

A COMPREHENSIVE BOOK ON

ASHWAGANDHA (WITHANIA SOMNIFERA)

UM Chandrashekara
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KC Chacko
Jeetendra Kumar Vaishya



REGIONAL CUM FACILITATION CENTRE (SOUTHERN REGION)
National Medicinal Plants Board, Ministry of AYUSH, Government of India

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Editors

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KSCSTE – Kerala Forest Research Institute
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A Comprehensive Book on Ashwagandha (*Withania Somnifera*)

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Disclaimer:

The editors have taken utmost care to make this book a valuable compilation of information on Ashwagandha. However, the contributors of chapters of the book have the ultimate responsibility for the content included in this book.

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PREFACE

In the vast landscape of herbal medicines, few plants have captured the imagination and reverence of cultures around the world, like Ashwagandha. Scientifically known as *Withania somnifera*, it has been revered for its adaptogenic properties, helping to combat stress, enhance vitality, and promote overall well-being. In recent years, it has garnered significant attention, transcending its roots in traditional medicine to emerge as a prominent player in the realms of holistic health and wellness.

This comprehensive book on Ashwagandha aims to provide a thorough exploration of its multifaceted nature described in different systems of Indian Medicine. The editors and authors of this book delved into its historical roots, tracing its significance in traditional systems such as Ayurveda, Siddha, Unani, Homeo and folklore medicine. Each chapter seeks to illuminate the depth of knowledge surrounding Ashwagandha, merging historical insights with modern scientific understanding. Furthermore, the economic aspects of Ashwagandha cultivation and trade are explored, highlighting its significance in sustainable agriculture and its role in supporting local and national economies. As the demand for natural remedies continues to grow, understanding the economic implications becomes crucial for both practitioners and policymakers.

The book is intended for general readership, herbalists, naturopaths, alternative medicine practitioners, and life science/medical students and researchers to gain a comprehensive understanding of Ashwagandha's potential in improving health and well-being, while emphasising the national and international market opportunities for Ashwagandha growers and traders.

As we embark on this journey through the pages of history, science, and commerce, you may find inspiration and insight into the transformative potential of Ashwagandha, rooted in tradition yet blossoming in the modern age. It is also my hope that this book serves as a valuable resource for those seeking cultivation of Ashwagandha as a sole crop or as an intercrop with agricultural and horticultural crops.

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FOREWORD

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FOREWORD

Withania somnifera, also known as Ashwagandha or Indian Ginseng, a cosmopolitan plant growing throughout the drier and subtropical regions has been used since over 5,000 years for medicinal purpose in traditional systems of medicine. Its energy-boosting and memory enhancement properties are widely recognized in Ayurveda, Siddha, Unani, Homeopathy and folklore medicine. Around forty synonyms assigned to Ashwagandha in Ayurveda texts clearly indicate a diverse therapeutic property (karma) identified by ayurveda practitioners since the period of Acharya Charaka. A large number of medicines and formulations mentioned in ancient texts are widely accepted and successfully utilized for the treatment of nervous exhaustion, cognitive disorders, insomnia, fatigue, reproductive disorders, anxiety, and stress and also overall health management. Ashwagandha is also rich in several macro and micro-nutrients and thus gaining importance in production of several innovative functional foods. Several clinical studies have demonstrated the usefulness of Ashwagandha plant extracts in managing several health disorders mentioned in Indian traditional systems of medicines. There is a scope for application of modern approaches such as artificial intelligence (AI) in Ashwagandha drug repurposing via quick virtual screening to enhance and speed-up the identification of potential drug candidates against communicable and non-communicable diseases and in developing larger evidence base to further characterize formulations and quantify their benefits on human health. It is also necessary to support and conduct high quality research for the preparation of a revised package of practices for Ashwagandha for production of quality raw drugs and to ensure that the marketed product is absolutely safe for consumption. The growing demand for Ashwagandha in sectors such as herbal medicine, pharmaceuticals, cosmeceuticals, and nutraceuticals, is an opportunity for Ashwagandha growers. Ashwagandha is a unique profitable crop which can be grown in dry lands, both as a sole crop as well as mixed or intercrop with agriculture and horticulture crops. By adopting integrated nutrient management systems, the crop yield and quality parameters of Ashwagandha can be further enhanced. This is a valuable comprehensive book containing detailed descriptions and uses of Ashwagandha in Indian Systems of Medicine, current research in efficacy of Ashwagandha for promoting health, cultivation and management practices, and economics of Ashwagandha. With great pleasure I congratulate the NMPB team, and the RCFC (SR) team in their earnest endeavour in furthering the cause of medicinal plants through knowledge dissemination, resource augmentation outside forests, and bringing out the outcome through such a useful publication on Ashwagandha, based on exhaustive literature review.

(Dr. Mahesh Kumar Dadhich)



*if the wisdom is herbal,
many ailments are curable*

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Ashwagandha [*Withania somnifera* (L.) Dunal] – An Overview

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Introduction

Over 75 to 80% of the world population relies mainly on plants and plant extracts for health care (Fitzgerald *et al.*, 2020) and over 40% of the entire plant species are being used for medicinal purposes. Of the 2,50,000 higher plant species on earth, more than 80,000 (32%) are medicinal (WHO, 2020). In India, about 8,000 out of 17,000 -18,000 angiosperm species are medicinal plants (NMPB, 2021). While about 22% of the total raw drugs used in India is sourced through cultivation, the remaining quantity is collected from wild sources (NMPB, 2021). It is also estimated that at least 25% of all modern medicines are derived, either directly or indirectly, from medicinal plants, primarily through the application of modern technology to traditional knowledge. In the case of certain classes of pharmaceuticals, such as antitumoral and antimicrobial medicines, this percentage may be as high as 60% (WHO, 2020). The plants belonging to the genus *Withania* of Solanaceae family are generally acclaimed as medicinally essential due to the high therapeutic and nutraceutical potential. Out of five species of this genus, namely, *Withania somnifera* (L.) Dunal, *Withania japonica* (Franch and Sav) Hunz., *Withania coagulans* (Stocks) Dunal, *Withania frutescens* (L.) Pauquy, and *Withania begoniifolia* (Roxb.) Hunz. (The Plant List, 2013), India is represented basically by the two most eminent ones, that is, *W. somnifera* and *W. coagulans* (Srivastava and Sangwan, 2020). Among these five species, *W. somnifera* possess plethora of medicinal uses and pharmacological applications. In the present paper, distribution, morphological features, and cultivation practice of *W. somnifera* are given. Establishment of pharmacognostical parameters such as macroscopic and microscopic studies will help in identifying and authenticating the true drug and diagnostic characters are useful for differentiating authentic drug from adulterants

and substitutes. Thus, macroscopic, microscopic, phytochemistry and pharmacological features of *W. somnifera* are dealt with.

Geographic Distribution

W. somnifera, also known as Ashwagandha or winter cherry or *Indian Ginseng*, is cosmopolitan and grows throughout the drier parts and subtropical regions. The wild growth of this species has also been reported from India, Pakistan, Bangladesh, Afghanistan, Algeria, Angola, Botswana, Burundi, Cameroon, Philistine, Egypt, Jordan, Morocco, Sri Lanka, Spain, Canary Island, Eritrea, Ethiopia, Cyprus, Iran, Kenya, Kriti, KwaZulu-Natal, Lebanon, Syria, Lesotho, Libya, Malawi, Mali, Mauritania, Mozambique, Myanmar, Namibia, Nigeria, Oman, Palestine, Rwanda, Sardegna, Saudi Arabia, Sicilia, Sinai, Somalia, Sudan, Eswatini, Tanzania, Tunisia, Turkey, Uganda, Yemen, Zambia, Zaire and Zimbabwe (POWO, 2024; Figure 1).



Figure 1. Global distribution of *Withania somnifera*. (Reproduced from POWO, 2024).

In India, the plant can be seen growing wild in the North Western regions extending to the mountainous region of Punjab, Himachal Pradesh and Jammu, up to an altitude of 1,500 m (Singh and Kumar, 1998). While Rajasthan, Punjab, Haryana, Gujarat, Uttar Pradesh, Madhya Pradesh and Maharashtra are the top Ashwagandha producing States in India, it is also cultivated in semi-arid regions of

Karnataka, Andhra Pradesh and Telangana. Vernacular names of Ashwagandha in different languages are given in Table 1.

Table 1. Vernacular names of Ashwagandha in different languages

Language	Vernacular names
African	Koorshout
Arabic	Kaknaj-e-Hindi, Hajarat el dib, Marjan
Assamese	Asgandhisrol
Bengali	Ashvaganda, Dhuppa
Chinese	Cui mian shui qie, Nan fei zui qie
English	Winter cherry, Indian Ginseng
Ethiopian	Agol
French	Cerise d'hiver
German	Schlafbeere
Gujarati	Asan, Asana, Asoda, Asundha, Ghodaasoda
Haryanvi	Aksin
Hindi	Asgandh
Italian	Alchechengi falso
Kachchhi	Aasun, Aasund
Kannada	Hiremaddinagida, Angara beru, Ashwagandhi,
Malayalam	Amukkiram, Pevetti
Marathi	Askandha, Kanchuuki, Tilli
Marathi	Askandha
Nepalese	Aasoganda
Norwegian	indisk ginseng
Odiya	Asugandha
Persian	Kaknaj-e-Hindi, Asgand Nagaori, meheman
Punjabi	Aksan, Asgand
Rajasthani	Sarvgandha
Sanskrit	Ashwagandha, Ashvakandika, Gandha Patri, Palash Parni
Sinhala	Amukkara
Sotho	Bofepha
Spanish	Ginseng indio
Tamil	Amukkara Kizhangu, Asubam, Asuvagandi
Telugu	Asvagandhi, Penneru, Pennerugadda, Dommadolu
Tibetan	Ba-dzi-gandha
Xhosa	Ubuvuma
Zulu	Ubuvimbha

It may be mentioned here that, in Ayurveda, there are more than 40 different names to Ashwagandha in Sanskrit language (Prabhu, 2024; in this book). According to Berlin (1973), species identified by several traditional names within a native language are likely to be culturally important possibly because the names employed may capture varietal or utilitarian diversity. Thus, presence of several synonyms to Ashwagandha also indicate its importance in Ayurveda system of medicine.

Taxonomy

According to the biological classification, Ashwagandha belongs to the Kingdom Plantae (plants), Phylum Tracheophyta (vascular plants), Class Magnoliopsida, Order Solanales, Family Solanaceae, Genus *Withania*, and Species *Withania somnifera* (L.) Dunal.

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Solanales
Family	Solanaceae
Genus	<i>Withania</i>
Species	<i>Withania somnifera</i> (L.) Dunal

The Latin genus name *Withania* is named after Henry Witham, an English palaeobotanist of the early 19th century. The Latin species name *somnifera* means 'sleep-inducing'.



Morphology

Ashwagandha is a perennial small or medium size undershrub, 30 to 200 cm tall, erect, greyish, with strong disagreeable smell of horse's urine. Almost the complete plant is covered and surrounded with very short, small, fine, branched hairs and silver-grey in colour. Stems greyish tomentose. The leaves alternate and simple. The leaf blades ovate to obovate or oblong, 29-80 mm long and 21-50 mm broad, acute to obtuse at the apex with slightly waved margins, cuneate at the base, with entire margins or almost so, subglabrous above, densely tomentose beneath. Petiole 5-20 mm long. Flowers mostly in 3-6-flowered axillary clusters; pedicels up to 5 mm long, tomentose. Calyx 4-5 mm long in flower, enlarging to 10-28 mm in fruit, tomentose outside; lobes narrowly triangular, acute. Corolla greenish, 5-7 mm long, thinly tomentose outside; lobes triangular, shorter than the tube. Stamens with filaments about 2-3 mm long; anthers about 1 mm long. Ovary with inconspicuous disk at the base; style 1.5-2.5 mm long. Fruits berries. Berry globose, 5-8 mm in diam., shiny, red, surrounded by and much exceeded by the enlarged ovoid-acuminate calyx. Seeds about 2 mm in diameter (Figure 2). Roots long, woody, tuberous, outer surface buff to grey-yellow with longitudinal wrinkles (Figure 3), with characteristic odours and taste bitter and acrid.

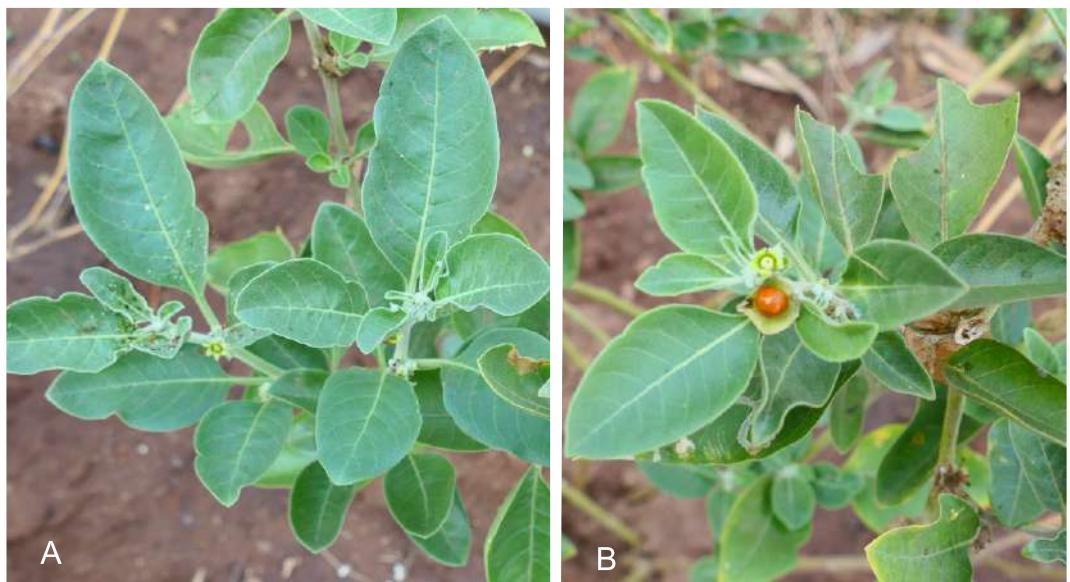
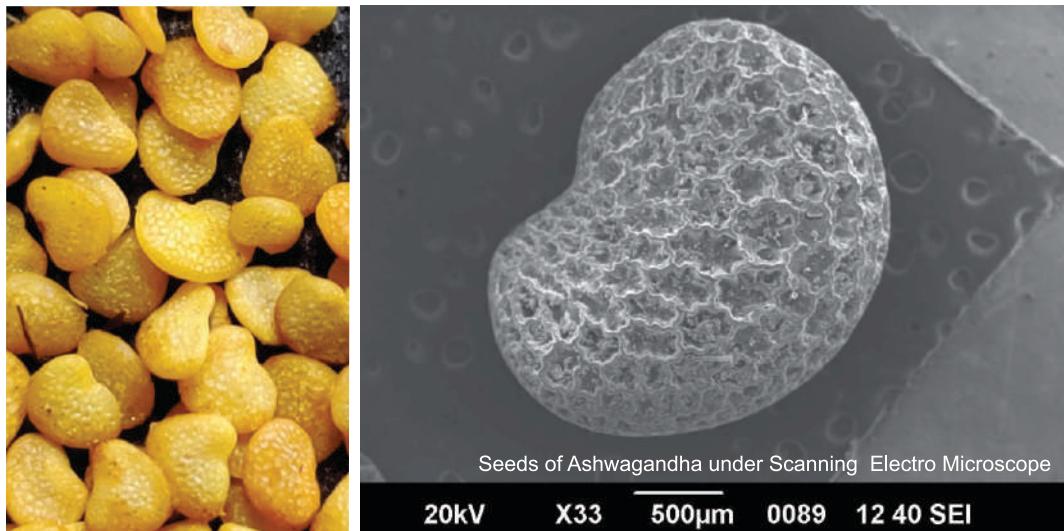


Figure 2. Morphology of *Withania somnifera*: A. Whole plant; B. Flower and Fruits



Anatomy

The anatomical characterization of root, stem, leaf, flower and fruit of *W. somnifera* given by Calalb and others (2015) is a key for authentication of the whole plant of this species.

Root: The periderm is narrow and easily exfoliate. The specific feature is the presence of calcium oxalate sands in the cortex cells. The outer ring of the secondary structure of central cylinder is represented by phloem which is rich in starch and wood from lignified vessels, crossed by numerous medullar rays with starch.

Stem: The surface of the epidermis is pubescence by multicellular, branched and dendroid trichomes with random in distribution. The cortex with large lacuna, interspersed by oxalic sand cells with sclerenchymatic fibre pericyclic ring.

Leaf: The anatomical structure of the leaf is bifacial, dorsiventral. The both upper and lower epidermis are covered with multicellular, dendroid trichomes like on the stem, and more abundant on the lower epidermis. The lower epidermis, also, is characterized by rarely secretory hairs (with uni- or multicellular glands on the unicellular stalk). On the young leaves geometrical wax crystals are distinguished. In the spongy mesophyll a lot of calcium oxalate rosettes can be seen. The vascular bundles are collateral.

