapeutic solutions for a variety of chronic diseases. Their bioactive components work synergistically in reducing oxidative stress, modulating inflammatory processes, and regulating metabolism, making them essential elements of contemporary phytotherapy. Due to their low toxicity and clinically confirmed efficacy, Urtica dioica, Berberis vulgaris, and Withania somnifera are valuable tools in the treatment and prevention of chronic diseases such as diabetes, cancer, and atherosclerosis, as well as improving overall patient well-being.

Phytotherapy utilizing these plants highlights their therapeutic potential and emphasizes their growing importance in integrating natural components into modern medicine.

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References:

[1] Dhouibi R, Affes H, Ben Salem M, Hammami S, Sahnoun Z, Zeghal KM, Ksouda K. Screening of pharmacological uses of Urtica dioica and others benefits. Prog Biophys Mol Biol. 2020 Jan;150:67-77. doi: 10.1016/j.pbiomolbio.2019.05.008. Epub 2019 Jun 1. PMID: 31163183.

[2] Gülçin I, Küfrevioglu OI, Oktay M, Büyükokuroglu ME. Antioxidant, antimicrobial, antiulcer and analgesic activities of nettle (Urtica dioica L.). J Ethnopharmacol. 2004 Feb;90(2-3):205-15. doi: 10.1016/j.jep.2003.09.028. PMID: 15013182.

[3] Jasaman Taheri , 1 Cristina Quispe,2 Jezumy Herrera-Bravo , 3 , 4 Javad Sharifi-Rad , 1, 5Shahira M. Ezzat , 6 , 7 Rana M. Merghany, 8 Szabnum Szaheen,9 Lubna Azmi, 10Abhay Prakash Mishra , 11 Zęba Sener,12 Mehtap Kılıç, 13 Surjit Sen, 14,15Krishnendu Acharya, 14 Azadeh Nasiri, 16 Nat´p.s. Cruz-Martins , 17,18,19,20Patrick Valere Tsouh Fokou , 21 Alibeka Ydyrysa, 22 Żandos Bassygarayev,23Sevgi Durna Dasdębnik, 24,25 Mohammed M. Alshehri , 26 Daniela Calina , 27i William C. Cho; *Urtica dioica*-Derived Phytochemicals for Pharmacological and Therapeutic Applications; Evidence-based Complementary and Alternative Medicine 2022 | Journal article DOI: 10.1155/2022/4024331

[4] Jinous Asgarpanah, Mohajerani R; Phytochemistry and pharmacologic properties of Urtica dioica L; Journal of Medicinal Plants Research Vol. 6(46), pp. 5714-5719, 3 December, 2012; DOI: 10.5897/JMPR12.540;

[5] Sabrina Esposito, Alessandro Bianco, Rosita Russo, Antimo Di Maro , Carla Isernia and Paolo Vincenzo Pedone; Therapeutic Perspectives of Molecules from Urtica dioica Extracts for Cancer Treatment; Department of Environmental, Biological, and Pharmaceutical Sciences and Technologies, University of Campania “Luigi Vanvitelli”, 81100 Caserta, Italy; https://doi.org/10.3390/molecules24152753

[6] Khuma Kumari Bhusal, Saraddha Khasu Magar, Ronika Thapa, Ashish Lamsal, Sagar Bhandari, Rashmi Maharjan, Sami Shrestha, Jiban Shrestha; Nutritional and pharmacological importance of stinging nettle (Urtica dioica L.): A review; Received 3 February 2022; Received in revised form 10 March 2022; Accepted 8 June 2022; https://doi.org/10.1016/j.heliyon.2022.e09717

[7] Nicola Di Virgilio, Eleni G. Papazoglou, Zofija Jankauskiene, Sara Di Lonardo, Marcin Praczyk, Kataryna Wielgusz; The potential of stinging nettle (Urtica dioica L.) as a crop with multiple uses; June 2015; Industrial Crops and Products 68:42-49; DOI:10.1016/j.indcrop.2014.08.012

[8] Yarnell, E. Leki botaniczne na drogi moczowe. World J Urol 20 , 285–293 (2002). https://doi.org/10.1007/s00345-002-0293-0Yarnell, E. Leki botaniczne na drogi moczowe. World J Urol 20 , 285–293 (2002). https://doi.org/10.1007/s00345-002-0293-0

