

# Ashwagandha-*Withania somnifera* for Sustainable Socioeconomic Empowerment

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## ABSTRACT

Ashwagandha, a renowned medicinal plant within the AYUSH (Ayurveda, Yoga, Unani, Siddha, Homeopathy) System, stands as a plant of paramount significance due to its multifaceted health benefits. Recognizing its pivotal role, the AYUSH Ministry, Delhi's National Medicinal Plants Board (NMPB) launched the "Ashwagandha - A Health Promoter" campaign in the year 2022. This initiative signifies the plant's potential in promoting health and well-being. This comprehensive review endeavours to elucidate various facets of Ashwagandha, encompassing pharmacognosy, phytochemistry, conservation strategies, cultivation practices, therapeutic applications, market dynamics, exploration of value-added products and an overview of current research endeavours.

**Keywords:** Ashwagandha, *Withania somnifera*, Solanaceae, Value added products.

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## INTRODUCTION

The exploration of Ashwagandha's pharmacognostic attributes delves into the plant's morphology, microscopy, physicochemical standards and adulteration, providing a foundational understanding of its botanical features. Furthermore, an in-depth analysis of the phytochemical composition sheds light on the bioactive compounds responsible for the plant's excellent medicinal properties. Conservation strategies are discussed to address the sustainable utilization of Ashwagandha resources for economic development. Cultivation practices are explored to fulfil the market demand, optimize yield and quality. Therapeutic values are elucidated, emphasizing the diverse health benefits associated with Ashwagandha consumption. In addition, market research findings contribute insights into the commercial landscape of Ashwagandha-derived products, while discussions on value-added products provide avenues for innovation and start-ups.

Ashwagandha, derived from the dried mature roots of plant *Withania somnifera* Dunal, family – Solanaceae known as "Sattvic Kapha Rasayana" and "Queen of Indian herbs."<sup>[1]</sup>

## Vernacular Names<sup>[1-3]</sup>

Sanskrit: Hayagandhā, Vajigandha

Tamil: Amukkaramkizangu

Malayalam: Amukkuram

Assamese: Ashvagandha

Telugu: Pennerugadda

Kannada: Angarberu, Hiremaddina-gida

Oriya: Aswagandha

Punjabi: Asgandh

Gujarati: Asgandha

Hindi: Asgandh

Bengali: Ashvagandha

Urdu: Asgand

Kashmiri: Asagandh

Marathi: Asagandha, Ashwagandha

## Species

The genus *Withania* belongs to the Solanaceae family, comprising 23 species distributed across The Canary Islands, the Mediterranean, the southern European continent, the west Asian region, southern Asia, and Northside of Africa. Among these varieties, *Withania somnifera* (commonly known as ashwagandha) and *Withania coagulans* (referred to as Ashutosh Booti) hold economic importance due to their medicinal properties. These two species are actively cultivated in various regions to harness their therapeutic benefits.<sup>[1-4]</sup>



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## Distribution

Ashwagandha (*Withania somnifera*) exhibits a broad global distribution, with its native range encompassing parts of Canary Islands, North Africa, south Asia, Mediterranean, southern Europe and western Asia. Renowned for its adaptogenic and medicinal properties, ashwagandha has transcended its original habitats and is now cultivated in diverse regions around the world due to its adaptability.

The plant has found favourable environments in locations with warm climates, well-drained soil, and ample sunlight. Notably, regions such as India, particularly in Madhya Pradesh and Rajasthan mention in Figure 1 and have become key cultivation areas due to the conducive agro-climatic conditions.<sup>[5]</sup>

## PHARMACOGNOSY<sup>[1-4]</sup>

### Morphology of *Withania somnifera*

Plant Part	Macroscopic Character	Observation
Fresh Root	The roots measure between 20 to 30 cm in length and have a diameter ranging from 6 to 12 mm. Additionally, there are a few lateral roots, typically 2 to 3 in number, which exhibit a slightly smaller size compared to the main root. The primary roots are characterized by their straight and unbranched morphology.	
Dried root	The external surface displays a coloration ranging from buff to grey-yellow and features longitudinal wrinkles. Internally, the core exhibits a soft, solid mass characterized by a grey-yellow hue and scattered pores in Figure 3.	