Flower: Gamosepalous calyx which enclosed the mature fruit possess anomocytic stomata (rarely) and two types of trichomes: unicellular and long (rarely) and multicellular (dense), branched, like on the leaf but shorter. Presence of geometrical, often polygonal wax formations is another special feature.

Fruit: The epidermis of fruit is covered by thick colourless cuticle layer and interrupted by anomocytic stomata on the basal region of fruit. The internal tissue is mainly parenchymatous with higher degree of vacuolization. The mesophyll cells are rich in orange to red carotenoidoplasts, fatty globules and sometimes were seen the oxalate rosettes. The endocarp lobes enclose the individual seeds in separate chambers.

Phytochemistry and biological activities

Ashwagandha is a pharmacologically significant medicinal plant with rich reservoir of bioactive constituents (Tewari *et al.*, 2022). Various phytochemical studies have revealed the presence of different bioactive constituents from various parts of *W. somnifera* (Table 2). These bioactive compounds have enormous potential to target multiple biomolecules involved in the pathogenesis of various diseases. The bioactive compound/s responsible for some of the biological activities of *W. somnifera* listed in Table 3.

Table 2. Phytoconstituents of Ashwagandha. (Based on Saleem *et al.*, 2020).

Phytochemical compound class	Phytoconstituents
Steroidal lactones	Withaferin-A, Withanone, Withanolide A, E, F, G, H, IJ, K, L, M
Alkaloids	Withanine, Withasomnine, Withananine, Somniferine, Tropeltigloate, Somnifeinine, Nicotine, Somninine, Pseudowithamine, Anaferine, Cucsohygrine, Anahygrine
Steroids	Cholesterol, B-Sitosterol, Stigmastadien, Stigmasterol, Diosgenin, Sitoinosides VII-X
Nitro-compounds	Somnisol, Somnitol, Withanol
Flavonoids	Kaempferol, Quercetin, Catechin, Naringenin

Table 3. Bioactive compounds of *W. somnifera* and their biological activities.

	Biological activity	Bioactive compound
1	Anti-Stress and Anti-Anxiety/ Psychotropic Activity	Withanolide glycoside , Sitoindoside VII, VIII and IX (Bhattacharya et al., 2001)
2	Relaxant and Anti-Spasmody Activity	Alkaloids (Withanine, Withasomnine, Withananine, Somniferine, Tropeltigloate, Somnifeinine, Nicotine, Somninine, Pseudowithamine, Anaferine, Cucsohygrine, Anahygrine) (Rasool and Varalakshmi, 2006)
3	Anti-Inflammatory Activity	Withaferin- A and Withanolide-F (Meena et al., 2020)
4	Anti-Microbial Activity	Withaferin-A and Withanolide-F (Owais et al., 2003)
5	Anti-diabetic Activity	Withanolides (Gaurav et al., 2023)
6	Anti-carcinogenic Activity	Withaferin A, 3-hydroxy-2,3-dihydrowithanolide F, and Withanolides D and E (Singh et al., 2011)
7	Anti- neurodegenerative Activity	Glycowithanolides, Withaferin-A, and Sitoindosides VII–X (Dickon and Vickers, 2001)
8	Immunomodulatory Activity	Withaferin-A, Sitoindosides IX and X, Glycowithanolides and 3-b-hydroxy-2,3-dihydro-withanolide F (Rasool and Varalakshmi, 2006)
9	Antioxidant Activity	Sitoindosides VII–X, Withaferin A, and Glycowithanolides (Mishra et al., 2001)

Being a rich source of different bioactive compounds, *W. somnifera* is one of the most useful medicinal plants that has been used for centuries in different systems of Indian medicine (Prabhu, 2024; Vaquar Ahmed and Najeeb Jahan, 2024; Murthy, 2024; Hubaib and Chandrashekara, 2024, Shine Vaidyar 2024: all in this book) to cure various disease conditions. Although several individual bioactive constituents mentioned above have been isolated and characterised for their health benefits, there is still need to explore the treasure of small molecules in this plant, identify their bioactive properties and undertake pharmacological evaluation.

Cultivation and crop management

It is estimated that the annual requirement in Indian market stands at approximately 7000 tonnes, while India's estimated production is just 1,500 tonnes. At the global level, ashwagandha market is expected to grow at a CAGR (Compounded Annual Growth Rate) of 10.9% during 2022 to 2032. In 2022, Ashwagandha market was valued at 433 million USD which is expected to increase to 1,187 million USD by 2032 (market.us, 2024). Therefore, it is necessary to promote cultivation of Ashwagandha at commercial scale by following scientifically validated agro-techniques.

Ashwagandha is a drought tolerant crop. It grows well in dry tracts with mean annual rainfall between 600 mm and 750 mm and temperature between 14°C and 42°C. Black and laterite type of soils having good drainage are suitable. The soil should be loose, deep, well drained and slightly alkaline (pH 7.5-8.0). Ashwagandha is a short duration (4 to 4.5 months) late rainy season (Kharif) crop. Late winter rains are conducive for the proper development of the plant roots.



For cultivating Ashwagandha, land should be prepared in such a way that it should be loose enough for development of long and thick roots. After receiving a pre-monsoon rain, plough the land once with mould board plough and harrow twice to bring the soil to fine tilth. About 10-20 tonne of farm yard manure per hectare should be mixed into the soil at the time of last ploughing. Many studies recommended the integrated nutrient management by using organic manures along with inorganic fertilizers and biofertilizers is important both for improving physico-chemical and biological properties of soil and provide all the nutrients in available form to crop plants. The field is then levelled by planking.

In India, around thirteen varieties Ashwagandha are cultivated (Table 4). All these cultivars vary in root yield; morphological features such as the colour of the fruits, plant height, leaf morphology, stem branching, capsule morphology, etc.; secondary metabolite content such as total alkaloid, total phenolics, total flavonoids, total tannins, Withanolide, and Withaferin-A (Khabiya *et al.*, 2024). The crop yield and desirable amounts of bioactive constituents in a given variety may differ in different agroclimatic and soil conditions. Thus, farmers must opt for a variety that can give good yields with desirable amounts of bioactive constituent in their lands.

Table 4. Dry root yield of different varieties of Ashwagandha. Source: Khabiya *et al.*, 2024.

	Cultivars	Dry root yield (kg per ha)
1.	CIMAP-Pratap	3,495
2.	NIMITLI-101	2,300
3.	Poshita	2,199
4.	NMITLI-118	1,500
5.	Rakshita	1,400
6.	CIMAP-Chetak	1,177
7.	Arka- ashwagandha	1,000
8.	CIM-Pushti	900–1,000
9.	Jawahar Ashwagandha-134 (JA -134)	600–800
10.	Raj Vijay Ashwagandha (RVA-100)	600–700
11.	Gujarat Anand Ashwagandha-1 (GAA -1)	650
12.	Jawahar Ashwagandha-20 (JA -20)	500–600
13.	VA -1	589

Broadcast sowing, and transplanting seedlings from nursery beds are the two methods of cultivation of Ashwagandha. Ashwagandha seeds do not have dormancy. Broadcasting with higher seed rates at 15 kg per hectare is the most common method for cultivation of ashwagandha in rainfed areas. The optimum time for sowing is 2nd to 3rd week of August. If rainfall is more, then sowing can be delayed up to September.

In recent time, apart from direct sowing by broadcasting, line sowing and raised bed sowing are also gaining popularity as they have been reported to yield higher quantity of roots and also help in performing intercultural practices properly.

Transplanting seedlings is another method of cultivation followed for Ashwagandha. For raising seedlings, seeds are sown in well-prepared, raised nursery beds. In June-July, the seeds are sown in lines spaced at 5 cm at about 1-3 cm deep in soil and cover with light soil. A light irrigation after sowing of seeds ensures good germination. Germination commences within 6-7 days of sowing, and completes within ten days from sowing. When the seedlings are 6 weeks old and sufficiently tall, they are transplanted at 60 X 60 cm spacing in well- prepared land in July-August. About 5 kg of seeds are required to provide enough seedlings for planting in one hectare.

In fields where seeds are sown, by broadcasting or in the line, seedlings should be thinned out by hand at 25-30 days after sowing to maintain a plant population of about 3 to 6 lakh plants per hectare (Figure 4). One hand-weeding at an early stage is sufficient to enable the ashwagandha plants to take over the growth of weeds. Organic mulching (using residues of previous crops) can be done both for inhibiting weed growth and conserving soil moisture. Excessive rainfall or watering is harmful for Ashwagandha crop. Thus, one or two lifesaving irrigations can be given if required.

In some places, Ashwagandha crops may be affected by insect pests such as aphids and hadda beetles, and diseases such as seedling rot and *Alternaria* leaf blight. Bio-pesticides prepared by using neem (*Azadirachta indica*), chitrakmool (*Plumbago indica*), dhatura (*Datura metel*) and cow urine may be used to control insect pests, and neem cake can be applied to soil to control the diseases.

Ashwagandha plants start flowering and bearing fruits from December onwards. Mature fruits can be collected for extracting seeds for further propagation.



Figure 4. Ashwagandha cultivation in Gadag, Karnataka

Roots of Ashwagandha are mainly used in herbal industry and it will be ready to harvest in January-February, at 4 to 4.5 months after planting. The maturity of crop is judged when leaves start drying and berries become yellow red. Ashwagandha should be harvested in the dry weather. Harvesting is done by uprooting the whole plant without damaging the roots. There should be sufficient moisture in the soil at the time of harvesting for easy uprooting the plants. From the harvested crop, separate the roots from aerial parts by cutting the stem 1 - 2 cm, above the base. The roots have to be dried for 10 days continuously under the sun and then packed in white polythene bags.

Crop yield and Economics

An average yield of 625 - 750 kg of Ashwagandha root (dry weight) can be obtained from one hectare land (Figure 5). The cost of cultivation ranges from Rs. 20,000 to 25,000 per hectare with an average revenue of Rs. 92,500 to Rs. 1,12,500 per hectare. With an average B:C ratio of 4.5, cultivation of Ashwagandha also generates about 100 man-days of work per hectare during the cropping period of 5 to 6 months (Sujanapal *et al.*, 2024).

Root powdering and storage

Potency refers to the amount of drug needed to produce a specific response. In the case of Ashwagandha, its root powder is the most potent form. The root powder is



made after cleaning, washing and drying roots thoroughly. Drying of Ashwagandha by using hot air under 45 to 55°C is efficient than shade drying that takes more time. The dried roots are allowed to cool down before grinding using pulveriser into a fine powder. Store the powder in an airtight container, away from direct sunlight and heat to maintain its freshness and potency.

Use of Ashwagandha in functional foods

Functional foods are defined as the products similar in appearance to a conventional food that are demonstrated to have physiological benefits or reduce the risk of chronic disease beyond basic nutritional functions (Tur and Bibiloni, 2016). Increasing awareness about health among

consumers results in increased demand for innovative functional foods incorporated by various medicinal plants, including Ashwagandha. As already mentioned, Ashwagandha contains a variety of bioactive compounds that are responsible for making it an adaptogenic plant and offer a wide range of health benefits. In addition, Ashwagandha root powder is a nutritional powerhouse, offering essential macro and micro nutrients (Table 5).



Figure 5. Roots of Ashwagandha harvested from a field at Gadag, Karnataka

Several products, such as Shrikhand, Namakpara, Missi roti, Chutney, Muruku, Ashwagandha chai (tea), Golden Milk latte, Roasted cashew nuts with Ashwagandha, Vegan Ashwagandha smoothie bowl with frozen berries, Almond milk, Kitchari, Chappati, Naan, Thepla etc. are prepared by incorporating Ashwagandha root powder. There are reports to indicate that in markets the value-added products prepared by Ashwagandha root powder are more acceptable (Gill *et al.*, 2019). Ashwagandha supplementation can be used effectively as a source of value addition in preparation of sweets like ladoos to increase fiber and micronutrient contents in addition to imparting beneficial medicinal properties (Indu and Awasthi, 2018). There is also scope to standardize and develop more value-added products of Ashwagandha root powder based, so as to promote its health beneficial effects because despite of possessing great therapeutic value Ashwagandha cannot be consumed in raw form due to its bitter taste (Neelam *et al.*, 2018).

Table 5. Macronutrients and Micronutrients in Ashwagandha root powder. (Source: Ashwagandha Expert, 2023)

Macronutrients	
	Quantity (in 100 gm of Ashwagandha)
Energy	245 kcal
Fat	0
Protein	3.0 mg
Iron	3.3 mg
Carbohydrate	499 mg
Calcium	23 mg
Dietary Fibre	323 g
Vitamin C	3.7 mg
Micronutrients	
Vitamin A	75.7 µg
Vitamin B6	0.8 mg
Vitamin B12	1.3 µg
Pantothenic acid	3 mg
Riboflavin	1.4 mg
Thiamine	1.1 mg
Vitamin C	9.5 mg
Fiber	32.2 mg
Calcium	23 mg
Iron	3.3 mg
Copper	Moderate amount
Zinc	5 mg

Conclusions

Ashwagandha is one of the most useful and multi-purpose medicinal agent by possessing a diverse bioactive constituents, such as Withanolides, Sitoindosides and many useful alkaloids. However, further studies to understand the role of bioactive compounds either individually or in combination need to be undertaken

to support the plants therapeutic uses. Ashwagandha is also rich in several macro and micro-nutrients which can contribute for overall health management. Thus, now a day, several innovative functional foods consisting of Ashwagandha are gaining importance. However, systematic and scientific evaluation of the contents in such value-added products, food safety and shelf-life issues etc. are needed. Both at national and international level, the demand for Ashwagandha in the herbal, pharmaceutical, cosmeceuticals, and nutraceutical industries is increasing considerably. Thus, cultivation using improved high-yielding varieties by applying improved agricultural and processing technology is imperative. However, multilocation studies for systematic scientific evaluation and validation of the released high-yielding varieties of Ashwagandha in terms of crop yield, phytochemistry and pharmacological activities in different agroclimatic zones of India to determine the best suitable variety(es) for each geographical location are needed. In addition, there is growing concerns over dosage, efficacy, toxicity and risks associated with use of Ashwagandha formulations at international level (Hancocks, 2023). In this context, it is necessary to support and conduct high quality research to prove that the marketed product is absolutely safe for consumption.

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Ashwagandha in Ayurveda

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Introduction

Ayurveda (Ayus=life; Veda=knowledge) is the science of life more than 5000 years old, and a comprehensive integrative healing system. The glory of Ayurveda is because of the rich and authentic knowledge base studded with universal principles and profound insights into the connection between mind and body and the laws of nature which structure all progress in life. In Ayurveda, over 1540 botanicals are used and among them Ashwagandha (*Withania somnifera*) is one of the prominent species used since Vedic period (Atrideva Vidyalankara, 1976). Medicinal properties of Ashwagandha are well described in Ayurvedic literature like different Samhitas, Chikitsa Nighantus and Chikitsa Granthas. In Ayurveda, Ashwagandha is considered as the best adaptogenic, excellent rejuvenator (Rasayana), aphrodisiac (Vrishya) with properties to treat a large number of ailments. Thus, Ashwagandha is used in Ayurveda for treating cold, cough, bronchitis, ulcers, arthritis, inflammation, tuberculosis, diabetes, epilepsy, insomnia, leprosy, Parkinson's disease, nervous disorders, mental stress, asthma, and impotence etc. Ashwagandha is used alone or in combination with other medicinal plants in various ayurvedic formulations. In this Chapter, descriptions and uses of Ashwagandha given in Ayurvedic literature, and current research in efficacy of Ashwagandha for promoting health are presented.



Ashwagandha in Vedic Literature

In Rigveda (6,000 BC), the Oushadhi Sukta (Rigveda: 10.97, 1-23) is the authoritative document of plants used for the benefit of humanity. Here, Ashwagandha, named as 'Asyabati', is described as a strong herb that is used for revitalization and fostering energy. In Atharvaveda also similar medicinal properties of Ashwagandha (Asyabati) are mentioned (Atrideva Vidyalankara, 1976).

Ashwagandha in Charaka Samhita (4th Century BCE)

Charaka Samhita is the oldest and the most authentic treatise on Ayurveda (Bhavana and Shreevastha, 2014). In this Samhita, Charaka called Ashwagandha with different names, such as, Ashwagandha, Hayagandha and Hiyahwa, and considered it as a Balya (plant that promotes body strength) and Brihana (plant that nourishes body). There are several Sutras in Charaka Samhita to show that in Kayachikitsa, Ashwagandha is an important ingredient in different preparations, such as, Basti, Dhuma, Dhupana, Ghrita, Kashaya, Lehya, Lepa and Thaila (Patel, 2023) (Table 1).