[9] Bill Roschek Jr., Ryan C. Fink, Matthew McMichael, Randall S. Alberte; Nettle extract (Urtica dioica) affects key receptors and enzymes associated with allergic rhinitis; https://doi.org/10.1002/ptr.2763

[10] Bakhshaee M, Mohammad Pour AH, Esmaeili M, Jabbari Azad F, Alipour Talesh G, Salehi M, Noorollahian Mohajer M. Efficacy of Supportive Therapy of Allergic Rhinitis by Stinging Nettle (Urtica dioica) root extract: a Randomized, Double-Blind, Placebo-Controlled, Clinical Trial. Iran J Pharm Res. 2017 Winter;16(Suppl):112-118. PMID: 29844782; PMCID: PMC5963652.

[11] Imanshahidi M, Hosseinzadeh H. Pharmacological and therapeutic effects of Berberis vulgaris and its active constituent, berberine. Phytother Res. 2008 Aug;22(8):999-1012. doi: 10.1002/ptr.2399. PMID: 18618524.

[12] Mokhber-Dezfuli N, Saeidnia S, Gohari AR, Kurepaz-Mahmoodabadi M. Phytochemistry and pharmacology of berberis species. Pharmacogn Rev. 2014 Jan;8(15):8-15. doi: 10.4103/0973-7847.125517. PMID: 24600191; PMCID: PMC3931204.

[13] Ruhsam M; Royal Botanic Garden Edinburgh Genome Acquisition Lab; Darwin Tree of Life Barcoding collective; Plant Genome Sizing collective; Wellcome Sanger Institute Tree of Life Management, Samples and Laboratory team; Wellcome Sanger Institute Scientific Operations: Sequencing Operations; Wellcome Sanger Institute Tree of Life Core Informatics team; Tree of Life Core Informatics collective; Darwin Tree of Life Consortium. The genome sequence of *Berberis vulgaris* L. Wellcome Open Res. 2024 Dec 3;9:710. doi: 10.12688/wellcomeopenres.23427.1. PMID: 39925663; PMCID: PMC11803380.

[14] Alpaslan Ağaçdiken A, Göktaş Z. Berberine-induced browning and energy metabolism: mechanisms and implications. PeerJ. 2025 Feb 7;13:e18924. doi: 10.7717/peerj.18924. PMID: 39931072; PMCID: PMC11809318.

[15] Imenshahidi M, Hosseinzadeh H. Berberine and barberry (Berberis vulgaris): A clinical review. Phytother Res. 2019 Mar;33(3):504-523. doi: 10.1002/ptr.6252. Epub 2019 Jan 13. PMID: 30637820.

[16] Ni YX. [Therapeutic effect of berberine on 60 patients with type II diabetes mellitus and experimental research]. Zhong Xi Yi Jie He Za Zhi. 1988 Dec;8(12):711-3, 707. Chinese. PMID: 3248329.

[17] DeFronzo RA, Goodman AM. Efficacy of metformin in patients with non-insulin-dependent diabetes mellitus. The Multicenter Metformin Study Group. N Engl J Med. 1995 Aug 31;333(9):541-9. doi: 10.1056/NEJM199508313330902. PMID: 7623902.

[18] Yin J, Xing H, Ye J. Efficacy of berberine in patients with type 2 diabetes mellitus. Metabolism. 2008 May;57(5):712-7. doi: 10.1016/j.metabol.2008.01.013. PMID: 18442638; PMCID: PMC2410097.

[19] Kong W, Wei J, Abidi P, Lin M, Inaba S, Li C, Wang Y, Wang Z, Si S, Pan H, Wang S, Wu J, Wang Y, Li Z, Liu J, Jiang JD. Berberine is a novel cholesterol-lowering drug working through a unique mechanism distinct from statins. Nat Med. 2004 Dec;10(12):1344-51. doi: 10.1038/nm1135. Epub 2004 Nov 7. PMID: 15531889.

[20] Och A, Och M, Nowak R, Podgórska D, Podgórski R. Berberine, a Herbal Metabolite in the Metabolic Syndrome: The Risk Factors, Course, and Consequences of the Disease. Molecules. 2022 Feb 17;27(4):1351. doi: 10.3390/molecules27041351. PMID: 35209140; PMCID: PMC8874997.

