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A review of Ashwagandha powder as a herbal and dietary supplement

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Abstract
Ashwagandha (*Withania somnifera* (L.) Dunal) is a prominent herb in Ayurvedic medicine, traditionally valued as a rejuvenator (Rasayana) to enhance vitality, resilience, and longevity. Recently, global interest in Ashwagandha root powder has surged, primarily due to its adaptogenic properties and health benefits. The plant is rich in various bioactive compounds, particularly with anolides such as withaferin A and withanolide D, which have demonstrated antioxidant, anti-inflammatory, immunomodulatory, neuroprotective, and anticancer effects. Advances in extraction and standardization techniques have enhanced the stability and effectiveness of these compounds, facilitating their incorporation into modern nutraceuticals.

Clinical research has demonstrated that Ashwagandha supplements can help reduce stress and anxiety, improve sleep quality, enhance memory and cognitive function, and support reproductive health. Furthermore, there is evidence suggesting potential ergogenic benefits, including increased muscle strength, improved aerobic capacity, and faster recovery from fatigue. Powdered forms of Ashwagandha are particularly popular due to their affordability, convenience, and ability to retain phytochemicals, making them one of the most accessible options for dietary supplementation.

Despite its extensive therapeutic potential, safety concerns persist. Reports of hepatotoxicity, nephrotoxicity, and herb-drug interactions underscore the necessity for stricter regulations, quality control, and pharmacovigilance. Additionally, variability in preparation methods and this review aims to compile the current evidence regarding Ashwagandha root powder as a herbal and dietary supplement. It highlights the traditional significance of Ashwagandha, its diverse phytochemical composition, pharmacological effects, safety profile, and potential avenues for future research.

Keywords: Ashwagandha, *Withania somnifera*, herbal powder supplement, adaptogen, withanolides, nutraceutical, stress relief, cognitive support, physical performance

Introduction

Ashwagandha (*Withania somnifera* (L.) Dunal) is one of the most revered sources in Ayurvedic medicine, widely recognized for its invigorating and adaptogenic properties [1]. Frequently referred to as "Indian ginseng," it has traditionally been used to promote strength, vitality, and life [2]. While the roots, leaves, and berries of the plant are valued for their different pharmacological properties, the root is the generally used part in both traditional and ultramodern phrasings [3].

The name "Ashwagandha" is derived from Sanskrit, where "Ashwa" means steed and "Gandha" means smell, inferring that the condiment imparts the vigor and strength of a steed [4]. It has been used for centuries to treat conditions such as stress, wakefulness, nervous prostration, inflammation, and infertility [5]. The remedial properties of this condiment are primarily attributed to its bioactive ingredients, known as withanolides, a group of steroidal lactones that exhibit antioxidant, anti-inflammatory, immunomodulatory, and neuroprotective effects [6].

Ultramodern scientific exploration has increasingly supported numerous of these traditional claims [1]. Studies have reported that Ashwagandha exhibits adaptogenic properties by modulating the hypothalamic-pituitary-adrenal (HPA) axis and reducing cortisol levels in stressful situations, thereby enhancing the body's capability to repel both physical and internal stress [7]. Likewise, its part in perfecting muscle strength, endurance, and cognitive function has led to its addition in several nutritional and functional food products [8].

Fig 1: Ashwagandha (*Withania somnifera*) [26]

- **Botanical Name:** *Withania somnifera* (L.) Dunal
- **Family:** Solanaceae (The Latin species name "somnifera" means "sleep-inducing")

Taxonomy of Ashwagandha

Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta
Super division	Embryophyta
Division	Tracheophyta
Subdivision	Spermatophytina
Class	Magnoliopsida
Superorder	Asteranae
Order	Solanales
Family	Solanaceae
Genus	Withania
Species	*Withania somnifera*

Traditional and Historical Use of Ashwagandha

Ashwagandha has been described in the Charaka Samhita, Sushruta Samhita, and Ashtanga Hridaya as a potent Rasayana (rejuvenator) [4].