Table 1. Formulations in Charaka Samhita where Ashwagandha is used

No.	Formulation	Indication	Chapter and Shloka number in Charaka Samhita *
Basti (Medicated enema)			
1.	Baladi Yapana Basti	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	C.S.Si.12/6
2.	Basti	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	C.S.Si.12/2
3.	Erand Basti	Ashmari (Urinary Calculi)	C.S.Si.3/39
Dhuma and Dhupana (Smoke and fumigation)			
4.	Ingudi Tvangadi Dhuma	Kasa (Cough)	C.S.Ci.18/75
5.	Dhuma	Arsa (Piles)	C.S.Ci.14/51
Ghrita (medicated ghee)			
6.	Amritha Grhita	Prativisha (Antidote), U dara roga (Abdomen disorders)	C.S.Ci.23/244
7.	Ashwagandha Grhita	Dhupana (Fumigation)	C.S.Ci.14/5
8.	Vajikarana Grhita	Vajikarana (Aphrodisiac)	C.S.Ci.2/33-37

Kashaya (Water -based extract of medicinal herb/s)			
9.	Balya Mahakashaya	Balya (Strengthening)	C.S.Su.4/7
10.	Brmhaniya Mahakashaya	Brmhana (Weight gain)	C.S.Su.4/2
Lepa (Medicated paste that applied externally)			
11.	Lepa	Rajayaksma (Tuberculosis)	C.S.Ci.8/175
12.	Lepa	Udara roga (Abdominal disorders)	C.S.Ci.13/108
13.	Lepa	Granthi Visarpa (Herpes zoster)	C.S.Ci.21/123
14.	Gandhahasthadi Lepa	Pilla and Kandu (Eye diseases)	C.S.Ci.23/80
15.	Gandhahasthi Lepa	Unmada (Mental derangement)	C.S.Ci.23/70
16.	Lepa for Utsadana	Urusthambha (Stiffness of thigh)	C.S. Ci.27/50
17.	Kusthadi Lepa	Kushta (Skin diseases)	C.S.Su.3/7 -8
18.	Lepa	Vataroga (Neurological disorders)	C.S.Ci.29/73
Thaila (Medicated oil)			
19.	Agurwadi Thaila	Jwara (Fever)	C.S.Ci.3/266
20.	Balaswagandhadi Thaila	Sirah Kampa (Parkinson's disease)	C.S. Si. 9/87
21.	Bilva Thaila	Vata roga (Neurological disorders)	C. S. Si. 4/4
22.	Kusthadya Thaila	Urusthambha (Stiffness of thigh)	C.S.Ci.27/43
23.	Rasna Thaila	Vata roga (Neurological disorders)	C.S.Ci.28/166
24.	Vrsamuladi Thaila	Kanda Bagna (Bone fracture) and Asthi -kshaya (Osteoporosis)	C.S.Ci.28/170

Ashwagandha in Sushruta Samhita (6th Century BCE)

The Sushruta Samhita, a most important ancient medical treatise, is another fundamental text of the medical tradition in India. In Sushruta Samhita, Ashwagandha with two synonyms: Vajigandha and Turangagandha, is used in different forms of drugs, such as, Agada, Anupana, Basti, Churna, Dhum, Ghritha, Kalka, Kwatha, Lehya, Lepa, Taila and Vamaka Dravya (Patel, 2023) (Table 2).



Table 2. Formulations in Sushruta Samhita where Ashwagandha is used

No.	Preparation	Indication	Chapter and Shloka number in Sushruta Samhita *
1.	Agada (Anti-venomous compound; Antidote)	Nullifying the poison of a Visvambara insect	S.S.Ka.8/5
2.	Anupama (The liquid that is advised along with the medicine)	Balavardhaka, Pushtikaraka (Strength provider)	S.S.Su.46/432-2
Basti - Medicated enema			
3.	Basti	Guda Rakta Srava (Bleeding from rectum)	S.S.U.45/40
4.	Sampakadi Basti	Grahani roga (Duodenal ailments)	S.S.Ci.38/43
Churna – Powder			
5.	Churna	Yakshma (Tuberculosis)	S.S.U.41/41
6.	Ashwagandhadichurna	Shosaroga (Emaciation)	S.S.U.41/42
7.	Churna	Shopha (oedema)	S.S.U.41/43
Dhuma - Medicated smoking/fuming			
8.	Dhum	Karnaroga (Ear disease)	S.S.U.21/4-5
Ghrita – Medicated ghee			
9.	Dasamuladi Ghrita	Rochana (Stimulates appetite)	S.S.U.41/49
Kalka (medicated paste used both for internal and external purposes)			
10.	Yavadikalka	Karnapali vriddhi (Enlarging earlobe)	S.S.Su.16/20

11.	Ajagandhadikalka	Vrana ropaka (Wound healing)	S.S.Su.36/2
12.	Ropana-varti Kalka	Vranam (Ulcer)	S.S.Su.36/22
13.	Kalka	Vata-rakta (Gout)	S.S.Ci.5/14
14.	Kwatha - Decoction	Revati Graha Roga (Psychiatric disorders of Children)	S.S.U.31/3
15.	Lehya – Semi solid paste	Yakshma (Pulmonary Tuberculosis)	S.S.U. 41/42
Lepa – Paste – for external application			
16.	Lepa	Karnapali vridhhi (For the growth of ear-lobe)	S.S.Su.16/20
17.	Lepa	Kaphaja sophia (Edema)	S.S.Su.36/6
18.	Lepa	Vrana ropaka (Wound healing)	S.S.Su.36/31
19.	Lepa	Kaphaja visarpa (Herpes)	S.S.Ci.17/14
20.	Lepa	Karnapali Shopha (Ear-lobe inflammation)	S.S.Ci.25/14
Taila			
21.	Bala Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	S.S.Ci.15/33
22.	Bhutikadi Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	S.S.Ci.37/20
23.	Citrakadi Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	S.S.Ci.37/16
24.	Vacadi Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	S.S.Ci.37/12
25.	Taila	Aroga Timira (Myopic Astigmatism)	S.S.U. 17/34
26.	Taila	Rukhamandika roga (Psychiatric disorder)	S.S.U. 35/4
27.	Vamaka Dravya (Emetic drugs)	Urdhvabhaga Dosha (Diseases above shoulder)	S.S.Su.39/3

* S.S.Ci.: Sushruta Samhita Chikitsa Sthana; S.S.Ka.: Sushruta Samhita Kalpa Sthana;
S.S.Su.: Sushruta Samhita Sutra Sthana; S.S.U.: Sushruta Samhita Uttara Sthana

Ashtanga Hridaya (7th Century AD)

In this Samhita, Ashwagandha is described at many places for the treatment of various diseases (Patel, 2023). Preparations, such as Basti, Churna, Dhupana, Ghrita, Kalka, Kwatha, Lepa, Lehya and Taila and their indication in different diseases are listed in Table 3.

Table 3. Formulations in Ashtanga Hridaya where Ashwagandha is used

No.	Preparation	Indication	Chapter and Shloka number in Ashtanga Hridaya *
Basti			
1.	Vata-hara Basti	Grahani roga (Digestive disorder)	A.H. Ka. 4/7
2.	Anuvasana Vasti	Vataja Roga (Musculoskeletal and neuromuscular disorders)	A.H.Ka. 4/54
3.	Churna	Unmada (Schizophrenia)	A.H.U.18/45
4.	Dhupana	Arsha (Piles)	A.H.Ci. 8/19
Ghrita			
5.	Dadhika Ghrita	Gulma (Abdominal tumour), Apasmara (Epilepsy)	A.H.Ci.14/14
6.	Ghrita	Kapha Jvara (Fever)	A.H.U. 3/53
7.	Nagabala Ghrita	Balapustikara (Strength giving), Kasa (Cough)	A.H.Ci. 3/122-123
8.	Satpala Ghrita	Sosanasak (Emaciation)	A.H.Ci. 5/25
9.	Sukumarka Gritha	Vata-rakta (Gout), Vataja Roga (Neurological disorders)	A.H.Ci.13/41
10.	Kalka	Sopha (Oedema)	A.H.Ci.17/37
Kwatha			
11.	Kwatha	Shosha (Cure emaciation)	A.H.U. 2/51
12.	Kwatha	Karnapali Sandhana (Otoplasty)	A.H.U.18/56
Lepa			
13.	Lepa	Pushti, Varna and Bala (Strength, Colour complexion and Vitality)	A.H.Ci.5/79
14.	Lepa	Palisosa (Ear-lobe treatment)	A.H.U.18/39
15.	Lehya	Svasa and Hikka (Asthma and Hiccup)	A.H.Ci. 4/39
Taila			
16.	Bala Taila	Garbha Vyapada (Pregnancy disorder)	A.H.Su. 2/50
17.	Laksadi Taila	Unmada (Schizophrenia), Apasmara (Epilepsy)	A.H.U. 2/52

*, A. H. Ci.: Ashtanga Hridaya Chikitsa Sthana; A. H. Ka.: Ashtanga Hridaya Kalpa Sthana; A. H. Su.: Ashtanga Hridaya Sutra Sthana; A.H.U.: Ashtanga Hridaya Uttara Sthana

Chikitsa Kalika (10th century AD)

This book was written by Acharya Tisatacharya in 10th Century A.D. and it was further corrected by Chandrata in 13th Century. A.D. In this book, Ashwagandha has been described in Vatasmana Gana and used in the preparation of Laksadi Taila (Chapter 1/Sloka 120) for the treatment of fever, and Bala Taila (30/283 and 30/290-291), Prthusatavari Taila (30/286-287), Dasanga Taila (30/295-297), Prasarini Taila (30/298-302), Mahatprasarinī Taila (30/303-304); all used to treat neurological ailments. Ashwagandha is also used to prepare Phala-ghrita (30/367) to treat neurological diseases and infertility (Sharma, 1987).



Chakradatta (11th Century AD)

Acharya Chakrapani Datta has written Chikitsa Sangraha (commonly known as Chakradatta). In this treatise, Ashwagandha is very much appreciated for treatment of various diseases (Sharma, 1998). Several formulations and their uses to treat different ailments are mentioned in this book (Table 4).

Table 4. Formulations in Chakradatta where Ashwagandha is used

No.	Preparation	Indication	Chapter and Shloka number in Chakradatta
1.	Churna	Urahkshata (Injury of the lungs)	10/93-95
2.	Srnga-Arjunadya churna	Rajayaksma (Tuberculosis)	10/26
3.	Ashwagandha Ghrita	Veerya Vardhaka (Potency booster), Mamsa Vardhaka (muscle strength booster)	22/90
4.	Kamdeva Ghrita	Raktapitta (a bleeding disorder)	9/53-63
5.	Nagabala Ghrita	Rajayaksma (Tuberculosis)	10/78-82
6.	Ashwagandhadi Kashaya	Rajayaksma (Tuberculosis)	10/9

7.	Masabaladi kwatha	Vatavyadhi (Musculoskeletal and neuromuscular anomalies)	22/23-24
8.	Krsnadilehya	Rajayaksma (Tuberculosis)	10/14
9.	Mahabala Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	22/101-110
10.	Narayana Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	22/120-130
11.	Trayodasanga Guggulu Vati (Tablet)	Gradhrasi (Sciatica)	22/69-73

Sharangadhara Samhita (13th Century AD)

Sharangadhara Samhitha, written in medieval period, serves as another useful tool for processing the various formulations of drugs. This Samhita is described in three Khandas (Sections)- Purva, Madhya and Uttara Khandas (Tripathi, 2006). In Purva Kanda, Ashwagandha is mentioned with Veerya Vardhaka dravyas (plant that increases vitality). In other two Khandas their preparations and indications are given (Table 5).

Table 5. Formulations in Sharangadhara Samhitha where Ashwagandha is used

No.	Preparation	Indication	Chapter and Shloka number in Sharangadhara Samhitha
Madhyama Khanda			
1.	Ashwagandha Churna	Vajikarana (Aphrodisiac)	6/157-158
2.	Kamdeva Ghrita	Rakta-Pitta (Bleeding disorder)	9/27-37
3.	Maharanadi Kwatha	Sarva-Vataroga (all types of Neurological disorder)	2/20-96
4.	Kandarpa Sundara Rasayana	Vajikarana (Aphrodisiac)	12/268-274

5.	Madankamadeva Rasayana	Vajikarana (Aphrodisiac)	12/259-266
6.	Baladi Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	9/117-118
7.	Dhatturadi Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	9/200-210
8.	Narayana Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	9/101-106
9.	Satavari Taila	Vatavyadhi (Musculoskeletal and neuromuscular disorders)	9/133-141
10.	Laksadi Taila	Vishama Jwara (Intermittent fever)	9/94-98
	Uttara Khanda		
11.	Stanavridhikara Lepa	Stanyavrddhi (Increases lactation)	11/112-113
12.	Lingvridhikara Lepa	Linga Vriddhi (increases penis size)	11/115
13.	Maha Salavana Sweda	Vataja Roga (Musculoskeletal and neuromuscular disorders)	2/23-27

Bhaishajya Ratnavali (18th Century AD).

This book, written by Kavi Raj Govinda Das Sen has the references of use of Ashwagandha in the preparation of drugs to treat ailments like fever, piles, bleeding disorders, dysuria, toxicity etc. (Rao, 2019). Some details of Ashwagandha-based ayurvedic preparations mentioned in Bhaishajya Ratnavali are given in Table 6.

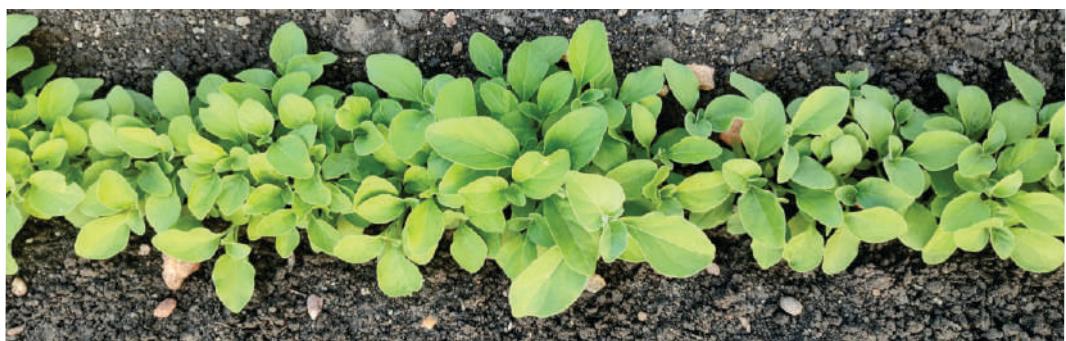


Table 6. Formulations in Bhaishajya Ratnavali where Ashwagandha is used

No.	Preparation	Therapeutic indications	Chapter and Shloka number in Bhaishajya Ratnavali
1.	Snayu Sholahara Churna	Snayu Roga (Tendon related disorders)	82/20
2.	Yavanyadi Churna	Gadaroga (Piles)	78/7
3.	Ashwagandha Ghrita	Vajikarana (Aphrodisiac)	74/279
4.	Amritaprasa Ghrita	Vajikarana (Aphrodisiac)	74/299
5.	Kamadeva Ghrita	Raktapitta (Bleeding disorder)	13/145
6.	Madanakamadeva Ghrita	Dhwajabhangha (Male infertility)	92/20
7.	Sindukadi Dhupa	Arsha (Piles)	9/153
8.	Chandanadi Kwatha	Mastishka Shotha (Encephalitis)	100/2
9.	Ashwagandha Rasayana	Visha (Toxicity)	78/355
10.	Gokshuradi Modakam	Mutrakrichra (Dysuria)	74/230
11.	Jayantivati	Jwara (Fever)	5/536
12.	Jwarabhairava Rasa	Jwara (Fever)	5/1375
13.	Adigya Pakwa Taila	Khalitya Roga (Baldness)	83/3,4
14.	Lakshmivilasa Taila	Mastishka Shotha (Encephalitis)	101/31

Ashwagandha in Ayurveda Nighantus (Ayurveda lexicons)

As explained above, in Ayurveda Samhitas, Ashwagandha is used for the preparation of different formulations to treat different ailments. In these Samhitas, based on morphology, medicinal uses, place of origin etc., Ashwagandha acquired multiple names (synonyms). Many Ayurveda Nighantus prepared subsequently by different authors contain verses having the basonym – the primary name (Ashwagandha) and all its available synonyms (Table 7). These Nighantus help in determining the correct identify of Ashwagandha in the current context.

In Dhanvantari Nighantu, Sodhala Nighantu and Bhava Prakasha Nighantu and Saligrama Nighantu, Ashwagandha and its synonyms are mentioned under Guduchyadi Varga. On the other hand, Ashwagandha and its synonyms are mentioned in Oshadi Varga in Kaiyadeva Nighantu, Shatahvadi Varga in Raja Nighantu, Abhayadi Varga in Madanapala Nighantu, Kantakaryadi Varga in Nighantu Adarsh, and Satapushpadi Varga in Priya Nighantu (Sharma, 1995).