### Morphology

The roots are unbranched and straight, with thickness varying according to age. These roots bear secondary roots that resemble fibers. Externally, the roots have a buff to grayish-yellow hue, marked by lines that run longitudinally. The top is composed of two to six remnants of the stem base, exhibiting varied thickness. Nodes are noticeable solely on the side where the petiole is visible. The stem mention in Figure 4, cylinder like in shape, is greenish with creases running lengthwise which is mention in Figure 2, and its fracturing is uneven and brief. The distinctive Odour is distinctive, while the flavour is sharp and harsh.

## Physicochemical Standards of *Withania Somnifera* Roots

Organic Foreign matter: > 2.0%

Total Ash Value: > 7.0%

Acid Insoluble Ash Value: > 1.2%

Alcohol Soluble Extractive Value: < 20.0%

Water Soluble Extractive Value:< 16.0%

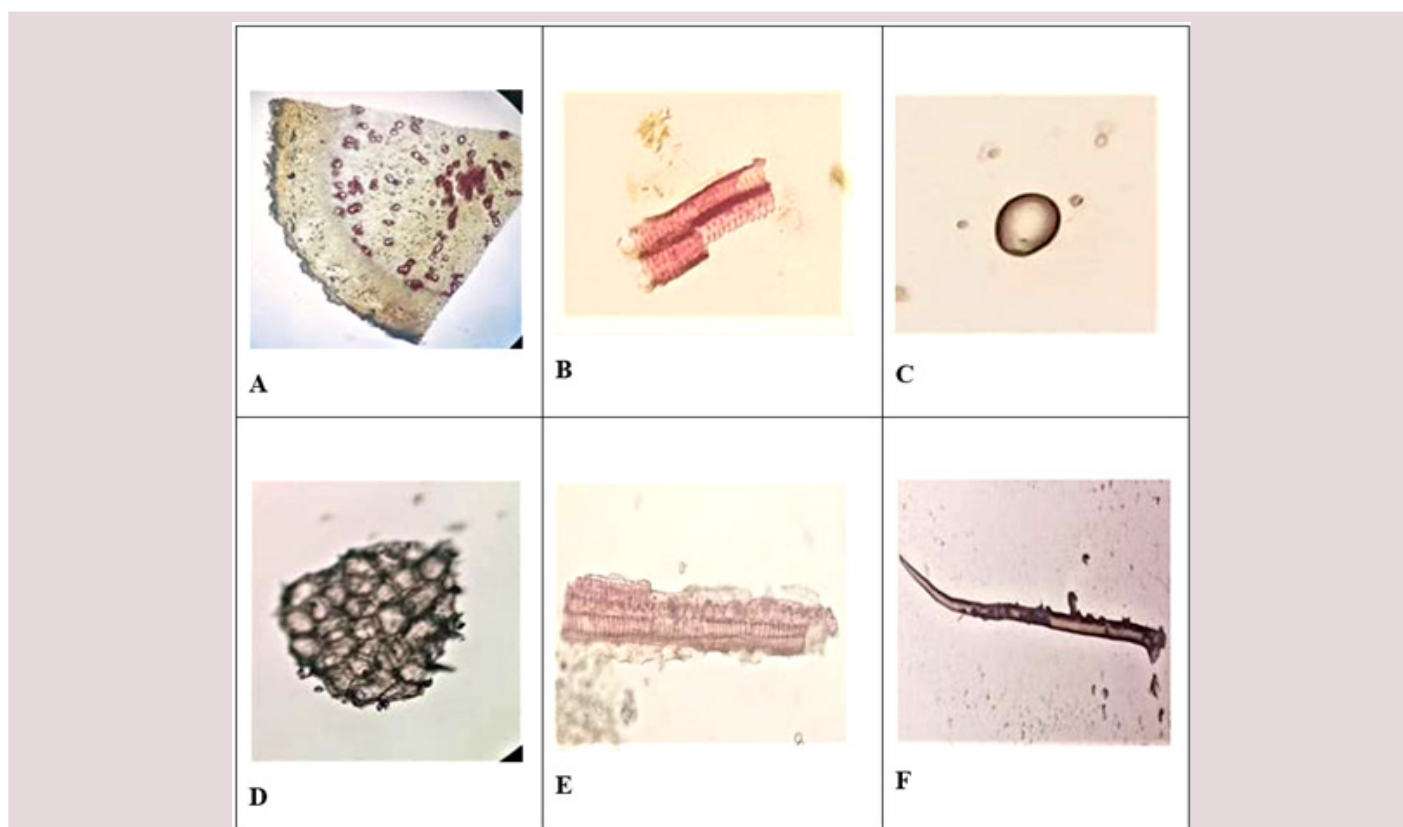
## Substitutes/Adulterants

Common instances of adulteration involve unidentified non-root components of *W. somnifera*, including stems, leaf, and other aerial components, which are plentiful in withaferin A and several other Withanolides. Another significant species, *W. coagulans* Dun, is the only other major *Withania* species found in India.

Distinguishing characteristics between the roots of *W. somnifera*; *W. coagulans* include a parenchymatous cortex & simple round starch grains in the former.<sup>[1,7]</sup>Top of Form

## PHYTOCHEMISTRY

The primary constituents are steroidal lactones (Withanolide having ergostane skeleton) and alkaloids. This diverse group of Withanolides includes Withanone, Withaferin-A, Withanolides I-III, III, Withanolides - A, D, E, F, G, H, I, J, K, L, M, P, and S, WS-I), as well as withasomi-dienone and withanolide-C mention in table 5. Additionally, the