Rasayana (Rejuvenate) Applications

Traditionally, Ashwagandha root powder (churn) was mixed with milk or ghee and consumed to delay aging, improve memory, and restore vitality. [1] In Panchakarma therapies, it was utilized to rebuild strength following chronic illness or physical exhaustion [1].

Nervine and Mental Health Uses

As a medhya rasayana (nootropic herb), ashwagandha was used to enhance mental clarity, memory, and concentration. [4] It was prescribed for stress, anxiety, insomnia, and nervous fatigue, conditions often associated with aggravated Vata dosha [1].

Reproductive and Sexual Health

In Ayurveda, Ashwagandha is regarded as a Vajikarana Rasayana (aphrodisiac). Traditionally, it was prescribed for male infertility and low libido, while in women, it was used to support fertility, hormonal balance, and menstrual regulation [9].

Strength and Immunity

Historical accounts suggest its use among warriors in ancient India to enhance stamina and endurance. [1] It was also widely utilized in convalescence, childhood, and old age to improve immunity and resilience.

Household Remedies

In folk medicine, ashwagandha preparations were applied for cough, fever, joint pain, and weakness [2]. Root paste was used to treat wounds, ulcers, and swellings, showcasing its role as a multipurpose household remedy [2].

Cross-Cultural Traditional Usage

Its traditional use extends beyond India. In Unani medicine, it was prescribed for nervous exhaustion and arthritis [1]. In African folk medicine, the roots were utilized for fever, inflammation, and snakebites [2]. In Middle Eastern practices, it was regarded as a natural tonic [1].

Botanical Description and Cultivation.

Botanical Description

Ashwagandha (*Withania somnifera* (L.) Dunal) belongs to the family Solanaceae, which includes well-known plants such as tomato (Solanum lycopersicum) and belladonna (Atropa belladonna). [2] It is a perennial woody shrub, typically growing to a height of 30-150 cm. [2]

- **Stem:** The stem is erect, branched, and covered with fine, velvety hairs, giving it a grayish-green appearance [2].
- **Leaves:** The leaves are simple, ovate, and measure 5-10 cm long, with a dull green upper surface and lighter undersides. They are arranged alternately and emit a faint odor when crushed.
- **Flowers:** The plant bears small, greenish-yellow, bell-shaped flowers, which are usually solitary or found in clusters at the leaf axils.
- **Fruits:** The fruits are glucose red berries enclosed within a persistent calyx, resembling small lanterns. Each fruit contains numerous reinform (kidney-shaped) seeds.
- **Roots:** The tapering, thick, fleshy roots are light brown to whitish-yellow in color and are the most pharmacologically valuable part of the plant. They emit a characteristic odor reminiscent of a horse, which inspired the Sanskrit name Ashwagandha ("smell of a horse").

Morphologically, two common varieties are described in traditional literature:-

- This variety is known for its superior medicinal quality and is commonly cultivated in Madhya Pradesh and Rajasthan.
- Rasputin Ashwagandha: A less potent variety found in arid regions.

The plant's diagnostic features include a chromosome number of 2n = 48 and the presence of steroidal lactones (withanolides) in the roots and leaves, which are responsible for its therapeutic properties [6].

Cultivation and Propagation

Ashwagandha is a drought-tolerant crop adapted to subtropical and dry tropical regions. [2] It is extensively cultivated in India, Sri Lanka, Nepal, Pakistan, and parts of Africa and the Mediterranean region [10].

Climate and Soil Requirements

- **Climate:** The crop thrives in temperate to semi-arid climates, with a temperature range of 20-35°C and moderate rainfall (500-750 mm annually) [10].

- **Soil:** Ashwagandha prefers sandy loam or light red soils with good drainage and a pH range of 6.0-8.0 [10]. Waterlogged conditions can be detrimental to root development.

Propagation is primarily done through seeds. Mature berries are collected at the end of the growing season, and the seeds are dried before sowing. Seed germination takes about 6-8 days under warm, moist conditions [11].