Table 7. Synonyms of Ashwagandha in Ayurveda Nighantus

No.	Nighantu	Synonyms of Ashwagandha	Reference
a.	Ashtanga Nighantu of Vagbhatacharya (8 th Century AD)	Gayi, Tutagi and Vaji	Sharma and Sarma (2004)
b.	Dhanvantari Nighantu (<i>Drvayavali Samuccchaya</i>) (10th - 13th century AD)	Ashwavarohaka, Balya, Kacchuka, Turagi, Vajigandha, Vajikari, Varahkarni	Singh (2008); NIIMH (2012)
c.	Sodhala Nighantu of Acharya Sodhala (12 th Century AD)	Ashwarohaka, Balya, Elaparni, Kamarupini, Kusthagandha, Pivara, Punya, Sistagandha, Syamala, Turagi, Vajukara and Varahakarni	Dwivedi (2009); NIIMH (2012)
d.	Madanapala Nighantu (Madanavinoda) of King Madanapala (14th century AD)	Ashwarohaka, Balya, Gokarna Turangahava, Varahakarni, Varda, Vajikari and Vrasa	Shastry (2010); NIIMH (2012)
e.	Kaiyadeva Nighantu (Pathya-Apathya-Vibodhaka) of Kaiyadeva Panditha in the 15th Century AD	Ashwarohaka, Balya, Bahirpich, Gokarni, Hiyahwa, Kacchuka, Kusthagandha, Peeta, Turgi, Varahkarni, Vajikari, Varda, Vrasa	NIIMH (2012); Singh (2023)
f.	Bhava Prakasha Nighantu of Acharya Bhava Misra in 16th century AD.	Balada, Hayagandha, Kusthagandhini, Vajigandha, Varahakarni and Varda	NIIMH (2012); Vinayak (2021)

g.	Raja Nighantu of Narahari Pandita (17th century AD)	Balada, Balya, Gandhapatri, Hayagandha, Hayaprya, Hayi, Kamarupini, Kambukastha, Palasakarni, Pivara, Punya, Pustida, Turagi, Vajigandha, Vajini, Vataghni, Varahkarni, and Varahapatri	NIIMH (2012); Sankhyadhar (2012)
h.	Raja Vallabha Nighantu of Raja Vallabha Vaidya (18th century AD)	Ashwagandha, Balya, Rasayani, Vataghni and Vrisya	NIIMH (2012)
i.	Saligrama Nighantu of Lala Saligrama Vaidya in 1896	Ashwarohaka, Balya, Haya, Katuka, Turgi, Vajigandha, Vajikari and Varahkarni	Pandey (2007)
j.	Nighantu Adarsha of Vaidya Bapalal G. Shah in 1927	Kandini, Parpotivatphala, Vajigandha, Vanja and Vrataparni	Vaidya Bapalal (2021)
k.	Mahausadh Nighantu of Pandith Aryadash Kumarasingha in 1971	Hiyahwa, Kamrupini, Kusthagandhini, Vajigandha, Vajini, Varahkarni and Varda	Tripathi (2006)



Synonyms of Ashwagandha in Ayurveda literature

In Ayurveda, medicinal plants are named on different basis like nature or type of a plant (Jati), shape or morphology (Akruti or Lanchana), colour (Varna), potency (Veerya), based on similes (Upama), taste of the drug (Rasa), special action of the drug (Prabhava), properties of the drug (Guna) etc. Due to this, a single plant may possess one or more synonyms. For instance, Ashwagandha has around 40 synonyms (Table 8).

Table 8. Synonyms and their interpretations in Ashwagandha

No.	Name	Interpretations
Akruti (shape or morphology)		
1.	Parpotivatphala	Fruit covered with inflated calyx
2.	Vrataparni	Plant with oval-shaped leaves
Guna (Basic nature or property)		
3.	Ashwagandha	Plant with its roots and other parts emits horse's smell
4.	Hayagandha	Plant with its roots and other parts emits horse's smell
5.	Katuka	Plant with bitter taste
6.	Kushtagandha	Plant that has smell of Kushta (<i>Sassuerea lappa</i>)
7.	Kusthagandhini	Plant that has smell of Kushta (<i>Sassuerea lappa</i>)
8.	Sistagandha	Plant has smell of an Aphrodite
9.	Turangahava	Plant has smell of horse
10.	Turgi	Plant has smell of horse
11.	Vajigandha	Plant has smell of horse
Prabhava (special actions of the drug)		
12.	Ashwarohaka	Aphrodisiac plant
13.	Brimhana	Nourishes body
14.	Balada	Promote strength
15.	Balya	Promote strength
16.	Haya	Plant that provides horse strength
17.	Hayahvaya	Plant that provides horse potency
18.	Hayi	Plant that provides horse strength
19.	Kalapriyakari	Plant that provides virility
20.	Kamrupini	Plant that increases libido
21.	Kanchuki	Retains semen

22.	Kandini	Treats pruritis and relieves itching
23.	Pivara	Plant that provides potency
24.	Pustida	Plant that nourishes the body
25.	Rasayani	Plant that rejuvenates the cells and extend life
26.	Vajikari	Plant that increases sexual potency
27.	Vajini	Plant that increases sexual potency
28.	Vajukara	Plant that increases sexual potency
29.	Vataghni	Pacifies vata dosha
30.	Vrisya	Plant that increases sexual potency
	Upama (based on similes)	
31.	Elaparni	Leaves having shape of Ela (Cardamom)
32.	Gandhapatri	Plant having smell like horse
33.	Gayi	Plant with leaves resembling shape of cow's ear
34.	Gokarna	Plant with leaves resembling shape of cow's ear
35.	Gokarni	Plant with leaves resembling shape of cow's ear
36.	Palasakarni	Plant with leaves resembling that of <i>Butea monosperma</i> (Palash)
37.	Varahakarni	Plant with levees resembling pig's ear
	Varna (Colour)	
38.	Peeta	Plant having yellow colour
	Itarahvaya (other features)	
39.	Kambukastha	A precious plant
40.	Punya	Plant that possesses quality of purity
41.	Varda	Boon for mankind

The knowledge of Rasapanchaka (organoleptic properties), namely, Rasa (taste), Guna (qualities or basic nature), Veerya (potency), Vipaka (taste conversion after digestion) and Prabhava (special effect), and Karma (therapeutic property) of the natural drugs are important to understand their pharmacokinetic, pharmacodynamic and toxicological effects. In many Ayurveda Nighantus, the rasapanchaka and karma of Ashwagandha are also described, besides the synonyms. The rasa of Ashwagandha root is considered as Tikta (bitter) and/or Kashaya (astringent) in many Nighantus (Dhanvantari Nighantu, Madnapala Nighantu, Kaiyadeva Nighantu, Bhava Prakasha Nighantu, Raja Nighantu and Priya Nighantu). In Raja Nighantu and Nighantu Ratnakara, it is mentioned that

Ashwagandha root has Katu (pungent) and Kinchitkatau (slightly pungent) taste respectively. Ashwagandha has laghu (light) Guna (Quality) as mentioned In Nighantu Ratnakara. All the above Nighantus mentioned that Ashwagandha is hot (Usna) in potency (Veerya) with main Karma (therapeutic property) to balance thridosha, but mainly vata and kapha dosha. Besides this, in some Nighantus the detailed notes on therapeutic effects of Ashwagandha on different organ systems are provided, and some of them are listed in Table 9.

Table 9. Therapeutic effects of Ashwagandha mentioned in Ayurveda Nighantus

Ayurveda terms	Meaning	Ayurveda Nighantu*
Krumihara	Used in intestinal worm infestation	KN, NR
Vishahara	Useful in detoxification/Anti -dote	RN, PN
Balya	Improves Strength	MN, BPN, RN, PN
Jwara vyadhi nashaka	Manages fever and associated ailments	NR
Ksharahara	Healings wound	KN, NR
Rasayani	Acts as anti-aging and improves life expectancy	MN, BPN, KN, PN
Sophahara	Treats inflammation	MN, BPN, KN, NR
Vranahara	Wound healing	RN
Dhatuvriddhikara	Sustains and nourishes body organs	NR
Balaprada	Improves strength	DN
Balapushtiprada	Provides strength and nourishment to the body	KN
Kshayahara	Treats muscle wasting/emaciation	MN, BPN, KN
Ati-shukrla	Improves semen quality and quantity	MN, BPN
Veeryaprada	Bestows potency	DN
Vrushya	Acts as a natural aphrodisiac	KN, NR, PN
Kasahara	Pacifies or get rid of cough	KN, RN, PN
Shwasahara	Treats asthma and other chronic respiratory diseases	KN, RN, NR

Vatakaphara	Pacifies Vata and Kapha dosha	DN, MN, BPN, KN, NR
Kanduhara	Treats pruritis and relieves itching	KN, NR
Kantiprada	Bestows radiance	DN
Shvitrahara	Effective in treating vitiligo	MN, BPN

BPN: Bhava Prakasha Nighantu, DN: Dhanvantari Nighantu, KN: Kaiyadeva Nighantu, MN: Madanapala Nighantu, NR: Nighantu Ratnakara, RN: Raja Nighantu and PN: Priya Nighantu



Research on the pharmacological effects of Ashwagandha

Above discussion on Ayurveda literature clearly indicates that Ashwagandha has been used, one way or the other, to treat several ailments of almost all twelve organ systems (Integumentary System, Skeletal System, Muscular System, Nervous System, Endocrine System, Cardiovascular System, Lymphatic System, Respiratory System, Digestive System, Urinary System, and Reproductive System). In recent years, there has been a growing interest in testing the efficacy of Ashwagandha in treating some of the ailments envisaged in Ayurveda literature, by conducting clinical trials.

Neurodegenerative diseases, such as Alzheimer's disease (Smritibhramsha) and Parkinson's disease (Kampavata), cause the destruction of central nervous system,

resulting in irreversible loss. Over the course of Alzheimer's disease, an abnormal deposition of β -amyloid protein in the brain can be observed. In its fibrillar form, β -amyloid protein has a neurotoxic effect because it induces the formation of free radicals and impairs glucose transport in neurons, which leads to cell damage and death. In addition, accumulating senile plaques accompanied by microglia (inflammatory response cells) break down and remove damaged and dead neurons as well as senile plaques. Microglia cells produce toxins, destroying both diseased and healthy cells and enhancing the brain's inflammatory response (Tiwari *et al.*, 2019). Recent studies indicate that Withaferin-A extracted from Ashwagandha appears to be a promising ingredient in terms of Alzheimer's disease treatment. It works by reducing β -amyloid aggregation and inhibiting T-protein accumulation. In addition, Withaferin-A is responsible for inhibiting oxidative and pro-inflammatory chemicals and regulating heat shock proteins (HSPs), the expression of which increases when cells are exposed to stressors. In addition, Withaferin in the form of Ashwagandha extract significantly inhibits the gene expression of neuroinflammatory molecules related to nuclear factor kappa B (NF- κ B) (Bhargava *et al.*, 2019).

The primary cause for Parkinson's disease is the degeneration of the dopaminergic neurons of the nigrostriatal systems which lead to an imbalance between dopamine's inhibitory action and acetylcholine and glutamic acid's excitatory action (DeMaagd and Philip, 2015). An In -vivo rat study demonstrated that administration of Ashwagandha extract counteracts biochemical deficits associated with Parkinson's disease (De Rose *et al.*, 2016) increases the level of dopamine, 3,4-dihydroxyphenylacetic acid and Homovanillic acid and also normalizes the levels of lipoperoxidation markers in the striatum of the mice (Raja Sankar *et al.*, 2009). These studies provide hope for treatment of Parkinson's disease effectively using Ashwagandha extract.

Since ages, Ayurvedic physicians like Charaka and Sushrutha have used Ashwagandha for the treatment of generalised anxiety disorders (Manodwega) and stress (Sahasa) (Trikamji, 2001). Recently conducted clinical studies have also clearly demonstrated that Ashwagandha root and leaf extracts exhibit noteworthy anti-stress and anti-anxiety activity in animals and human (Lopresti *et al.*, 2019; Speers *et*

al., 2021). Ashwagandha may alleviate stress and anxiety conditions predominantly through modulation of the hypothalamic-pituitary-adrenal and sympathetic-adrenal medullary axes, as well as through GABAergic and serotonergic pathways. While some studies link specific Withanolide components to their neuropsychiatric benefits, there is evidence for the presence of additional yet unidentified active compounds in Ashwagandha (Speers *et al.*, 2021).

The most common sleep disorder experienced by almost every person is insomnia (Roach *et al.*, 2021). In ancient ayurveda literature, such as Charaka Samhitha and Sushrutha Samhitha, causes for insomnia (Nidranash) and effective remedies for insomnia using a variety of herbs, including Ashwagandha are mentioned (Nirgude *et al.*, 2013). Recent pharmacological studies indicate that through its adaptogenic properties, Ashwagandha manages sleeping disorders by balancing stress hormone levels and modulating neurotransmitters, such as serotonin and Gamma-aminobutyric acid (GABA) (Kalgane *et al.*, 2020).

Ashwagandha is a very revered plant of the Indian Ayurvedic system of medicine as a Rasayana (rejuvenator) and is recommended primarily for balavardhana



(strengthening body) and mamsavardhana (strengthening muscles). In traditional clinical practice, Ashwagandha root powder preparations are most commonly prescribed for enhancing the general strength. Recent pharmacological studies have reported that Ashwagandha may improve body composition, muscle strength and size, and increase strength (Sandhu *et al.*, 2010; Raut *et al.*, 2012; Wankhede *et al.*, 2015). Wang and others (2021) have reported that Ashwagandha Withanolides (withaferin-A and withanone) possess multimodal activities such as promotion of stronger differentiation of myoblasts to myotubes, de-aggregation of heat- and metal-stress-induced aggregated proteins, and activation of hypoxia and autophagy pathways. All these activities together help in stress reduction, muscle differentiation, and improvement of muscle strength and size.

The traditional Ayurvedic texts describe cancers as inflammatory or non-inflammatory swellings called *Arbuda* (major neoplasm) or *Granthi* (minor neoplasm). The translation of these terms has been described differently over time with “*Arbuda*” translated as round, large, muscular, immovable, or swelling ‘tumor’ and *Granthi* as a benign cystic node or nodule or swelling, or glandular enlargement. Several products, such as Ashwagandha Rasayana and Dadhika Ghrita, Ashwagandha Churna, mentioned in Ayurveda Samhitas and Nighantus have been used for their anti-tumour effects. In a recently reviewed article (Mehta *et al.*, 2021), it is reported that different compounds isolated from root, stem, and leaves of Ashwagandha display significant anti-cancerous and immunomodulating properties and thus can be used alone or in combination with other chemotherapeutic drugs for cancer treatment. According to Mehta and others (2021), the active constituents (Withanolides) of Ashwagandha specifically target and suppress the oncogenic mediators MMP-9, NF- κ B, PI3K/Akt pathway, MMP-2 and JAK/STAT system.

In Ayurveda, ashwagandha is a popular plant that aids in the improvement and maintenance of normal sexual health. The aphrodisiac (Vajikarana) property of Ashwagandha has been identified in traditional ayurveda texts (example: Charaka Samhitha, Sharangadhara Samhita, Bhaishajya Ratnavali). In such texts, many formulations, such as Vajikarana Grhitha, Ashwagandha Churna, Kandarpa Sundara Rasayana, Madankamadeva Rasayana etc. are suggested for improvement of

semen quality and quantity (Ati-shukrala), bestowing potency (Veeryavardhana) and desire (Vrushyavardhana). Clinical trials indicated that Ashwagandha has the potential to increase testosterone and luteinising hormone (LH), decrease follicle-stimulating hormone (FSH) and cortisol levels in men (Mahdi *et al.*, 2009; Ahmed *et al.*, 2010; Gupta *et al.*, 2013). It is also reported that the antioxidant and possibly nutritional properties of ashwagandha may also contribute to the improvements in fertility (Shukla *et al.*, 2011). The benefit of Ashwagandha in reducing weakness and improving diminished sexual desire and function in women are also mentioned in Ayurveda literature. Based on a pilot study, Dongre and others (2015) demonstrated that oral administration of a high concentration root extract of Ashwagandha, without any adverse effects, may improve sexual function in healthy women.



Conclusions

Ashwagandha is one of the highly revered medicinal plants in ayurveda, due its potential in managing a wide range of ailments and overall health. Around twenty synonyms assigned to Ashwagandha in Ayrurveda texts clearly indicate a diverse therapeutic property (karma) identified by ayurveda practitioners since the period of Acharya Charaka. A large number of Ayrurveda medicines and products mentioned in ancient ayurvedic texts are widely accepted and successfully utilised for the treatment of nervous exhaustion, cognitive disorders, insomnia, fatigue, reproductive disorders, anxiety, and stress and also overall health management. It may be mentioned here that Ayurveda treatises indicate the use of the Ashwagandha root in its classical formulations. It is prescribed commonly in healthcare for various therapeutic purposes; and preventive and health promotive indications, with minimal adverse events and good tolerability. Recently, several clinical studies are demonstrating the usefulness of Ashwagandha plant extracts in managing different indications mentioned in Ayurveda treatises. However, extensive large-scale pharmaceutico-analytical and clinical studies on classical formulations are still to be undertaken for larger evidence base to further characterize formulations and quantify their benefits on human health.