approximately 0.2% total alkaloid components consist of Tropine, pseudotropine, anaferine, cuscohygrine, and anahygrine, isopellatierine, and 3-tropyltigloate, contributing to the plant's pharmacological profile. Both withanolides and alkaloides are found contributing to its diverse therapeutic properties and establishing it as a significant botanical resource

**Microscopy of *Withania Somnifera* Roots<sup>[1-4]</sup>**

**Microscopic characteristics:** In cross-sectional view of the root, the cork exhibits exfoliation or crushing, and when present, it appears both non-lignified and isodiametric. The cambium of cork is comprised of 2-4 rows of cells spread out. The plant secondary cortex consists of approximately 20 layered densely packed cells with parenchyma. The plant phloem contains sieve tubes, complementary cells, and phloem-parenchyma. The plant cambium is characterized by four to five rows of cells with tangential elongation. The auxiliary xylem is rigid, creating a ring of closed vessels and is divided by medullary rays that are multiseriate. Additionally, A handful of xylem tissue parenchyma cells are observed in this context.

**A.** T.S of root: The cork cells are isodimetric and non-lignified. Intercellular spaces are present in phloem parenchyma. fibres absent in phloem and present in xylem **B.** Tracheids stained with phloroglucinol, **C.** Starch grain, **D.** Parenchyma cell packed with starch grains, **E.** Scalariform vessels stained with phloroglucinol, **F.** Fiber.

within traditional medicine systems. Structures of important phytochemicals present in Ashwagandha<sup>[6,7]</sup> are summarised in Table 1.

The comprehensive summary of various chemical constituents present in various parts of *W. somnifera* explores its potential applications as traditional medicine.<sup>[6-9]</sup>