Sowing and Spacing

Sowing is generally conducted at the onset of the monsoon (June-July). Seeds can be sown directly in the field or initially in nursery beds and later transplanted. Optimal root yield is achieved with the recommended spacing of 30 × 20 cm between plants [11].

Irrigation and Manuring

As a low-input crop, Ashwagandha requires minimal irrigation, typically 2-3 light irrigations during dry spells. [10] The application of organic manure, such as farmyard compost (5-10 tons/ha), can improve soil texture and root quality [11].

Pests and Diseases

Common pests include leafhoppers and aphids, while root rot (caused by Alternaria alternate) and leaf spot are significant fungal diseases. [11] Crop rotation and seed treatment with Trichoderma are recommended for control. [11]

Harvesting and Yield

The crop matures approximately 150-180 days after sowing. Harvesting should occur when leaves dry and berries turn orange-red. Roots are carefully dug up, cleaned, and shade-dried. [10] An average yield of 300-500 kg of dried roots per hectare is typical [10].

Post-harvest Processing

After drying, the roots are graded based on thickness and color. They can be cut into small pieces or powdered for use in formulations such as churna, granules, or capsules. The seeds are preserved for the next sowing season [11].

Distribution and Production in India

India is the largest producer and exporter of Ashwagandha, with major cultivation areas including Madhya Pradesh, Rajasthan, Gujarat, Uttar Pradesh, and Haryana. [2] The National Medicinal Plants Board (NMPB) promotes Ashwagandha cultivation under medicinal plant schemes to ensure sustainable trade and standardization [12].

Phytochemistry and Active Compounds

Ashwagandha (*Withania somnifera* (L.) Dunal) Phytochemical Composition and Pharmacological Relevance [6]. Ashwagandha, belonging to the Solanaceae family, is a medicinal plant famed for its rich and diverse phytochemical composition. Its pharmacological conditioning is largely attributed to biologically active secondary metabolites such as alkaloids, steroidal lactones, flavonoids, saponins, tannins, and glycosides. [13] These composites contribute to the factory's wide remedial eventuality, including adaptogenic, anti-inflammatory, immunomodulatory, antioxidant, and neuroprotective goods [6].

Phytochemical Webbing

Primary qualitative tests of *Withania somnifera* excerpts confirm the presence of several crucial phytochemical groups. [5]

- **Alkaloids:** The Wagner's test (iodine-potassium iodide reagent) produces a sanguine-brown precipitate, attesting to alkaloid presence.
- **Flavonoids:** The lead acetate test yields an unheroic precipitate, indicating the presence of flavonoids.
- **Tannins:** The ferric chloride test produces a greenish-blue or brown color, specific to tannin composites.
- **Saponins:** The froth test confirms saponins by forming a 1 cm froth subcaste upon shaking.
- **Carbohydrates:** The Fehling's test shows red effects of cuprous oxide, indicating reducing sugars.
- **Glycosides:** The conformation of an unheroic color upon the addition of waterless NaOH confirms glycosides.

These tests establish the presence of multiple bioactive emulsion groups in the root and splint excerpts of Ashwagandha, supporting its broad pharmacological profile [13].

Major Active Composites

More than 35 distinct phytochemicals have been isolated and linked from *Withania somnifera*. The most pharmacologically significant composites belong to two primary classes: alkaloids and steroidal lactones (withanolides). [6]