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Amukkara Kizhangu (Ashwagandha) in Siddha system of Medicine

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Introduction

The Siddha System of Medicine, an ancient Indian System of medicine, has its root even before 300 BC., and its lineages trailed with Tamil culture. The term 'Siddha' means 'one who has attained a siddhi, paranormal capabilities' and the "Siddhars" are saintly persons who attained greater knowledge on different subjects like science, medicine, alchemy etc. The ancient Tamil literature indicate that eighteen Siddhars have contributed towards the development of the Siddha System of Medicine (Subramanian and Madhavan, 1983). In the treatise Thirumoolar Thirumanthiram of Thirumoola Siddhar (one of the eighteen Siddhars) postulated a definite and distinct theory for the treatment of diseases which are caused by physiological and psychological disorders, and pathological factors.



“Medicine is the one that ensures physique therapy
Medicine is the one that ensures psycho therapy
Medicine is the one that warrants cure on diseases
Medicine means one that safeguards us against impermanence
 -In Thirumoolar Thirumanthiram, Verse 800 (Ganapathy, 2013)

The Siddha System is based on the Pancha Mahabhuta (Five great elements) theory, which postulates that the universe and human bodies are composed of primordial elements of pancha-bhudham (Pancha Bhutas) which are *Nilam* (earth), *Neer* (water), *Thee* (fire), *Vali* (air), *Visumbu* (space). This concept of Panch-bhudham is given by Tolkaappiyar as follows:

நிலம்தீ நீர்வளி விசும்போடைந்து கலந்த மயக்கம் உலகம் ஆதலின் (தொல்- பொருள்

(“Nilam thee neer vali visumbodainthum kalantha mayakkam ulagam aathalin: In Tolkappiyam Porulatikaram, Verse 638”) (Sastri, 2002).

Siddha medicine is also based on the concept of three humors or three Doshas, namely, *Vali* (Vata), *Azhai* (Pitta) and *Iyyam* (Kapha). These three Doshas co-exist in all the cells of the body and function in a harmonious manner to create a balance. There is also link between Pancha Bhutas and three doshas. Vata is formed by Vali and Visumbu (Vayu and Akasam). It controls the sensory and motor functions of the nervous system such as sensation and movement. Pitta is formed by *Thee* (fire). It controls the metabolic processes in the body such as digestion, and assimilation, and helps to maintain the warmth of the body. Kapha is formed by *Neer* (water) and *Nilam* (earth) and controls stability. Siddha medicine believes that when there is a disequilibrium or imbalance in these humors or if their individual harmony is disturbed it will lead to diseases. The balance can be restored by correcting the underlying thodam (dosha) by the application of the Siddha medicine system. Siddha medicine works by revitalizing and rejuvenating the organs which will lead bring back the optimal ratio of three doshas and in turn a healthy state of equilibrium in the body. The siddha literatures, such as Agasthiyar 2000, Angathipatham, Noi Naadal Noi Muthal Naadal part I and Theriyar Vaakadam have listed around 4448 types of disease. These diseases are classified according to anatomical structures of body parts, tri humors and diseases (Raveendran, 2020). The Siddha system has developed a rich treasure of medicinal knowledge to treat

different diseases using herbs, metals, and minerals. Siddha literatures describe 220 minerals which include Metals (Ulokam – 11), Salts (Karasaram – 25), Mercury and Arsenic compounds (Paatanam - 64) and other minerals (Uparasam – 120). Coral, conch, horn of deer, musk, honey etc. are some of the animal products utilised. A number of medicinal plants (Mooligai) are used in Siddha Medicine. The scattered knowledge of medicinal herbs that were found in various manuscripts was first compiled as Mooligai Gunappadam of Siddha system (Mudaliar, 1969). In this book, the properties of more than 500 medicinal plants are explained. The database of medicinal plants given by National Medicinal Plants Board indicates that around 2260 medicinal plants are used in Siddha System of Medicine (NMPB and FRLHT, 2010). Amukkara [Ashwagandha; *Withania somnifera* (L.) Dun.] is one of the multi-faceted medicinal plants described in century old various palm leaf manuscripts of Siddha system. In these manuscripts, morphological, organoleptic and medicinal properties of Amukkara, besides therapeutic uses of mono-herbal and poly-herbal drugs of Amukkara are described. Descriptions and uses of Amukkara given in Siddha literature, and current research on efficacy of formulations in which Amukkara is one of the major ingredients are presented in this Chapter.



Synonyms of Amukkara in Siddha literature

In Siddha, Amukkara is the basonym and denotes the action of the plant, as it cures the swelling (Inflammation) in the body (பற்றிட்டால் வீக்கத்தை அமுக்குவதால் அமுக்கரா). Amukkiri, Amukkuravi, Amukkuravu are the linguistic differences of Amukkara in various regions. The synonyms of Amukkara include Asuvagantham (அசுவகந்தம்), Asuvagenththi (அசுவகந்தி), Asuvam (அசுவம்), Irulichhevi (இருளிச்செவி), Kidichevi (கிடிச்செவி), Varaka karni (வராககர்ணி), Naguda ver (நகுட வேர்). Here, some synonyms indicate the Guna (the basic nature or property) of the plant. For instance, names like Asuvagantham, Asuvagenththi, and Asuvam indicate that the roots and other parts of this plant emits horse's smell, and the name Naguda ver indicates that this plant has smelly roots. The names like Irulichhevi, Kidichevi and Varaka karni represent the plants with leaves resembling pig's ear, and thus these names are based on similes.

Properties of Amukkara

In Siddha system, importance has been given for the knowledge of five organoleptic properties, namely, *Suvai* (taste), *Gunam* (qualities or basic nature), *Virium* (potency), *Pirivu* (taste conversion after digestion) and *Mahimai* (therapeutic action) of the natural drugs as these properties are important to understand their pharmacokinetic, pharmacodynamic and toxicological effects. The organoleptic properties of Amukkara described in the book Gunapadam Mooligai Vaguppu (Mudaliar, 1969) are as follows: The *Suvai* (taste) of Amukkara root is considered as *Kaippu* (bitter taste) and its *gunam* (basic nature) is *laku* (lighter). Amukkara is hot (*veppam*) in potency (*virium*) with spice (*Karppu*) taste conversion after digestion (*pirivu*). The main therapeutic actions (*Mahimai*) of leaf and seed of Amukkara, described in Agathiayar Gunavagadam, are *Veppakatri* (Febrifuge) and *Cirunirperukki* (diuretic) respectively (Srinivasan and Tirunarayanan, 2022). On the other hand, the root of Amukkara has properties like Alterative (Udal thetri), Aphrodisiac (Anmaiperukki), Rejuvinating (Kayakarpamakki), Anti-inflammatory (Vikkamurukki), Diuretic (Cirunirperukki), Tonic (Uramakki), Soporific (Urakkamundakki), Sedative (Udalveppakarri), mild Astringent. As the roots of Amukkara has hot potency, it should be consumed along with milk (Mudaliar, 2017).

Therapeutic uses of Amukkara

The therapeutic uses of Amukkara have been described by Agathiyan and many other ancient Siddhas, and they are compiled in Siddha literature, such as, Agathiyan Gunavagadam (Srinivasan and Tirunarayanan, 2022), Bogar Karukkidakai (Anonymous, 2019), Siddha Medical Dictionary (Pillai, 1998), Siddha Maruthuvam Sirappu (Thiyagarajan, 1998), Yugi Vaithya Chinthamani (Ramachandran, 2013).

In the following verse of Agathiyan Gunavagadam, it is mentioned that the Amukkara can be used to cure ailments like tuberculosis, eczema, fevers and inflammation. Amukkara also stimulates appetite, helps to increase sperm potency and cure the debility of aged persons and incontinence of urine.

கொஞ்சந் துவர்ப்பாங் கொடியகயஞ் சூலையரி
மிஞ்சகரப் பான்பாண்டு வெப்பதப்பு - விஞ்சி
முசவரு தோடமும்போ மோகம்அன லுண்டாம்
அசுவகந் திக்கென் றறி.

According to Yugi Munivar, Amukkara is a rejuvenator medicine which is evident by the following verse

“கோல நகுட வெருண்டுதிர நாட்டுவையேன் மேலை நகுட வெருண்டுறுவாழ் நாள்”

It means that when Amukkara is taken orally as powder or ghee form it provides stamina, beauty and longevity (Ramachandran, 2013).



In the Siddha Medical Dictionary (Pillai, 1998), Amukkara roots (Amukkara Kizhangu), also called as Horse root, is denoted as a Bazaar drug. In this dictionary, it is also mentioned that the powdered root of Amukkara is given for cough, constipation, dropsy and bowel complaints. The paste of Amukkara roots and dried ginger can be externally applied to cure swelling, rheumatic swellings of the joints, eczema, boils and abscesses. Amukkara roots also have cooling de-obstruent and diuretic qualities. The uses of leaves, fruits and seeds are also mentioned in the Siddha Medical Dictionary (Pillai, 1998). The infused Amukkara leaf decoction is used to fever. The leaf paste is applied to inflamed tumours. The fruit is medicinally diuretic and the roots and leaves are powerfully narcotic and alexipharmac. The seeds coagulate milk and thus help in making butter.

Amukkara, in Bogar Nigandu (Anonymous, 2019), is regarded as one of the Kaya-karpa (Siddha system for total body rejuvenation) herbs and it cures body emaciation (Elaippu noi/Kshaya diseases). In the Thirumoolar Thirumanthiram, it is mentioned that Amukkara is one among 108 medicinal plants for rejuvenation, and if the root powder of Amukkara is taken properly with right Anupanam (the liquid that is advised along with the medicine or advised after intake of the medicine) it makes the physique long lasting; further it postpones aging and death (Thiyagarajan, 1998).

Amukkara formulations in Siddha Medicine

In Siddha, as in Ayurveda and Unani, drug formulation is based on two principles: single-drug use and multiple drug use, the latter of which is known as polyherbal formulations. Amukkara root is being used in Siddha both as single drugs and polyherbal drugs; and for both the cases, it is mentioned that Amukkara root has to be purified before use (Pillai, 1998). The purification process (Sutthi) for Amukkara involves cutting the roots into small pieces, soaking them in cow milk, then boiling till water content in the milk evaporates, and then drying them in sunlight. Some of the single drug use of Amukkara mentioned in Siddha literature are listed in Table 1.

Table 1. Some single drug use of Amukkara in Siddha Medicine. (Source: Mudaliyar,2017).

Sl.no.	Method of usage	Indication/s or Ailment/s
1.	Consume Amukkara leaf soaked in boiled water	<ul style="list-style-type: none"> • Fever
2.	Take Amukkara powder mixed with honey	<ul style="list-style-type: none"> • Vali and Iyam (Vata and Kapha) related diseases • Inflammatory swelling • Loss of appetite • Obesity
3.	Eat Amukkara powder mixed with ghee	<ul style="list-style-type: none"> • Tiredness and breathlessness • Body Rejuvenation • Increase sperm count
4.	Eat Amukkara tuber powder with sugar candy in every morning and evening, with a glass of milk	<ul style="list-style-type: none"> • Nervous tension • Body rejuvenation • Bestow radiance
5.	Make a paste of raw Amukkara roots and boil with cow urine. Apply the obtained paste to affected body parts	<ul style="list-style-type: none"> • Lymph node swelling • Tumours • Neck swelling • Back pain • Inflammation
6.	Ground Amukkara root and dry ginger powder with hot water and apply the paste over the affected body parts	<ul style="list-style-type: none"> • All types of swelling in the body
7.	Apply Amukkara root paste over the affected body parts	<ul style="list-style-type: none"> • Syphilitic tumours, • Painful swelling • Skin ulcers

Polyherbal Formulations of Amukkara in Siddha Medicine

Polyherbalism is a key therapeutic herbal strategy of almost all traditional systems of medicine, including the Siddha system. This strategy involves preparation of formulations by combining several medicinal herbs to increase therapeutic effectiveness. It improves helpful impact and diminish the harmfulness of any of the ingredients present in the formulation. In Siddha medicine, apart from the use of medicinal plants, suitable minerals and animal products are also used to prepare

certain formulations. The list of some compound formulations, where Amukkara is one of the ingredients, along with their formulations mentioned in Siddha literature is given in Table 2.

Table 2. Some important formulations in Siddha medicine where Amukkara is used

No.	Formulation	Page number or Verse number in the literature	Therapeutic indications
Siddha Vaithiya Thirattu (Mudaliar and Uthamarayan, 2009)			
1.	Amukkara Churanam	Page 213	Ennvagai kunmam (8 types of gastric disorders), Idappaattu eeral noi (spleen disorders), Vettai (venereal disease), Pramiyam (leucorrhoea), Vikkal (hiccup), Paandu (anemia), Ilaippu sayam (tuberculosis), Kuthu vayvu (body pain), Varatchi (body dryness), Kai kaall erivu (burn sole and palm), increases body weight.
2.	Rasagandhi Mezhugu	Page 174 -177	Painful conditions of diverse types such as Vedi soolai, Idi soolai, Aega soolai, Pudai soolai, Thudai soolai, Vadha soolai. Kkaal kudaichal (excruciating pain in leg), Karanai, Vippuruthi (fissures), and Kkandamalai (Scrofula), Visha neer (Anasarca), Sori sirangu (itching, scabies) Puzhuvettu (alopecia), Thadippu (rashes) yoni Silanthi and linga Silanthi (chancre), various kinds of glandular enlargement such as Seng kiandhi, Karung kiranthi,

			Ari kiranthi, Pori kiranthi, Pparu kiranthi, puraiyodum pun (chronic ulcers), arai kadi, thandir pun (penile ulcers), Thodai Vazhai, Vilaa vazhai (swellings in thigh and rib area), Marbu silanthi (carbuncles in chest), Yoni putru, Linga putru, Idiputru (various kinds of cancerous growth), Kanna putru (Buccal mucosa cancer), Silanthi, Pilavai, Nethira pilavai, Thadi silanthi, Pudai silanthi (various kind of chronic wounds), Moola mulai (piles), Pouthiram (fistula), Patha sakkaram (varicose ulcers)
3.	Idivallathi Mezhugu	Page 177-179	Thozhu noi (Leprosy), Kiranthi (glandular hypertrophy), Soolai (neuralgic pain), Araiaappu (lymphadenopathy), Megam (diabetes), Envagai kunmam (ulcers), Sukkila vaivu (male fertility disorders), Irana megam (diabetic ulcers)
4.	Kandhaga Rasayanam	Page 235	Mega viyathi (venereal diseases), Moothira kiricharam (dysuria), Moothira silanthi (bladder Hunner's Ulcer), Kuttam (leprosy), Kirani (dysentery), Moolam (piles), Kunmam (peptic ulcer), Vatham (arthritic conditions), Veekkam (inflammatory conditions)

5.	Maha Elathy Kuligai	Page 35-37	Thaba suram, Thaga suram (types of fever), Kannoi (eye diseases), Kan kasam (cataract), Kalladaippu (urinary calculus), Kamalai (jaundice), Neerizhivu (Diabetes), sobai (anasarca), Uzhalai (pain), Vaanthi (vomiting)
6.	Sivanar vembu churanam	Page 216-217	Mega soolai (Venereal pain), Mega vayu (Venereal heat), Karappan (Eczema), Sori (Itching), Sirangu (scabies), Vettai (Gonorrhoea), Vishakadi (Poisonous bite), Silvisham (Insect bite), Viranam (Ulcer) and Erichal (Burning sensation)
7.	Nandhi Mezhugu	Page 183-189	Vandu, Seyyan, thavali kadikal (insect and, centipede bites), Solai (neuralgic pain), Kunmam (8 types of gastric disorders), Karappan (eczema), Andaputru (ovarian carcinoma), Kkndamalai (cervical nodules), Araiappu (inguinal nodules), Vippuruthi (nodules), Kabala kuttam (leprosy) sori (itch), Ilaippu (TB), Suram (fever) Thalaivali (head ache), Paandu (anemia), Sogai (dropsy), Magotharam (ascites), Neer moolam (piles), Amaikatti (liver tumor), Kai vedippu (crack palm), Pavuththiram (fistula), Pallaranai (dental inflammation), Pal soolai (dental pain), Thodai vazhai (swellings in thigh), silanthi pilavai (carbuncles),

			Puraiyodum pun (pus filled wounds), Kaal putru (Osteosarcoma), Oon azgal (Muscle necrosis), Peleegai (spleen enlargement), Sil vidam (insect bites), Kanna putru (buccal cancer), Yoniputru (uterine cancer), Linga putru (penile cancer), Narambu silanthi (varicose veins), Elumbu silai pun (osteomyelitis), Kazhal vatham (joint pain), Maarbaani (corns in chest), Anda vatham (varicocele), Padarthamarai (tineal skin infection), Karppa azhivu noi (spontaneous abortion), Pilavai (Thadippu (erythema), Aranai kadi (garden lizard bite)
8.	Narathai llagam	Page 244	Pitha Kunmam (Gastric ulcer), Nenjerippu (epigastric irritation), Arosagam (Ageusia), Thaba suram (Fever), Vanthi (vomiting), Pitham (body heat), Krirkiruppu (giddiness), Vayvu (bloating), Thalai noi (headache), Akkini (loss of appetite), Malaneer kattu (constipation, low urination), Kaanthal (body irritation)
Varma Odivu Murivu Sara Suthiram-1500 (Mohanraj, 2009)			
9.	Amukkara kashayam	Verse 948	Thol pattai vatham and nazhuval (Traumatic inflammation in the shoulder, dislocation of shoulder joint and scapula), Soolai (general body pain), Suram (Fever) and Kaba noikal (Kapham illnesses)