[21] Ye M, Fu S, Pi R, He F. Neuropharmacological and pharmacokinetic properties of berberine: a review of recent research. J Pharm Pharmacol. 2009 Jul;61(7):831-7. doi: 10.1211/jpp/61.07.0001. PMID: 19589224.

[22] Dar NJ, Hamid A, Ahmad M. Pharmacologic overview of Withania somnifera, the Indian Ginseng. Cell Mol Life Sci. 2015 Dec;72(23):4445-60. doi: 10.1007/s00018-015-2012-1. Epub 2015 Aug 26. PMID: 26306935; PMCID: PMC11113996.

[23] Speers AB, Cabey KA, Soumyanath A, Wright KM. Effects of *Withania somnifera* (Ashwagandha) on Stress and the Stress- Related Neuropsychiatric Disorders Anxiety, Depression, and Insomnia. Curr Neuropharmacol. 2021;19(9):1468-1495. doi: 10.2174/1570159X19666210712151556. PMID: 34254920; PMCID: PMC8762185.

[24] Paul S, Chakraborty S, Anand U, Dey S, Nandy S, Ghorai M, Saha SC, Patil MT, Kandimalla R, Proćków J, Dey A. Withania somnifera (L.) Dunal (Ashwagandha): A comprehensive review on ethnopharmacology, pharmacotherapeutics, biomedicinal and toxicological aspects. Biomed Pharmacother. 2021 Nov;143:112175. doi: 10.1016/j.biopha.2021.112175. Epub 2021 Sep 27. PMID: 34649336.

[25] Bhat JA, Akther T, Najar RA, Rasool F, Hamid A. *Withania somnifera* (L.) Dunal (Ashwagandha); current understanding and future prospect as a potential drug candidate. Front Pharmacol. 2022 Dec 12;13:1029123. doi: 10.3389/fphar.2022.1029123. PMID: 36578541; PMCID: PMC9790970.

[26] Tetali SD, Acharya S, Ankari AB, Nanakram V, Raghavendra AS. Metabolomics of Withania somnifera (L.) Dunal: Advances and applications. J Ethnopharmacol. 2021 Mar 1;267:113469. doi: 10.1016/j.jep.2020.113469. Epub 2020 Oct 16. PMID: 33075439.

[27] Pandit S, Srivastav AK, Sur TK, Chaudhuri S, Wang Y, Biswas TK. Effects of *Withania somnifera* Extract in Chronically Stressed Adults: A Randomized Controlled Trial. Nutrients. 2024 Apr 26;16(9):1293. doi: 10.3390/nu16091293. PMID: 38732539; PMCID: PMC11085552.

[28] Gopal S, Ajgaonkar A, Kanchi P, Kaundinya A, Thakare V, Chauhan S, Langade D. Effect of an ashwagandha (Withania Somnifera) root extract on climacteric symptoms in women during perimenopause: A randomized, double-blind, placebo-controlled study. J Obstet Gynaecol Res. 2021 Dec;47(12):4414-4425. doi: 10.1111/jog.15030. Epub 2021 Sep 22. PMID: 34553463.

[29] Yadav N, Tripathi S, Sangwan NS. Phyto-therapeutic potential of Withania somnifera: Molecular mechanism and health implications. Phytother Res. 2024 Mar;38(3):1695-1714. doi: 10.1002/ptr.8100. Epub 2024 Feb 6. PMID: 38318763.

[30] Singh N, Yadav SS, Rao AS, Nandal A, Kumar S, Ganaie SA, Narasihman B. Review on anticancerous therapeutic potential of Withania somnifera (L.) Dunal. J Ethnopharmacol. 2021 Apr 24;270:113704. doi: 10.1016/j.jep.2020.113704. Epub 2020 Dec 25. PMID: 33359918.

[31] Verma N, Gupta SK, Patil S, Tiwari S, Mishra AK. Effects of Ashwagandha (*Withania somnifera*) standardized root extract on physical endurance and VO 2max in healthy adults performing resistance training: An eight-week, prospective, randomized, double-blind, placebo-controlled study. F1000Res. 2024 Apr 8;12:335. doi: 10.12688/f1000research.130932.2. PMID: 38988644; PMCID: PMC11234080.