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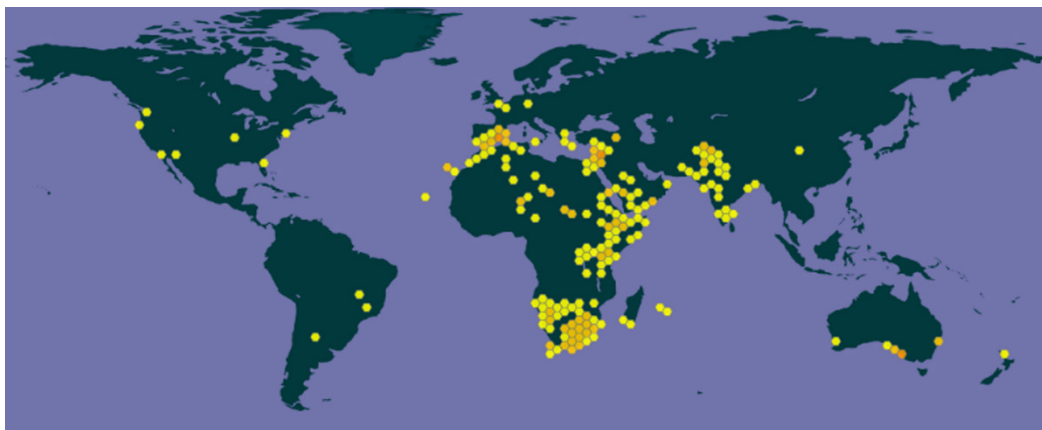
**TRADITIONAL USES AND PHARMACOLOGY**

The properties and actions of Ashwagandha, succinctly depicted in the provided table, highlight its diverse therapeutic attributes. With stress-relieving and adaptogenic properties, Ashwagandha is recognized for its ability to enhance resilience to various stressors. The table elucidates its anti-inflammatory

and antioxidant actions, contributing to its potential in promoting overall well-being. Additionally, Ashwagandha's immunomodulatory and neuroprotective effects underscore its multifaceted role in supporting health.<sup>[10]</sup> Ashwagandha the entire plant has biocompatible, hepatoprotective, neurotic regenerator, insect killer, larval killer, antioxidant, immune-modulating, and cardio protective mention in Table 3.

**Side Effects**

Ingesting large doses of ashwagandha may lead to adverse effects such as upset stomach, diarrhoea, vomiting, and potential liver problems. Additionally, it has the potential to irritate the intestinal mucosa, causing digestive issues. Studies also advise against the use of ashwagandha during pregnancy due to potential distress to the fetus. However, based on available research in for animals as well as humans, it can be inferred which ashwagandha generally



**Figure 1:** In the GBIF Secretariat (2021), *W. Somnifera* (L.) Dunal's ethnographic distribution.<sup>[5]</sup>



**Figure 2:** *Withania somnifera* Fresh Plant.

considered secure for both brief and extended utilization. There have been no notable negative consequences. Notably, individuals with responses of hypersensitivity to *Solanaceae* plants, particularly more especially to this species, should exercise caution and avoid its use.<sup>[7,12]</sup>

## IMPORTANT TRADITIONAL FORMULATIONS

Ashwagandha serve as a primary component in over 300 Indian traditional formulations. Asvagandhadyarista, Asvagandhadi Leha, Balasvagandha Laksadi Taila, Awagandhadichurna, Asvagandharasayana, Shatpatha-ghrita, Shatpatha-rishta, Asvagandha-taila arayana-taila Madhyaman, Ashvagandha-ghrita Brihat, Bharatiya Chakradya-Ghrita, Pramehamihihira-taila, Saraswata-churna, and Nagabala-ghrita, Aswgandharishata, Aswgandha-taila, Brahmivati, Manasamitravada, Balaaswgandhadithailam, Brihat Ashwagandha-ghrita, Aswgandhachurna, and Madhusnuhi-rasayana Ajaaswgandhadilehyam, as documented in traditional Ayurvedic textbooks.<sup>[1,4]</sup>



**Figure 3:** *Withania somnifera* Crude drug.

## DOSAGE<sup>[4]</sup>

3-6 g of the medication in a powdered form and 4-8 mL of liquid ashwagandha extract.

## CULTIVATION AND AGRO-TECHNIQUES

India offers commercial ashwagandha cultivation for a number of released types, including Raj Vijay Ashwagandha (RVA-100), Jawahar Ashwagandha (JA-20), Poshita, Jawahar Ashwagandha (JA-134), CIMAP-Chetak, Rakshita, CIMAP-Pratap, Anand *Withania somnifera*-1 (AWS-1), Vallabh Ashwagandha-1 (DWS-132) or Gujarat Anand Ashwagandha-1 (GAA-1), Pushti, Arka, WSR NIMITLI-101, and NIMITLI-118. Among them, the native variety, Nagori, is prominent, while CIMAP-Pratap exhibits the highest dry root production, followed by Poshita and NIMITLI-101.<sup>[20,21]</sup> Table 4 elaborates the details of Ashwagandha cultivation.