Agathiyar Vaithya Kaviyam 1500 (Ramachandran, 2001)			
10.	Asuwaghandhadhi nei	Page 750 Verse 244-249	Saya noi (Tuberculosis), Swasa kasam (asthma), Peeligai (spleen enlargement), Arosagam (ageusia), Suram (fever), Kunmam (gastritis), Aaru soolai (severe pain), Iraththa piththam (hypertension), Elumburukki (Tb emaciation), Veppupaalai (fever)
11.	Aswaghandhi Chooranam	Page 713 Verse 767-769	Vayu (bloating), Vali (rheumatism), Arosakam (ageusia), Vatha piththa silethuma vagai, uppisam (flatulence), Nenjerivu (hyper acidity), Piththam (gastritis), Kural varatchi (sore throat), Vanthi (vomiting), Sayam (Tuberculosis), Eelai (asthma), Irumal (cough), Kirani (sprue), Kunmam (gastric ulcer)
12.	Aswaghandhi Thailam	Pages 615 - 616. Verse 1126-1135	Asthi suram (ptysis), Vettai (leucorrhoea), Panaippu, thonthippu, sura thodam (Fever consequences), Vayu (bloating), Neeretram (dropsy), Varatchi (dryness), Irumal (cough), Thagam (excess thirst), Pitha varthanai (body heat), Thalai noi (head ache), Peenisam (Sinusitis), Udar kaanthal (body irritation), Kabangal (cough related illness), Vida paagam (anasarca), Vikkal (hiccup)

Kannusamy Parambarai Vaithiyam (Pillai, 1948)			
13.	Maha Elathy Choornam	Page 104-105	Dhega erivu (body irritation), Thaagam (excess thirst), mayakkam (vertigo), piththa thalaivali (head ache), asthi suram (ptysis), vaayu (bloating), visha suram (dropsy with fever, Eelai (asthma), irumal (cough), vayittruppisam (flatulence), nenjerivu (hyperacidity)
14.	Raja Sinthamani Ennai	Page 273-276	Kaikaal kudaichal (limb pain), kaikaal pidippu (limb swelling), (glandular hypertrophy), araiaappu (lymphadenopathy), korukku (venereal disease), megapadai (skin infections), ooral padai (skin rashes), mega ranam (venereal ulcers)
15.	Ashwgandhi Lehiyam	Page 176-179	Ilaippu noiyil kaanum udal melivu (Emaciation in Tuberculosis), uram (gives strength and stamina), prasava kala balheenem (improves post-partum weakness), maladu pokkum (improves fertility)
16.	Elathi Kirutham	Page 237	Eelai (asthma), elumburukki (TB), piththa varatchi (body dryness), kasam, ulamanthai
17.	Kandangaari Kirutham	Page 243	Ulamanthai, suvasa kasam, eelai (asthma), irumal (cough), sayam (TB)

18.	Sarva Megathennai	Page 271-272	Araiaappu katti (lymphadenopathy), kai kaal pidippu (stiffness of limbs), korukku (venereal disease), paandu (anemia), vellai (leucorrhoea), kandamaalai (cervical lymphadenopathy), kandamaalaiyin aratha ranam (chronic ulcer in neck lymphnodes), mega ranam (venereal ulcers), sori (skin rashes), sirangu (scabies), padai (erythema), veekkam (dropsy)
19.	Pala Arakku Thailam	Page 280	Used for Head bath. Natpatta suram (chronic fevers), vettai (venereal infection), thega veppam (body heat), thega erivu (irritation of the body).
20.	Arakku Santhanaathi Thailam	Page 281	Suram (fever), sanni (fits), kasam (TB), peenisam (sinusitis), thalai vali (head ache), sori sirangu (scabies)
21.	Arkkaathi Thailam	Page 298	Kabala sanni (fits due to head imbalance), pidari vali (occipital pain), kazhuththu narambu esivu (neck stiffness)
22.	Parangipattai Rasayanam	Page 460-461	Soolai rheumatic pain), viranam (wound), kiranthi (glandular hypertrophy), vaai konal (facial palsy), kuttam (leprosy), piramegam (leucorrhoea), kunmam (peptic ulcer), mega vayu (rheumatism related to megam), moorchai (syncope), vai naatram (halitosis), akkini mantham (loss of appetite)

23.	Thippili Lehiyam	Page 169	Eelai (asthma), irumal, kasam, sayam (TB), arosakam (ageusia), vanthi (vomiting), kudal purattal (abdominal discomfort), vayu (flatus), vayitru vali (abdominal pain)
24.	Soolai Kiyazham	Page 71	18 vithamana soolaikal (18 types of rheumatic pain)
	Kan Vaithiyam ennum thiru neththira Chinthamani (Munusamy Muthaliar, 1995)		
25.	Kannukku Ennai	Page 73-74	Nayana Kasam (cataract), Padalam (pterygium), pillam (Mucus fishing syndrome), thimiram (Amaurosis fugax), puzhuvettu (ulcerative blepharitis), pitha kasam (Yellow cataract), kann poo (pingueculas), kurudu (blindness), neer paichal (Keratoconjunctivitis), kuntham (Micropsia) and kannoigal (eye diseases).
	Chikitsa Ratna Deepam (Pillai, 1956)		
26.	Idivallathi Mezhugu (other)	Page 159-160	Kuttam (leprosy), thimir (body soreness), kandamalai (cervical lymphadenopathy), mega soolai (rheumatic pain), kiranthi (glandular hypertrophy), araiappu (inguinal lymphadenopathy), putru (carcinoma), karum pulli (hyperpigmentation of skin), mega ooral (eczema), padarthamarai (tineal infections), pavuththiram (fistula), kuzhiviranam (pitted ulcers), thodai vazhai (swellings in thigh)

27.	Aswaghandha Balalakshadhi Thailam	Page 192	Sarva pazhaya surangal (chronic pyrexia)
28.	Rasagandhi Mezhugu (other)	Page 255-256	Kuttam (leprosy), Thimir (body soreness), Kandamalai (cervical lymphadenopathy), Mega soolai (rheumatic pain), Kiranthi (glandular hypertrophy), Araiappu (inguinal lymphadenopathy), Putru (carcinoma), Karum pulli (hyperpigmentation of skin), Mega ooral (eczema), Padarthamarai (tinea infections), Pavuththiram (fistula), Kuzhiviranam (pitted ulcers), Thodai vazhai (swellings in thigh).
29.	Thummattikai Mezhugu	Page 262	Magotharam (ascites), Vayu thiratchi (bloating), Kunmam (gastritis)
Pulipani Marunthugal (Subramaniyam, 2001)			
30.	Thummattikai Pathangam	Page 95	Vatha soolai (rheumatic pain), kai kaal mudakkum (Paralysis of hands and feet), paarisa vayu (hemiplegia), aseeranam (indigestion), porumal (flatus), kirumi (worm infestation), vayitru vali (stomach pain), kunmam (peptic ulcer).

In Siddha medicine, for simple ailments either single herb formulations or multiple herbs formulations are generally given. If single herb formulations do not prove effective, polyherbal formulations are used due to the fact that the combination of botanicals containing pooled chemical compounds may give the anticipated activity in combination. In other words, polyherbal formulations have plant-based



pharmacological agents which may exert synergistic, potential, agonistic, antagonistic actions by virtue of its associated diverse active principles themselves. These pharmacological active principles work together in a dynamic way to produce maximum therapeutic efficacy with minimum side effects. Both Ayurveda and Siddha systems postulate that multiplicity of factors and complications cause diseases in most of the cases, leading to both visible and invisible symptoms. Here, combination of herbals may act on multiple targets at the same time to provide a thorough relief (Parasuraman *et al.*, 2014). In addition to these factors, polyherbal formulations bring to improved convenience for patients by eliminating the need of

taking more than one different single herbal formulation at a time, which indirectly leads to better compliance and therapeutic effect. It may also be mentioned here that, unlike Ayurveda, Siddha medicine also gives importance to the conjunctive use of plants and minerals. According to Siddha theory, compound preparations made of minerals like mercury and sulphur believed to invest the body with immunity from decay, enabling it to conquer disease. Thus, in Siddha systems we can see the use polyherbal formations and also compound formulations where plants and minerals are ingredients. The ingredients (Amukkara and other plants, animal products and minerals) of Siddha formulations are listed in Table 3.

Table 3. Amukkara and other ingredients of some Siddha formulations

Amukkara Choornam (Amala <i>et al.</i> , 2019)
Plant ingredients: <i>Cinnamomum verum</i> (Siru naagapoo), <i>Elettaria cardamomum</i> (Elam), <i>Piper nigrum</i> (Milagu), <i>Piper longum</i> (Thippili), <i>Zingiber officinale</i> (Chukku), <i>Saccharum officinarum</i> (Sarkkarai), <i>Withania somnifera</i> (Amukkara)
Amukkara kashayam (Mohanraj, 2009)
Plant ingredients: <i>Withania Somnifera</i> (Amukkara), <i>Piper nigrum</i> (milagu), <i>Cheilocostus speciosus</i> (Kostam), <i>Celastrus paniculatus</i> (Sirupunnalarasi), <i>Piper longum</i> (Thippili), <i>Tragia involucrata</i> (Kaanjori), <i>Borreria hispida</i> (Soori), <i>Abrus precatorius</i> (Venkunri), <i>Ficus carica</i> (Athi pattai), <i>Cynodon dactylon</i> (Aruku ver)
Aswaghandhadhi Nei (Ramachandran, 2001)
Plant ingredients: <i>Withania somnifera</i> (Amukkara), <i>Trianthema decandra</i> (Saaranai), <i>Cissus quadrangularis</i> (Pirandai), <i>Operculina turpethum</i> (Sivathai), <i>Piper nigrum</i> (Milagu), <i>Gmelina arborea</i> (Prungumil), <i>Oroxylum indicum</i> (Peruvaagai), <i>Premna tomentosa</i> (Munnai), <i>Aegle marmelos</i> (Koovilam), <i>Stereospermum chelonoides</i> (Paathiri), <i>Phyllanthus emblica</i> (Nelli), <i>Solanum xanthocarpum</i> (Kandangaari), <i>Solanum indicum</i> (Vazhuthalai ver), <i>Glycyrrhiza glabra</i> (Athimathuram), <i>Hemidesmus indicus</i> (Suryapathiri), <i>Heliotropium indicum</i> (Thetkkadai), <i>Cedrus deodara</i> (Devadaram), <i>Alpinia galanga</i> (Arathai), <i>Curcuma longa</i> (Manjal), <i>Plumbago zeylanica</i> (Kodiveli), <i>Cassia tora</i> (Thagarai), <i>Wrightia tinctoria</i> (Vetpalai), <i>Picrorhiza kurroa</i> (Kadukurokini), <i>Vitex agnus-castus</i> (Renugam), <i>Piper longum</i> (Thippili thool)
Animal products: Sangu (conch shell), Pasu nei (ghee), then (honey)
Mineral ingredients: Evacharam, Sathicharam, Kaaichuppu, Kantha parpam, Tthamira parpam

Aswaghandhi Thailam (Ramachandran, 2001)
<p>Plant ingredients: <i>Withania somnifera</i> (Amukkara ver), <i>Aegle marmelos</i> (Vilva ver), <i>Sida rhombifolia</i> (Chitramutti ver), <i>Pavonia odorata</i> (Peramutti ver), <i>Curculigo orchoides</i> (Nilappanai ver), <i>Dioscorea alata</i> (Neervallikizhangu), <i>Hemidesmus indicus</i> (Nannari), <i>Alternanthera sessilis</i> (Ponnanganni), <i>Plectranthus Vettiveroides</i> (Vilamichu), <i>Cyperus rotundus</i> (Muthakaasu), <i>Madhuca longifolia</i> (Iluppai poo), <i>Alstonia scholaris</i> (Kulappalai ver), <i>Saccharum spontaneum</i> (Naanal), <i>Gloriosa superba</i> (Mal kizhangu), <i>Nelumbo nucifera</i> (Thamarai valaiyam), <i>Alocasia macrorrhizos</i> (Verugan kizhangu), <i>Cyperus esculentus</i> (Perunkorai kizhangu), <i>Ipomoea batatas</i> (Boomisarkkai kizhangu), <i>Chrysopogon zizanioides</i> (Vetiver), <i>Tinospora cordifolia</i> (Seenthil), <i>Kaempferia rotunda</i> (Sengaluneer kizhangu), <i>Cucumis maderaspatanus</i> (Musumusukkai), <i>Alternanthera sessilis</i> (Kodupparai), <i>Cardiospermum halicacabum</i> (Mudakkatran), <i>Capparis zeylanica</i> (Kathotti), <i>Eclipta alba</i> (Karippan), <i>Aloe barbadensis</i> (Katralai), <i>Phyllanthus niruri</i> (Keelkainelli), <i>Plectranthus amboinicus</i> (Neervalli), <i>Emblica officinalis</i> (Nellikkai), <i>Pentanema indicum</i> (koonthan kuthambai), oil from <i>Sesamum indicum</i> seeds (Nalla ennai), <i>Glycyrrhiza glabra</i> (athimathuram), <i>Piper nigrum</i> / <i>Piper longum</i> / <i>Zingiber officinalis</i> (Thirikaduku), <i>Emblica officinalis</i>, <i>Terminalia bellirica</i>, and <i>Terminalia chebula</i> (Thiripalai), <i>Syzygium aromaticum</i> (Kirambu), <i>Mesua ferrea</i> (Sirunagapoo), <i>Alpinia calcarata</i> (Chitrarathai), <i>Cuminum cyminum</i> (Seeragam), <i>Kaempferia galanga</i> (Kacholam), <i>Dioscorea alata</i> (Sevvalli kodi), <i>Cedrus deodara</i> (Devadaram), <i>Wrightia tinctoria</i> (Vetpalai arisi), <i>Saussurea lappa</i> (Kottam), <i>Cinnamomum zeylanicum</i> (Lavangapattai), <i>Kaempferia galanga</i> (Adavi kacholam), <i>Coscinium fenestratum</i> (Maramanjal), <i>Picrorhiza kurroa</i> (Kadukuroni), <i>Sida cordifolia</i> (Kurunthotti verthol), <i>Rubia cordifolia</i> (Manjitti), <i>Senna tora</i> (Thagaram), <i>Nardostachys jatamansi</i> (Sadamanji), <i>Michelia champaca</i> (Senbagam), <i>Santalum album</i> (Chanthanam), <i>Elettaria cardamomum</i> (Elam), <i>Aquilaria malaccensis</i> (Akil), <i>Pterocarpus santalinus</i> (Senchanthanam), <i>Crocus sativus</i> (Kunguma poo)</p> <p>Animal products: Kadal nurai, Laccifer Lacca (Kombarakku), Curd extract, Milk, Kasthuri.</p> <p>Mineral ingredients: Pachai karpooram</p>

Ashwgandhi Lehiyam (Ramachandran, 2001)
Plant ingredients: <i>Withania Somnifera</i> (Amukkara), <i>Zingiber officinale</i> (Chukku), <i>Piper nigrum</i> (Milagu), <i>Piper longum</i> (Thippili), <i>Cinnamomum zeylanicum</i> (Lavangapattai), <i>Mesua ferrea</i> (Sirunaga poo), <i>Elettaria cardamomum</i> (Elam), <i>Coriandrum sativum</i> (Dhaniya), <i>Myristica fragrans</i> (Sathikkai), <i>Pterocarpus santalinus</i> (Senchanthanam), <i>Curcuma zedoaria</i> (Kichili kizhangu), <i>Senna tora</i> (Thagarai vithai), <i>Bambusa vulgaris</i> (Mongiluppu), <i>Syzygium aromaticum</i> (Kirambu), <i>Chrysopogon zizanioides</i> (Vetiver), <i>Plumbago zeylanica</i> (Chithira moolam ver), <i>Vitis vinifera</i> (Thiratchai pazham), <i>Phoenix sylvestris</i> (Pereechangai), <i>Saccharum officinarum</i> (Sarkkarai)
Animal products: Milk, Ghee, Honey
Aswaghanda Balalakshadhi Thailam (Pillai, 1956)
Plant ingredients: <i>Withania somnifera</i> (Amukkara), <i>Sida rhombifolia</i> (Chitramutti ver), <i>Plectranthus vettiveroides</i> (Vilamicham ver), <i>Alpinia officinarum</i> (Arathai) <i>Glycyrrhiza glabra</i> (Athimathuram), <i>Rubia cordifolia</i> (Manjitti), <i>Anethum sowa</i> (Sathakuppai), <i>Saussurea lappa</i> (Kottam), <i>Curcuma longa</i> (Kappu manjal), <i>Santalum album</i> (Santhanam), root of <i>Piper longum</i> (Modi), <i>Piper attenuatum</i> (Kattu milaku), <i>Picrorhiza kurroa</i> (Kadukuroni), <i>Cedrus deodara</i> (Devadaram), <i>Cyperus rotundus</i> (Korai kizhangu), <i>Hemidesmus indicus</i> (Nannari).
Animal products: Laccifer lacca (Kombrakku), Milk



Research on Amukkara products of Siddha medicine

Standardisation of Herbal Formulations

Siddha system is a medicinal plant based rich system of traditional medicine. Further development of this system with the perspectives of safety, efficacy and quality will help to preserve this traditional heritage but also to rationalise the use of natural products in the health care. Standardisation of herbal formulations is essential in order to evaluate the quality, purity and efficacy of the drugs based on the active principles. Standardization involves the development of technical standard methods for herbal drugs and is the tool to improve the quality control process (Sachan *et al.*, 2016).