- **Alkaloids:** The factory contains several important alkaloids, including withanine, somniferine, and somniferinine. These nitrogenous composites are linked to the factory's adaptogenic and anti-stress properties, as well as its neuroprotective eventuality.
- **Steroidal Lactones (Withanolides):** Withanolides are the hallmark ingredients of Ashwagandha, characterized by a lactone ring at the C-22 or C-26 position. [6] Crucial withanolides include withaferin A and withanolide D, considerably studied for their anti-inflammatory, antitumor, and adaptogenic properties [5].
- **Withanolide Glycosides:** Glycosidic derivations of withanolides, similar to sitoindoside IX and X, have been reported to enhance cognitive performance and exhibit antioxidant properties [13].
- **Flavonoids and polyphenols:** Lower the risk of flavonoids like quercetin, and polyphenolic composites similar to chlorogenic acid give fresh antioxidant eventuality [5].
- **Saponins and Sterols Ashwagandha:** Contains steroidal saponins, including sitoindosides VII and VIII, honored for their anti-stress and immunomodulatory properties, along with other phytoconstituents that enrich its chemical profile [13].

Phytochemical diversity and environmental influence

The chemical makeup of *Withania somnifera* varies depending on location, soil quality, harvest time, and breeding methods [3]. Research shows the presence of advanced Withanolides in roots collected during off-season, and hydroalcoholic extraction provides a more complete

phytochemical profile compared to water-based extraction [13].

Pharmacological Applicability

The synergistic action of multiple bioactive compounds enhances ashwagandha's reputation as a powerful adaptogen and rejuvenator [1]. The combined presence of withanolides, alkaloids, flavonoids, and saponins offers multi-targeted effects on the nervous, endocrine, and immune systems, supporting its traditional use in Ayurveda as a Rasayana (rejuvenating tonic) [1].

Pharmacological and Therapeutic properties

Adaptogenic and anti-stress exertion

Withania somnifera (Ashwagandha), frequently referred to as Indian Ginseng, is a prominent Rasayana(invigorating) condiment in Ayurveda, known for its capability to promote both physical and internal adaptability. [1] Its pharmacological profile parallels that of other adaptions such as Panax ginseng and Eleutherococcus Pentecosts (Siberian Ginseng), [1] which enhance nonspecific resistance to stress and restore homeostatic balance in natural systems [14, 15].

Antioxidant anti-inflammatory exertion

Ashwagandha exhibits significant antioxidant, anti-inflammatory, and immunomodulatory properties. [6] These parcels are largely attributed to its different bioactive ingredients particularly steroidal lac tones similar to withanolides, withering A, and 3β-hydroxyl-2,3-dihydrowithanolide F-which act at molecular, cellular, and systemic levels to alleviate oxidative stress and inflammation [5]. Withering A, particularly, has been reported to suppress pro-inflammatory cytokines and inhibit NF-KB signaling, contributing to its cytoprotective and adaptogenic profile [5].

Neuroprotective and Cognitive Benefits

Ashwagandha is classified as a Medhya Rasayana, a group of Ayurvedic invigorating sauces known to enhance intellect (Medha), cognitive performance, and memory. [4] Traditionally, it has been specified to ameliorate literacy capability, attention, and cognitive adaptability, especially in the elderly, children, and individuals recovering from neurological illness or injury [8].

Cognitive-Enhancing and Memory-Promoting exertion

Cognitive function encompasses literacy, attention, memory, and superintendent processing, all of which are influenced by neuronal malleability and neurotransmitter regulation.

A randomized, double-blind, placebo-controlled clinical trial by Choudhary *et al*. (2017) demonstrated that administration of standardized Ashwagandha root extract (300 mg twice daily for 8 weeks) significantly improved memory, attention, and recycling speed in healthy adults. The study also observed enhanced administrative function and psychomotor collaboration, attributed to cholinergic modulation and antioxidant protection.

Also, Chandrasekhar *et al*. (2012) reported advanced response time, attention, and task delicacy among individuals treated with Ashwagandha, supporting its adaptogenic and nootropic properties. [16] Its stress-reducing action, intermediate via repression of cortisol situations, helps stress-induced cognitive impairment a crucial contributor to neuronal degeneration and internal fatigue [15].

Reproductive Health and Fertility

In Ayurveda, Ashwagandha is deified as a Vajikarana Rasayana (aphrodisiac and reproductive rejuvenator) [1]. Traditionally used to enhance fertility, hormonal balance, and sexual vitality in both men and women.