## TRADE AND COMMERCE

Ashwagandha holds significance as one of 32 different species prioritized by the NMPB. Typically, from 6-to 8-month-old plants, ashwagandha harvests yield 8-10 q/ha of dried roots on average, resulting in a 75,000/ha overall return. However, market rates are subject to demand and supply fluctuations. To enhance net profits, selecting high-producing enhanced varieties tailored





**Figure 4:** *Withania somnifera* Fresh leaves, fruits, roots.

for specific circumstances related to agriculture and climate is recommended.<sup>[20,23]</sup>

Market research by Data Bridge organization indicates the worldwide market for ashwagandha is projected to expand between 2022 and 2029 at a CAGR of 11.4%, reaching an estimated value of by 2029, USD 102.72 million. The increasing market need for Ashwagandha across medicinal, herbal, cosmeceutical, and the fields of nutraceuticals underscores the necessity for utilizing enhanced, high-yielding cultivars and cutting-edge farming and processing technologies to produce high-quality raw materials.<sup>[20,23]</sup>

### Farmers, women's organizations, students, and start-ups can prepare value-added products

Powder or churna - whole plant or stem or leaves or fruits.

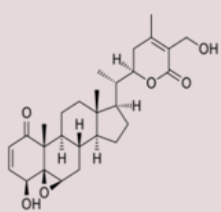
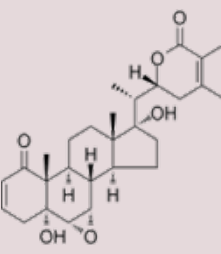
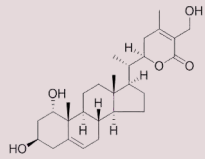
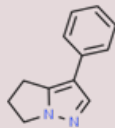
Kadha/Juice - whole plant or stem or leaves or fruits.

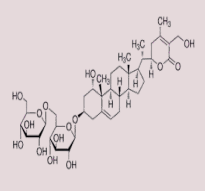
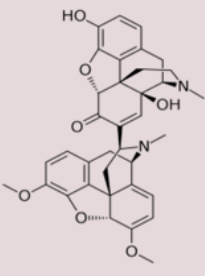
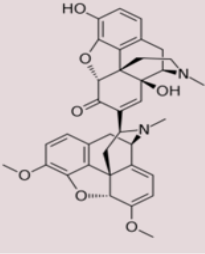
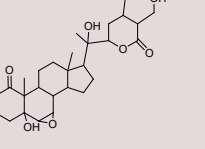
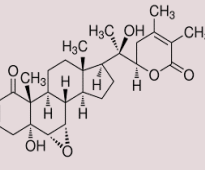
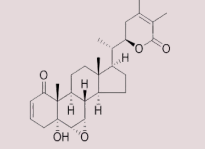
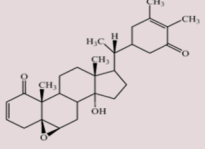
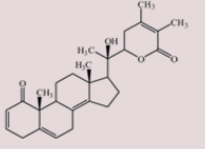
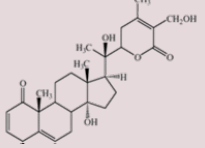
Drops of the entire plant, including the stem, leaves, and fruits  
Candies of whole plant, stem, leaves or fruits.

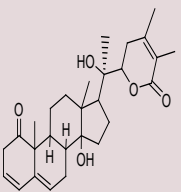
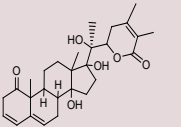
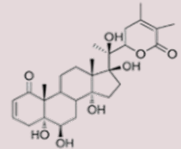
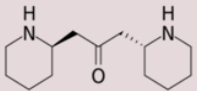
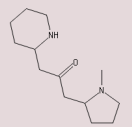
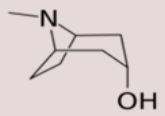
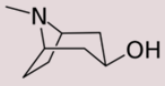
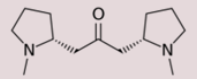
Fruit pickles.