The technical methods for standardization of herbal drugs include chromatographic and spectroscopic analysis, chemical parameters, microbiological parameters, pharmacological evaluation, physicochemical parameters etc. (Sivaraman *et al.*, 2019). Available literature indicates that certain attempts are made to standardise polyherbal formulations like Amukkara Choornam and Rasagandhi Mezhugu. For instance, Amukkara Choornam, a formulation which is official in Siddha Formulary of India (Anonymous, 1992), is therapeutically useful in the treatment of all types of gastric disorders, leucorrhoea, anaemia, tuberculosis, rheumatic pain, insomnia and sexual insufficiency. Jeganathan and others (2008) by using HPTLC method estimated Withaferin-A and Piperine in the extract of the standard Amukkara Choornam formulation and found that the recovery values of Withaferin-A and Piperine were found to be 94.52% and 98.73% respectively. Thus, they concluded that the proposed HPTLC method can be used to accurate quantitative estimation of Withaferin-A and Piperine in commercial formulation extracts also. Similarly, Amala and others assessed the quality of the drug Amukkara Choornam by conducting physicochemical analysis, preliminary phytochemical analysis and other analytical techniques. The results obtained indicate that the drug is of standard quality and can be used as reference standard in laying pharmacopoeia standard (Amala *et al.*, 2019). Shyamala and others (2021) characterized the Rasagandhi mezugu based on the physicochemical and chromatographic parameters. The outcomes of the physicochemical analysis of Rasagandhi mezugu were found within standard limits.

They also standardised the overall metal content in this formulation. The results attained from the study indicated that the proposed standardisation method could be used as a reference method for setting limits for the quality assurance and quality control of Rasagandhi mezhugu. With this background, further works for standardisation of other Siddha herbal formulations where Amukkara is one of the ingredients are suggested.

Assessment of efficacy of herbal formulations

The therapeutic effectiveness of the Siddha system of medicine in treating a variety of illnesses has been established. However, there are some impediments limiting the propagation of Siddha medicine, globally, including a dearth of supporting evidence and a lack of validation (Kumar *et al.*, 2023). Thus, adequate studies and documentations are needed to establish the safety and efficacy of Siddha formulations in the treatment of different ailments and pave way to prescribe these Siddha formulations in public health initiatives and programs to reduce the incidence and prevalence of ailments. In the case of Siddha formulations where Amukkara is one of the ingredients, very few studies are available to ascertain their efficacy to treat diseases for which they prepared. For instance, anti-oxidants which are present in the medicinal preparation play a major role against free radicals which is responsible for various diseases such as ageing process, cancer etc. Rajalakshmi and others (2017) evaluated the antioxidant power of Amukkara Choornam by estimating DPPH (2,2-Diphenyl1-picrylhydrazyl) radical scavenging



activity, Superoxide radical scavenging activity and Hydroxyl radical scavenging activity, and anti-inflammatory activity. Amukkara Choornam exhibited antioxidant activity in terms of radical scavenging potential against DPPH (IC-50: 2286 µg / ml), superoxide (IC-50: 5222 µg/ml), and hydroxyl radical (IC-50: 1147 µg/ml) and anti-inflammatory activity (IC-50: 35,19 µg / ml). According to Rajalakshmi and others (2017), compare to Amukkara Choornam, Thiriphala Choornam exhibits high antioxidant and anti-inflammatory potential, may also be due high content of phenolic compounds in the later formulation. In Amukkara, Withanolides and Withaferins are the most active components along with a few other metabolites including Withanone and Withanolides, and these biochemicals are effective against different types of cancer cell lines (Rai *et al.*, 2016). Thus, Amukkara holds an important place among various anticancer medicinal plants. It is very essential to further screen and investigate different formulations for anticancer therapy *in vitro* as well as *in vivo* in combination with established chemotherapy. It may be mentioned here that there are more than twenty polyherbal Siddha formulations in which Amukkara is one of the ingredients. Thus, there are opportunities to characterise them for therapeutic phytochemicals and to assess efficacy of these formulations for treating various ailments.

Repurposing Siddha Medicine

Drug repurposing is the novel treatment option accelerating the drug discovery process through the identification of a novel clinical use for an already existing approved drug which minimizes the costs, risks and saves time when compared with invention of a new drug. The concept of repurposing has gained significant attention in recent years. Identifying the right potential candidates, with the appropriate evidence to make new treatment options available for patients is critical. In Siddha Systems, like in other systems like Ayurveda, Unani and Chinese Medicine, drug repurposing or repositioning of compounds for new indications are gradually being employed against cancer, rheumatoid arthritis, multiple sclerosis, HIV/AIDS, and many other diseases. For instance, Amukkara Choornam, a Siddha polyherbal medicine constitutes seven herbal ingredients (*Cinnamomum*, *Elettaria cardamomum*, *Piper nigrum*, *Piper longum*, *Zingiber officinale*, *Syzygium*

aromaticum and *Withania somnifera*) and is being used in the treatment of various diseases like Gastric ulcer, Peripheral neuritis, Gonorrhoea, Asthma and Tuberculosis. In this, *Withania somnifera* and *Zingiber officinale* have antiviral activity that inhibits M protease and Spike protein and prevents the entry and growth of COVID-19. *Piper longum*, *Piper nigrum*, *Syzygium aromaticum* binds with M protease [MPro] and ACE2 receptors and *Elettaria cardamomum* binds with Nucleocapsid protein [N protein] thereby inhibiting the viral replication. The polyherbal synergism of Amukkara Choornam enhances its efficacy over co morbid conditions also. From various research reports, it is now known that ingredients of Amukkara Choornam exhibit anti-inflammatory, anti-viral, immune- enhancing properties, and in turn exhibit potential activities against COVID-19. This made reasonable grounds on drug repurposing of Amukkara Choornam as a novel clinical use for COVID-19 (Ayush, 2022). A recent study showed that Amukkara Choornam has promising effect in inhibiting the biofilm up to 60%. Thus, there is also a reasonable ground for repurposing Amukkara Choornam as a novel agent to treat *Candida albicans* biofilm mediated infections (Rajamohamed and Siddharthan, 2019). In Siddha system, there are numerous polyherbal formulations which can be repurposed to find quicker solutions to the over-exerted healthcare scenario and drug needs for several new diseases. Thus, in-depth studies on phytochemicals of herbs and their interactions in polyherbal formulations, their combined therapeutic actions etc. are need to be intensified. In addition to this, integrated approaches between computational and experimental methods may be required to ensure high success rates of repositioned drugs.

Conclusions

In Siddha system of medicine, Amukkara is one of the prominent medicinal plants used as single drug and in more than twenty polyherbal formulations to treat a variety of ailments. As Amukkara holds rejuvenation and anti-oxidant quality, as denoted by Siddhars like Bogar and Yugi Munivar, further research may be carried out to effectively use Amukkara and polyherbal formulations in which Amukkara is one of the ingredients, even to develop new drugs to treat aging and auto immune diseases. In addition to this, Amukkara-based formulations, similar to any other

Siddha medicines, with several biomolecules are potential candidates for drug repositioning to combat particularly, rare, difficult-to treat diseases and neglected diseases. It may be emphasised here that in Siddha System of Medicine, there is a scope for application of modern approaches like artificial intelligence (AI) in drug repurposing via quick virtual screening to enhance and speed-up the identification of potential drug candidates against communicable and non-communicable diseases.

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Asgand (Withania somnifera (L.) Dun.) in Unani System of Medicine

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Introduction

The Unani system of medicine, originated in Greece (Unan) during 4th Century BC, is introduced in India by the Arabs and Persians sometime around the eleventh century AD, where it became one of the important indigenous systems of medicine (Anonymous, 1982 and 2007). This system is developed based on Hippocratic theory of four humors viz. blood (*Dam*), phlegm (*Belgam*), yellow bile (*Safra*) and black bile (*Sauda*); which are analogous to the three doshas (body humors) of Ayurvedic medicine: *Vata* (Wind), *Pitta* (Bile) and *Kapha* (Phlegm), and the four qualities of states of living human body (*Mizaj*: Temperament) like hot, cold, moist and dry. Unani system considers that a perfect balance of *Arkan* (elements), *Akhlat* (humors) and *Mizaj* (temperament) keeps the body and mind healthy (Ishtiyaq, 1983). The Unani medicine also postulates that the health of the human body is



maintained by the harmonious arrangement of Al-Umoor Al-Tabiyah, the seven basic physiological principles, namely, a) *Arkan* (elements), b) *Mizaj* (temperament), c) *Akhlat* (body humors), d) *Aaza* (organs and systems), e) *Arwah* (vital spirit), f) *Guwa* (faculties or powers), and g) *Afa`al* (functions). The Unani system also believes that every individual has an inherent power of self-preservation called the "*Quwwat-e-Modabbira*". Unani system of medicine aims at restoring the equilibrium of various elements and faculties of the human body (Tipo *et al.*, 2019). The Unani medicine is based largely on plant origin drugs, animal origin drugs and mineral origin drugs (Razi, 1991; Ibn Sina, 1995). Crude drugs when used one at a time is called *Ilaj bil Mufrad* (treatment by single drug). When two or more than two drugs are combined together, it is called *Ilaj bil Murakkabat* (treatment by compound drugs) (Ibn Rushd, 1965; Hussain *et al.*, 2010).

Pedanius Dioscorides (78 AD), "the father of pharmacognosy", was a Greek physician, pharmacologist, and a great botanist of the 1st century A.D. He wrote the most important text on botany and pharmacognosy, a 5-volume Greek encyclopaedia about herbal medicine and related medicinal substances. The name of his great book is Περὶ ὑλῆς ἰατρικῆς (Peri hyles iatrikes) in Greek, which is more widely known by its Latin name, *De Materia Medica*. The Arabic translations of *De Materia Medica* were received the name of *Kitab al-Hashaish fi al-Tibb* [The Book of Medical Herbs]. This book with details of more than 600 herbal drugs, about 35 drugs from animal sources, and about 90 drugs prepared with minerals is regarded as one of the major contributions to Unani System of Medicine. *Asgand* (Ashwagandha: *Withania somnifera*) described by Dioscorides in this book (Gunter, 1956) has also been used in Unani medicine due its numerous therapeutic actions, such as, *Muhallile warm* (anti-inflammatory), *Moallide mani* (semen producer), *Musakkin* (sedative), *Muqawwie aam* (General tonic) and *Muqawwie Bah* (aphrodisiac) (Saiyed *et al.*, 2016). In this Chapter, descriptions and uses of *Asgand* given in Unani literature, and current research in efficacy and ability of Ashwagandha for promoting health are presented.

Organoleptic properties of *Asgand*

Two varieties of *Asgand* have been mentioned in Unani classical literature and they are *Asgand Nagori* and *Asgand Dakhni*. According to Unani physician, *Asgand*



Nagori is best for medicinal use. In Unani system of medicine, roots of Asgand are used for the preparation of several mono-herbal and poly-herbal formulations. The *Mizaj* (temperament) of Asgand is considered as hot and dry (*Garm Khushk*) in third degree. According to Hakim (2005), drugs with hot and dry third-degree temperament are strong in action and their side effects can be felt and seen after the administration of first dose. In heavy doses, even for a short duration use, such drugs may produce sometime sever adverse effects; but are not fatal. The odour (*Boo*) of Asgand is pungent and smell of horse's urine. It is also reported that Asgand has the property to eliminate *Balgham* (Phlegm) and *Sauda* (Black Bile) from the body of the consumer. Drugs can be remarkably beneficial and improve well-being but may also have toxic effects (*Muzir*) and potential to cause injury, even if used properly. In Unani literature, it is mentioned that Asgand may have slight toxicity (*Muzir*) for persons with hot temperament. The main action (*Nafa Khas*) of Asgand is Aphrodisiac (*Muqawwi-e-Bah*).

Pharmacological actions (*Afa`al*) of Asgand

Every drug has one or more than pharmacological action due to presence of chemical constituents (Hamiduddin et al., 2016). Unani scholars use *Asgand* for *Muqawwie aam* (General tonic), *Muqawwie rehem* (Uterine tonic), *Muwallid-i-*

mani (Spermatogenic), *Mughallize mani* (Semen inspissate), *Munaqqī rahem* (Cleansing morbid matters of Uterus), *Muqawwi-e-Bah* (Aphrodisiac), *Mushtahi* (Appetizer), *Musammine badan* (Calorific), *Muhallile waram* (Anti-inflammatory), *Muffatehe sudad* (Deobstruent), *Musakkin* (Soothing, analgesic, relaxant), *Munawwim* (Sedative), *Moaddile Akhlat* (Normalize humors), *Mufattite hisaat* (Lithotriptic), *Muwallid-i- Labn* (Galactopoietic), *Musaffie khoon* (Blood purifier), *Muqawwie meda* (Stomachic), *Musakkin Asab* (Nervine analgesic), *Muqawwie Gurda* (Nephro tonic, nephroprotective), and *Dafe Taqtirul boul* (Obviate urine incontinence) activities (Hakim, 2005;; Kabeeruddin, 2007; Ghani, 2010; Uddin *et al.*, 2012; Saiyed *et al.*, 2016).

Therapeutic Uses (Mahall-e-Istemal) of Asgand

Asgand is considered as alterative, anodyne, aphrodisiac, tonic, anti-inflammatory, nervine tonic, sedative, deobstruent, diuretic, and narcotic drug. Centuries of Unani medical experience using Asgandh have revealed that it can be used for management of rheumatism (*Hudaar*), lumbar pain (*Waja-uz-Zahr*), emaciation of children (*Huzal*), dyspepsia (*Fasad al-Hadm*), asthma (*Rabw*), bronchitis (*Ilthib al-Shu'ab Muzmin*), tuberculosis (*Hadaba*), insomnia (*Sahr*), epilepsy (*Sar'*), hypertension (*Daght al-Dam Qawi*), cough (*Su'al-o-Surfa*), fevers (*Humma*), dropsy (*Istisqa*), depression (*Inkhifad*), spermatorrhea (*Jiryan mani*), leucorrhoea (*Sailanur reham*), renal and vesicular calculi (*Hissate gurda wa masana*), bleeding piles (*Bawasire khooni*) etc.(Asthana and Raina, 1989).

Substitute (*Badal*) for Asgand

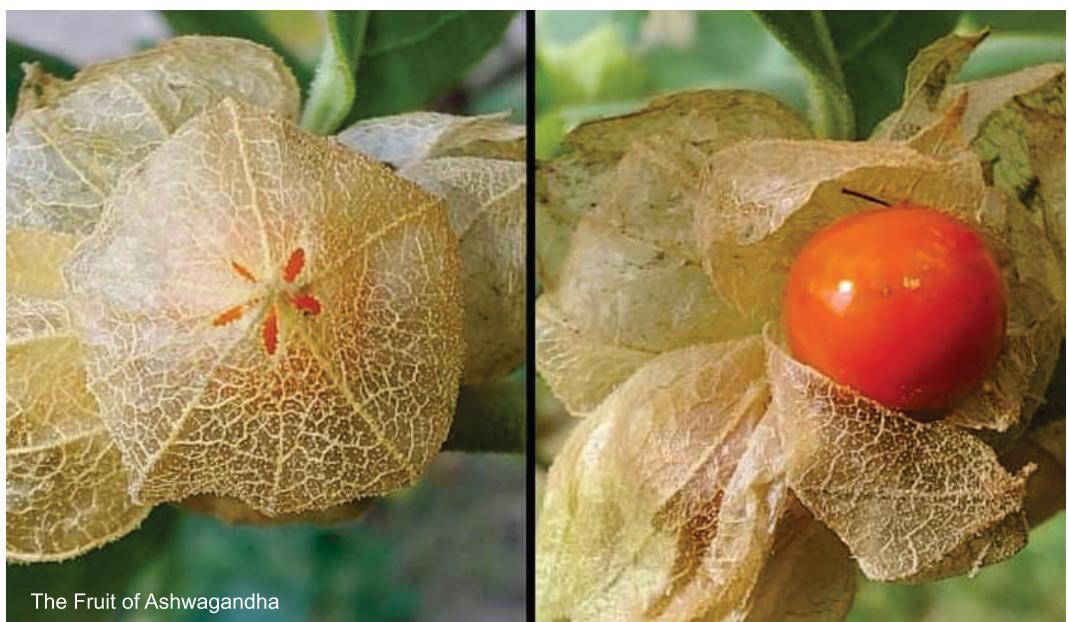
Substitution of drugs (*Abdaal-e-Advia*) is an important principle of Unani system of medicine. If the particular drug which is required for the treatment of particular disease is not available, to deal with this condition, ancient Unani scholars suggested to use their substitute. However, they also suggested that such substitute drug should be similar to the required drug in terms of physical properties, temperament, chemical constituents and actions (Parveen *et al.*, 2020). The Unani physician have suggested three substitutes namely *Qust* (*Saussurea lappa*= *Aucklandia costus* Falc.), *Suranjan* (*Colchicum luteum* Baker), and *Behman safaid* (*Centaurea behen* L.) (Ghani, 2010)

Mazarrat (Adverse effect) of Asgand

According to Unani concept, the drugs belonging to the temperament of 3rd and 4th degree have greater potency in treating diseases with minimal dosage, but at the same time they may have some harmful effects as well. For instance, *Asgand* has been described to be harmful to throat, and to people with hot temperament (Ghani, 2010). Unani scholars suggest corrective agents (*Musleh*) such as *Joshanda shehtoot shereen* (a sweet drink made of mulberry fruits) to gargle when the throat is affected, and *Kateera* (the gum of *Sterculia urens* can be taken in powder form or paste, or in herbal formulations) for the people with hot temperament (Saiyed *et al.*, 2016).