Improvement of Semen Quality and Spermatogenesis. Multiple clinical studies have verified that Ashwagandha improves semen parameters and enhances spermatogenesis. [17] Its bioactive withanolides and sitoindosides modulate the hypothalamic-pituitary-gonadal (HPG) axis, stimulating testosterone production and improving sperm count and motility [18].

Cerebral stress elevates cortisol, suppressing gonadotropin-releasing hormone (GRH) and injuring fertility. Ashwagandha's adaptogenic action helps normalize cortisol levels and restore hormonal balance. [15] A placebo-controlled trial demonstrated significant advancements in sperm quality and hormonal parameters in men experiencing stress-related growth issues following Ashwagandha supplementation [9].

Reproductive Health Regulation of Hormonal and Ovarian Function. In women, Ashwagandha helps maintain hormonal balance, regulate menstruation, and improve ovarian function [19]. Its adaptogenic and antioxidant properties boost ovulatory stability and lower oxidative stress. Research also indicates potential benefits in managing polycystic ovarian syndrome (PCOS) by reducing insulin resistance, excess androgens, and oxidative imbalance. [20]

Physical Performance and Muscle Strength

Ashwagandha, a well-known Balya Rasayana ("strength-promoting rejuvenated"), has long been used to enhance stamina, energy, and physical endurance [1]. Ultramodern exploration corroborates these traditional claims, demonstrating advancements in muscle strength, recovery, and aerobic performance through its adaptogenic and anabolic mechanisms [21].

Improvement of muscle strength and abidance

A randomized, double-blind, placebo-controlled trial estimated *Withania somnifera* root extract(300 mg twice daily for 8 weeks) in healthy, youthful males engaged in resistance training [22]. Results revealed significant increases in muscle strength (bench press and leg extension), muscle mass, and serum testosterone, alongside reduced exercise-induced muscle damage (creatine kinase levels) compared to the placebo [22].

Recovery and Fatigue Reduction

Ashwagandha supplementation accelerates post-exercise recovery and reduces fatigue [23]. In a study by Raub *et al*. (2020), actors entering 600 mg/day for 12 weeks displayed enhanced muscle recovery, dropped oxidative damage labels, and improved sleep quality-factors contributing to overall athletic exertion and acceptance [23].

Ashwagandha as a dietary supplement in powder form

Ashwagandha (*Withania somnifera*) is widely used as a dietary supplement in powder form, traditionally known as

Ashwagandha churna [1]. Prepared from dried roots, it contains essential bioactive compounds such as withanolides, which help reduce stress, enhance strength, improve immunity, and promote overall well-being [13]. The powder is commonly taken with milk or honey and valued for its adaptogenic and rejuvenating effects [4].

Preparation Methods

Drying Method-Ashwagandha Powder (Churna)

Ashwagandha (*Withania somnifera*) roots are the primary plant part used for preparing dietary supplement powder (churna). After harvesting mature roots (usually 150-180 days after planting), they are carefully washed, sliced into 5-10 cm pieces, and subjected to drying under controlled conditions [11]. The drying technique greatly influences the phytochemical stability of the powder. Shade and oven drying methods are preferred as they preserve bioactive withanolides such as Withaferin A and Withanolide D [6].

Table 1: Drying methods for Ashwagandha roots

Drying Method	Temperature Range (°C)	Drying Time (hours)
Shade Drying	25-30	7-10 days
Sun Drying	35-45	3-5 days
Oven Drying	40-50	6-8 hours
Freeze Drying	-40 to -50	24-36 hours

Grinding Method

After drying, the roots are coarsely crushed and then pulverized into a fine powder using mechanical grinders [11]. The powder is passed through a mesh with a pore size of 180 µm (Mesh No. 80) to ensure a uniform particle size, which improves dosage accuracy and solubility. Grinding under cool, dry conditions prevents the degradation of heat-sensitive phytoconstituents [13].