Leaf sauces and fruit stems.

**Table 1: Structures of important phytochemicals present in *W. somnifera*.**

Sl. No. Compound Code	Name	Structure	Molecular Formula (M.W)
1	Withaferin A		C <sub>28</sub> H <sub>38</sub> O <sub>6</sub> (470.6)
2	Withanone		C <sub>28</sub> H <sub>38</sub> O <sub>6</sub> (470.6)
3	Sominone		C <sub>28</sub> H <sub>42</sub> O <sub>5</sub> (458.6)
4	Withasomnine		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> (184.24)

5	Withanoside IV		$C_{40}H_{62}O_{15}$ (782.9)
6	Somniferine		$C_{36}H_{36}N_2O_7$ (608.7)
7	Withasomniferine A		$C_{28}H_{38}O_6$ (470.6)
8	Withasomniferol A		$C_{28}H_{40}O_7$ (488.6)
9	Withanolide A		$C_{28}H_{38}O_6$ (470.6)
10	Withanolide B		$C_{28}H_{38}O_5$ (454.6)
11	Withanolide E		$C_{28}H_{38}O_7$ (486.6)
12	Withanolide G		$C_{28}H_{38}O_5$ (454.6)
13	Withanolide H		$C_{28}H_{38}O_6$ (470.6)

14	Withanolide I		$C_{28}H_{38}O_5$ (454.6)
15	Withanolide K		$C_{28}H_{38}O_6$ (470.6)
16	Withanolide S		$C_{28}H_{40}O_8$ (504.61)
17	Anaferine		$C_{13}H_{24}N_2O$ (224.3)
18	Anahygrine		$C_{13}H_{24}N_2O$ (224.3)
19	Tropine		$C_8H_{15}NO$ (141.1)
20	Pseudotropine		$C_8H_{15}NO$ (141.1)
21	Cuscohygrine		$C_{13}H_{24}N_2O$ (224.3)

**Table 2: Different parts of Ashwagandha and their phytochemicals.**

Plant parts	Phytochemicals present
Leaves	The constituents of Ashwagandha leaves comprise a diverse array of chemical compounds, including Withanine; withasomnine; visamine; ashwagandhine; mesoanaferine; somniferine; choline; hentriacontane; 3-tropyltigloate; anahygrine; cuscohygrine; hygrine; mesoanaferine, somniferine, dl-isopelletierine; choline, and hentriacontane; withanine; withasomnine; 3-tropyltigloyloxtropine, & pseudotropine. Additionally, the composition includes Withanolide A, B, D, F, G–P, T, U, withanoside IV, Physagulin and withanoside VI. Noteworthy among these are Withaferin A, 17-hydroxy-27-deoxy withanone and 27-deoxywithaferin A. This intricate profile of bioactive compounds showcases the chemical diversity within Ashwagandha, contributing to its pharmacological properties and making it a significant botanical resource with potential therapeutic applications.

Roots	The chemical composition of Ashwagandha roots includes various bioactive compounds such as Withanolide D, 27-hydroxy withanolide B, withanone, 17-hydroxy withaferin A, 17-hydroxy-27-deoxy withaferin A, 17-hydroxy withaferin A withaferin A, and 27-deoxy withaferin A. Additionally, the constituents encompass Withasomnine, Together with pyrazole derivatives ashwagandhine and pseudowithanine, withanolide A, pseudotropine, isopelletierine, 3 $\alpha$ -tigloyloxtropine, tropine, dl-isopelletierine-3-tropyloxtroate, cuscohygrine, anaferine, hygrine, anahygrine, somniferine, mesoanaferine, choline, withanine, visamine, withananine, hentriacontane, withasomnine. Further components include Ashwagandhanolide, Withanosides I-VII, $\beta$ -sitosterol and d-glycoside, Withasomniferol A, B, and C, Physagulin D and coagulin Q, and Withanoside IV and VI. This diverse array of compounds highlights the complex and multifaceted nature of Ashwagandha, suggesting its potential for various therapeutic applications.
Fruits	The chemical constituents of Ashwagandha fruits include elaidic acid, oleic acid, tetracosanoic acid linoleic acid, palmitic acid. Additionally, Withanamide A to I are also present among the bioactive compounds in this botanical source.
Stem bark	The chemical profile of Ashwagandha stem-bark encompasses Somiferanolide and withasomnilide, somnifera withanolide, somniwithanolide and withasomniferanolide among its bioactive constituents.
Whole plant	Ashwagandha comprises a diverse array of chemical components, including Reduced sugars, starch, acylsteryl glucosides, and withaniol, hentriacontane, ducitol, proline, tyrosine, aspartic acid, alanine, glycine, glutamic acid, and other amino acids, cystine, along with tryptophans. Additionally, the composition includes specific compounds such as 6 $\alpha$ -chloro-5 $\beta$ , 17 $\alpha$ -dihydroxy along with Aferin A, 6 $\alpha$ -chloro-5 $\beta$ hydroxy along with Aferin A, (22R)-5 $\beta$ -formyl-6 $\beta$ ,27-dihydroxy-1-oxo-4-norwith-24-enolide, 2-didehydrosomnifericin, 3-methoxy-2,3-dihydrowithaferin A, 2,3-dihydrowithaferin A, withanone, withanoside IV, and withanoside X. In addition, Withanone and Withasomniferin-A, tubacapsenolide F, and iso-sominolide, as well as Viscosalactone B and sominone are integral components within the chemical composition of Ashwagandha.

**Table 3: Different parts of Ashwagandha and their Uses.**<sup>[10,19]</sup>

Plant part used	Uses
Traditional uses	Therapeutic Category – Adaptogen. Traditional Therapeutic Uses- Sotha, Ksaya, Daurbalya, Vataroga, Klaihya. Traditional Properties Rasa: Tikta; KasayaGuna: Laghu; Virya: Usna; Vipaka: Madhura; Karma: Vatakaphapaha, Balya, Vajikarana; Rasayana. <sup>[19]</sup>
Roots	Useful in liver diseases, tuberculosis, leucoderma, bronchitis, asthma, heart diseases, arthritis. It is antioxidant, immunomodulatory, antibacterial, anticancer, adaptogenic and neuroprotective. Additionally, it possesses abortifacient, astringent, aphrodisiac, and emmenagogue properties, showcasing a wide range of potential health benefits. <sup>[10,19]</sup> Top of Form
Leaves	Useful in haemorrhoids, oedema, eyesores, boils, syphilis, ulcers, excruciating swelling, and external discomfort. It is pesticidal, hepatoprotective, anti-inflammatory, diuretic, anti-arthritis, and anti-cancer. <sup>[11-13]</sup>
Seeds	It demonstrates diuretic, narcotic, and hypnotic properties. <sup>[14-16]</sup>
Fruits	Useful in treating ulcers and tuberculosis as well as acts as anthelmintic. <sup>[17-19]</sup>
Leaves, roots, and stem	The leaves, roots, and stems of Ashwagandha display antibacterial, antitumor, and herbicidal properties, indicating their potential roles in combating bacterial infections, inhibiting tumour growth, and acting as herbicides. <sup>[10,19]</sup>
Whole plant	Ashwagandha has been reported to exhibit various activities, including antistress, immunomodulatory, anticancer, antioxidant, anticonvulsive, antihelminthic, antiarthritic, chemopreventive, antibacterial, cardioprotective, antidepressant, immunosuppressive, adaptogenic, and antiradical effects. <sup>[10,19]</sup>