Table 2: Grinding and Sieving Process

Processing Step	Equipment Used	Purpose
Coarse Crushing	Cutter mill / Disintegrator	Reduce bulk root size
Fine Grinding	Pulverizer / Hammer mill	Produce uniform fine powder
Sieving	Mesh No 80 Sieve	Ensure consistent Particle Size

Standardization Method

Standardization guarantees the quality, purity, and potency of Ashwagandha powder [24]. The process follows WHO and Indian Pharmacopeia guidelines and includes tests for moisture content, ash value, microbial load, and withanolide concentration, [25] typically analyzed by HPLC or LC-MS techniques [24].

Table 3: Standardization parameters for ashwagandha powder

Parameter	Specification	Testing Method
Moisture content	≤ 5%	Loss on drying
Total ash	≤ 6%	Ash value test
Acid-insoluble ash	≤ 1%	Gravimetric
Withanolide content	≥ 2.5%	HPLC / LC–MS
Particle size	≤ 180 µm	Sieve analysis
Microbial load	Within limits	Plate count method

Advantages over other formulations

Ashwagandha in powder form preserves its full phytochemical profile, offers greater dosing flexibility, and is more economical compared to capsules or liquid extracts [1]. It also disperses better in the gastrointestinal tract and can be customized for traditional use with milk, ghee, or honey [4].

Table 4: Comparison of Ashwagandha powder with other formulations

Parameters	Ashwagandha Powder	Capsule/Tablet	Extract/Liquid Formulation
Processing Level	Retains full phytochemical profile	Moderately processed (binders & fillers)	Highly Processed (solvent extraction)
Bioavailability	Rapid dispersion in the GIT, enhanced with milk/honey	Moderate; depends on capsule disintegration	Fast absorption but shorter duration
Dosing Flexibility	Easily adjustable	Fixed per capsule/tablet	Fixed per measured dose
Additives/Preservatives	Usually absent (pure herbal powder)	Often contains excipients	May contain stabilizers or sweeteners
Shelf Life	Long (if stored dry and airtight)	Moderate	Shorter ; Prone to microbial growth
Cost Effectiveness	Economical and accessible	Relatively expensive	Higher cost due to extraction and preservation

Current gaps, research challenges and future prospects

Although Ashwagandha (*Withania somnifera*) has been extensively studied for its pharmacological and remedial value, several significant gaps and challenges remain [13]. Most current studies are based on preclinical data or small-scale trials, which limit the generalizability of their findings [13]. There is also an inconsistency in standardization and formulations, leading to variable remedial effects [24]. Additionally, relationships with conventional medicines, long-term safety, and mechanisms of action require further scientific investigation [6]. Analytical challenges in isolating and characterizing bioactive compounds, such as withanolides, add complexity to the process. Future research should focus on large, well-controlled clinical trials, standardized formulations, and advanced molecular technologies like genomics and metabolomics to explore the full potential of Ashwagandha [2]. Incorporating nanotechnology, sustainable practices, and modern delivery systems can further improve its bioavailability and therapeutic benefits, paving the way for wider acceptance in integrative medicine [10].

Conclusion

Ashwagandha (*Withania somnifera*) remains one of the most significant Rasayana herbs in Ayurveda, bridging ancient tradition with modern scientific research. Its rich array of withanolides, alkaloids, and other active constituents underpins its diverse health benefits, including stress relief, cognitive enhancement, reproductive health, and physical performance. The powdered root remains popular due to its affordability, ease of use, and ability to retain the plant's full phytochemical profile.

Despite substantial preclinical and clinical evidence, issues such as variable cultivation practices, lack of standardized dosage forms, and limited large-scale trials hinder its broader acceptance in global markets. Future efforts should

prioritize rigorous clinical studies, improved standardization, and sustainable cultivation to ensure safety, efficacy, and quality. With continued research and regulatory harmonization, Ashwagandha powder holds strong potential for wider integration into healthcare potential to emerge as a globally recognized, safe, and effective herbal supplement.

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