**Table 4: Method of propagation of Ashwagandha and their stages conditions.**<sup>[22]</sup>

Method of propagation	Broadcasting or by transplanting Broadcasting
	For directly sown crops, thinning of plants is carried out approximately twenty to thirty days following seeding, ensuring a group of plants ranging from 20000 to 25,000 per hectare. Effective weed control is achieved through manual weeding performed at intervals of 25-30 days. <sup>[22]</sup> Transplanting Approximately 2 Kg seeds are needed for generation small plants in an acre. Prior to sowing, the seeds should undergo treatment with 3 g per kilogram of Diathane M-45. The seed sowing in greenhouse takes place immediately before to the rainy season starting, covering them with thin layer of soil. Germination typically occurs within Seven to eight days after seeding. Once the plantlets reach approximately six weeks old, they are substituted into the sector, spaced sixty cm apart in sixty cm wide furrows. <sup>[22]</sup>
Time of propagation	July-August
Soil	Light red and sandy rich soil with adequate drainage and a pH of 7.5-8. <sup>[22]</sup>
Climate	Dry and subtropical parts Ashwagandha is a crop that is grown in the Kharif season
1. Temperature	30°C-35°C
2. Rainfall	660-750 mm
3. Altitude	13-150 cm
Irrigation	Hand weeding at 30 days.
Fertilizers	After 50 days, an application of 45 kg of nitrogen per hectare is advised. The cultivation primarily relies on residual fertility, and as such, there is no recommendation for the use of manure or fertilizers.
Diseases	Susceptible to fungal infection, Seed rooting. Major insects: Shoot borer and mite
Pesticides	2-3 spray of rogar or Nuvanat rate 0.6% The extract from neem seed kernels will affect mites more. Somicidin (10 mL per liter) can be used to control shoot borer. <sup>[22]</sup> Apply treatment to the seeds before to planting, soaking them in 3 mL/L of Calphomin at the nursery and applying 5 g/kg of seed. Spraying Diathane M-45 at a rate of 3 g/L of water should be done on the crop when it is 30 days old. If illnesses develop, the spraying should be done again at a 15-day interval. <sup>[22]</sup>
Harvest time and method	December or January lasts up to March by uprooting January marks the beginning of harvesting, which lasts until March (150-170 days after sowing). The drying of the leaves and crimson berries indicates the crop's maturity. To retrieve the roots, the entire plant is uprooted and the stem is chopped 1-2 cm above the crown to separate the roots from the aerial components. To aid in drying, they are then sliced into tiny pieces, around 7 to 10 cm. The dried berries that were picked to get the seeds, plants are threshed. <sup>[22]</sup>
Drying and storage	kept in a tightly sealed container and dried in the sun or shade.
Yield	Each hectare, 300-500 kg of roots and 50-75 kg of seeds.

**Table 5: Chemical constituents and their category.**

Type of Products	Parts of Plant	Most common Withanolides Content	Category and Form
Crude Ashwagandha Water or alcoholic or hydroalcoholic Ashwagandha Standardised extracts (KSM-66, Sensoril etc.,)	Root, leaf or leaf and root mix product	Between 1-10% Withanolides	Simple powder, granules, liquids or tablet, capsules

## CONCLUSION

*W. somnifera*, recognized as an Ayurvedic rasayana stands out as an ancient medicinal plant with widespread health-promoting attributes. Every part of this plant offers therapeutic benefits, and its long-standing reputation includes well-established neuroprotective, anti-stress, and anti-inflammatory properties. Demonstrating safety and effectiveness in overall health promotion, *W. somnifera* has yet to establish India's strong presence for its value-added products in the global market. Therefore, the development of value-added products derived from Ashwagandha holds immense potential for commercial success and can contribute significantly to the socioeconomic empowerment of India.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## ABBREVIATIONS

**AYUSH:** Ayurveda, Yoga, Unani, Siddha, Homeopathy; **NMPB:** National Medicinal Plant Board.

## SUMMARY

Ashwagandha has lot potential in healthcare, agriculture and beyond. Adaptogenic, neuroprotective, anti-stress, and anti-inflammatory properties are contributing to its potential in promoting overall well-being of humankind. This comprehensive review on pharmacognosy, phytochemistry, traditional uses and pharmacology, cultivation and agro-techniques, dosage and side effects, trade and commerce along with suggested value-added products surrounding Ashwagandha, offering valuable insights for researchers, practitioners, and stakeholders in the domain of complementary herbal medicine and natural products. Cultivation and collection practices knowledge will help to bridge gap between demand supplies in global market. A huge opportunity awaits the herbal industry, to be availed through innovative value-added products.

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