Miqdar-e-Khurak (Dose)

In Unani system of medicine, several factors are considered to determine the dose (Miqdar-e-Khurak) of a given drug that can be consumed. These factors include temperament and potency of drugs, temperament and age of the patient, nature of disease, severity of the disease, route of drug administration etc. The suggested dose of *Asgand* root in powder form is 3-5 gm (Kabeeruddin, 2007). Since *Asgand* is hot and dry (*Garm Khushk*) in third degree, if used for several times or in a higher dose than indicate may cause damage to the body.



Use of single drugs and compound formulations

In Unani system, *Asgand* is used as a single drug (*Mufrad*) or in combination with other drug/s in raw form or in compound formulations (*Murakkabat*). Some of the *Asgand* formulations used for treating certain ailments (Anonymous, 2007 and 2008) are given in Table 1.

Table 1. Use of *Asgand* as single drug for treating ailments

No.	Method of usage	Indication/s or Ailment/s
1.	Asgand powder with cow milk	<ul style="list-style-type: none"> • <i>Zofe bah</i> (Hypoactive sexual desire disorder) • <i>Jiryān mani</i> (Spermatorrhea) • Qillat and Riqqat-e-Mani (oligospermia) • <i>Sailanur reham</i> (Leucorrhea) • <i>Hissat-e gurda wa masana</i> (renal and vesicular calculi) • <i>Taqtirul boul</i> (dribbling of urine)
2.	Zimad (local application) of <i>Asgand</i> paste on any inflamed body part	Dissolves <i>warme khussiya</i> (orchitis) and relieves pain
3.	<i>Zaror</i> (Dusting) of <i>Asgand</i> powder on ulcer (<i>Quruḥ</i>)	Heals ulcer
4.	<i>Asgand</i> powder along with milk and sugar	<ul style="list-style-type: none"> • Aids in infertile women in conception. • Functions as <i>Muqawwie Bah</i> (aphrodisiac) in men
5.	Local application of bark and root powder of <i>Asgand</i> in milk	For correcting lax or flabby breast
6.	<i>Asgand</i> powder and sugar	For treating <i>Kasrate tams</i> (Menorrhagia).
7.	Drinking a decoction made of equal quantity of <i>Asgand</i> and <i>Misri</i> (crystallized sugar lumps) in milk twice a day.	Improves the complexion of the skin
8.	Consumption of a preparation made by mixing of ground black sesame and <i>Asgandh</i> 12g with honey, daily for a month	<ul style="list-style-type: none"> • Improves memory power. • Reduces dementia
9.	<i>Asgand</i> powder and <i>Baheedana</i> (<i>Cydonia oblonga</i>), with jaggery	Useful in palpitation (<i>Khafaqan</i>) and shock (<i>Suqut al-Quwwa</i>)
10.	Consumption of the powder of <i>Asgand</i> with <i>Chobchini</i> (<i>Smilax glabra</i>) with honey	<i>Tasfiyaal-dam</i> (Blood purification)
11.	Soak the crushed pieces of root of <i>Asgand taza</i> in a small pot full of water for 12hrs and drink this <i>zulal</i> (its decanted water) regularly for three days,	For the treatment of <i>Bawasire khooni</i> (Bleeding piles)
12.	Keeping <i>Asgand</i> powder in the mouth	Useful in dental caries (<i>Ta'akkul al-Asnan</i>)

Murakkab (Compound formulation) of Asgand

The well-known Unani compound formulations of *Asgandh* root are *Dawa-e-Takore*, *Habb-e- Asgand*, *Halwa-i- Gheekwar*, *Kushta-e-Gaudanti*, *Majun muqawwie reham*, *Majun Pumba Dana*, and *Majun zanjabeel* (Anonymous, 2008). The ingredients, action and therapeutic uses of these formulations as per the Unani Pharmacopoeias (Anonymous, 2008) are given in Table 2.

Table 2. Ingredients, action and therapeutic uses of Unani compound formulations of Asgand

<i>Dawa-e-Takore</i>
Ingredients: Asgand, Aamba haldi (<i>Curcuma amada</i>), Burada Dandaan -e-feel (Ivory powder), <i>Tukhm Arandi</i> (<i>Ricinus communis</i>), <i>Taj qalmi</i> (<i>Cinnamomum cassia</i>), <i>Til siyah</i> (<i>Sesamum indicum</i>), Kharateen Khushk (<i>Aristolochia indica</i>), <i>Zarawand Mudharaj</i> (<i>Aristolochia rotunda</i>), <i>Qaranful</i> (<i>Syzygium aromaticum</i>), <i>Ghungchi safed</i> (<i>Chlorophytum borivilianum</i>), <i>Malkangni</i> (<i>Celastrus paniculata</i>), <i>Maghz chironji</i> (<i>Buchanania lazan</i>), <i>Meda Lakdi</i> (<i>Litsea glutinosa</i>), Narjeel Kohna (<i>Cocos nucifera</i>)
Action: <i>Muqawwi-e-Asab</i> (Nervine tonic)
Therapeutic uses: Treating <i>Istirkha-e-Qazeeb</i> (Erectyle dysfunction) and <i>Sighar -e-Qajeeb</i> (Sexual disorders)
<i>Habb-e- Asgand</i>
Ingredients: Asgand, <i>Moosli safed</i> (<i>Chlorophytum arundinaceum</i>), (<i>Piper longum</i>), <i>Sataver</i> (<i>Asparagus racemosus</i>), <i>Vidhara</i> (<i>Argyreia speciosa</i>), <i>Zanjabil</i> (<i>Zingiber officinale</i>), <i>Asl</i> (Honey).
Action: <i>Mohallil Waram</i> (Anti-infammatory), <i>Musakkin Alam</i> (Analgesic), <i>Muqawwi-e-Bah</i> (Aphrodisiac)
Therapeutic uses: Treating <i>Waja-ul-Mafasil</i> (Arthritis) and <i>Waja-ul-Warik</i> (Low back ache), <i>Wajaul Mafasil</i> (Joint pain), <i>Kamer Dard</i> (Backache), <i>Balghami</i> and <i>Riyahi Amraz</i> (Phlegmatic and gaseous disease)
<i>Halwa-i- Gheekwar</i>
Ingredients: Asgand, <i>Elaichi Khurd</i> (<i>Elettaria cardamomum</i>), <i>Aamba Haldi</i> (<i>Curcuma amada</i>), <i>Talmakhana</i> (<i>Astercantha longifolia</i>), <i>Salabmisri</i> (<i>Orchis latifolia</i>), <i>Khulanjan</i> (<i>Alpinia galanga</i>), <i>Darchini</i> (<i>Cinnamomum zeylanicum</i>), <i>Zanjabeel</i> (<i>Zingiber officinale</i>), <i>Satawar</i> (<i>Asparagus racemosus</i>), <i>Shaqaql Misri</i> (<i>Pastinaca sativa</i>), <i>Qaranful</i> (<i>Syzygium aromaticum</i>), <i>Qust</i> (<i>Saussurea lappa</i>), <i>Malkangni</i> (<i>Celastrus paniculata</i>), <i>Majeeth</i> (<i>Rubia cordifolia</i>),

<i>Halwa-i- Gheekwar</i>
<i>Akhrot (Juglans regia), Badam (Prunus amygdalus), Narjeel (Cocos nucifera), Musli Safaid (Chlorophytum arundinaceum), Musli Saimbal (Bombax malabaricum), Shakar Safaid (Saccharum officinale), Khajoor (Phoenix dactylifera), Medah Gandum (Triticum aestivum), Arq Kewra (Pandanus odorifer), Sat Loban (Boswellia serrata), Sat Leemu(Citrus aurantium), Ghee</i>
Action: <i>Muqawwi-e-Asab</i> (nervine tonic), <i>Mulaiyin</i> (laxative) and <i>Muqawwi-e-Bah</i> (aphrodisiac)
Therapeutic uses: In <i>Waja-ul Mafasil</i> (joint disorders like inflammatory, non-inflammatory, infectious, metabolic and other musculoskeletal disorders), <i>Dard-e-Pusht</i> (back pain), <i>Sual</i> (cough) and <i>Zeequn Nafs</i> (Branchial asthma), <i>Husr</i> (constipation).
<i>Kushta-e- Gaudanti</i>
Ingredients: <i>Gaudanti</i> (Arsenic ore), Root of <i>Asgand</i> , Leaf of <i>Sheera Gheekwar</i> (<i>Aloe vera</i>)
Action: <i>Muqavvi Aasab</i> (Nervine tonic) and <i>Muqavvi Bah</i> (Aphrodisiac)
Therapeutic uses: In <i>Falij</i> (Hemiplegia), <i>Laqva</i> (Facial Palsy), <i>Khadr</i> (Numbness), <i>Wajaul Mafasil</i> (Arthralgia), and each type of <i>Huma</i> (Pyrexia, Fever).
<i>Majun muqawwie reham</i>
Ingredients: <i>Gond Keeker</i> (Acacia nilotica), <i>Asgand</i> , <i>Maghz Chironji</i> (<i>Buchanania lanza</i>), <i>Mochras</i> (<i>Bombax malabaricum</i>), <i>Musli safaid</i> (<i>Chlorophytum arundinaceum</i>), <i>Nishasta Gandum</i> (<i>Triticum aestivum</i>), <i>Qand safaid</i> (granular sugar), <i>Zafran</i> (<i>Crocus sativus</i>), <i>Gokhru Khurd</i> (<i>Tribulus terrestris</i>), <i>Elaichi</i> (<i>Elettaria cardamomum</i>), <i>Balchhar</i> (<i>Nardostachys jatamansi</i>), <i>Peepal Kalan</i> (<i>Ficus religiosa</i> fruit), <i>Tukhm Konch</i> (<i>Mucuna pruriens</i>), <i>Zanjabeel</i> (<i>Zingiber officinale</i>), <i>Sajaz Hindi</i> (<i>Cinnamomum tamala</i>), <i>Satawar</i> (<i>Asparagus racemosus</i>), <i>Singhara Khushk</i> (<i>Trapa natans</i>), <i>Filfil Siyah</i> (<i>Piper nigrum</i>), <i>Gul Dhawa</i> (<i>Woodfordia fructicosa</i>), <i>Gond Chuniya</i> (<i>Butea monosperma</i>), <i>Saad Kufi</i> (<i>Cyperus scariosus</i>), <i>Kharbuza</i> (<i>Cucumis melo</i>), cow milk, ghee
Action: <i>Muqawwi-e-Reham</i> (uterine tonic), <i>Sailan-e-Reham</i> (Leucorrhoea)
Therapeutic use: In <i>Zof-e-Reham</i> (uterine debility)

Majun Pumba Dana

Ingredients: Asgand, Jirjir (*Brucea javanica*), Tukhm Shalgham (*Brassica rapa*), Tukhm Gazar (*Daucus carota*), Tukhm Mooli (*Raphanus sativus*), Zanjabeel (*Zingiber officinale*), Gokhru Khurd (*Tribulus terrestris*), Badam (*Prunus amygdalus*), Maghz Pista (*Pistacia vera*), Maghz Pumba (*Gossypium arboreum*), Kaddu (*Cucurbita pepo*), Mochras (*Bombax malabaricum*), Musli safaid (*Chlorophytum arundinaceum*), Musli siyah (*Curculigo orchoides*), Nakhud (*Cicer arietinum*), Qiwan Shakar (Sugar).

Action: Muqawwi-e-Bah (aphrodisiac) and Muwallid-e-Mani (Spermatogenesis)

Therapeutic use: To treat sexual weakness

Majun Zanjabeel

Ingredients: Asgand, Elaichi (*Elettaria cardamomum*), Balchhar (*Nardostachys jatamansi*), Burada Sandal Safaid (*Santalum album*), Peepal Kalan (*Ficus religiosa* fruit), Qalmi (*Cinnamomum cassia*), Tukhm Konch (*Mucuna pruriens*), Sajaz Hindi (*Cinnamomum tamala*), Saad Kufi (*Cyperus scariosus*), Nagarmotha (*Cyperus rotundus*), Satawar (*Asparagus racemosus*), Filfil Siyah (*Piper nigrum*), Gul Dhawa (*Woodfordia fructicosa*), Gokhru Khurd (*Tribulus terrestris*), Gond Chuniya (*Butea monosperma*), Gond Keeker (*Acacia nilotica*), Maghz Chironji (*Buchanania lanza*), Kharbuza (*Cucumis melo*), Mochras (*Bombax malabaricum*), Musli Safaid (*Chlorophytum arundinaceum*), Nishasta Gandum (*Triticum aestivum*), Zanjabeel (*Zingiber officinale*), milk, ghee, sugar.

Action: Muqawwi-i-Mi'da (Tonic which strengthens the stomach and improves its function)

Therapeutic use: To treat Zof-e-Meda (Gastroparesis is a disease of the muscles of the stomach or the nerves controlling the muscles that cause the muscles to stop working), Sailan-e-Reham (Leucorrhoea), Kasrat-e-Tamas (Menorrhagia) and Waram-e-Reham (inflammation of uterus affecting its different parts).



Research on quality and efficacies of some *Murakkab of Asgand*

In Unani system of medicine, polyherbal formulations (*Murakkab*) dominate as the largest segment, capturing a significant share of the overall herbal supplements and remedies market worldwide. As the demand for polyherbal formulations is increasing, there is also a need for assessment of physico-chemical properties, efficacy and safety of *Murakkab*. In addition, standard criteria for the development and quality control of these herbal preparations by using modern techniques and by applying suitable parameters and standards are also required. In general, *Murakkab* drugs are formulated either taking in to consideration of drug actions that are in concordance to the nature of disease along with ameliorating the safety concern of the use of these drugs as proposed by Ibne Sina; or keeping the *Usoole Ilaj* (Treatment Strategy) in perspective and choosing the single drugs to suit it (Monis, et al., 2019). Available literature indicates that some of the polyherbal formulations in which *Asgand* is one of the components have been assessed for their therapeutic uses mentioned in ancient Unani literature. For example, a preliminary clinical, biochemical, and haematological study has demonstrated that the drug *Habb-e-Asgand* is non-toxic, safe and therapeutically effective in the treatment of *Waja 'al-mafasil* (rheumatoid arthritis) (Verma, et al., 2021). Similarly, Ali and others (2014) have evaluated the hepatoprotective and antioxidative potential of *Habb-e-Asgand* against paracetamol toxicity and found that it may be used as a prophylaxis for free radical induced diseases including liver disorders. They also reported that *Habb-e-Asgand* is also highly potential Unani formulation as an anti-cancer drug because this drug is a combination of several anti-cancerous activity possessing herbs and their active ingredients. In another study, Gupta and others (2022) investigated the anti-cancer properties of *Habb-e-Asgand* on multiple myeloma cells. Their study demonstrated that it could be used in therapy as an adjuvant with lower dose of lenalidomide as it showed favourable anti-proliferative effect. Reduction in the dose of lenalidomide due to use of *Habb-e-Asgand* thereby could reduce the side effects related to standard therapy. Hypothyroidism is the most common thyroid disorder, affects women more frequently, and incidence increases with age. Unani Physicians described various drugs (single and compound prescription) and their composition which has a hot and dry constitution (*Har Yabis Mizaj*) and acts as a diuretic,

emmenagogue, nootropic, expectorant, demulcent, detergent, blood purifier, deobstruent, anti-inflammatory, hepatoprotective, cardiotonic, stimulant, anticancer, antioxidant, and immunomodulatory activities which balance the humor (Anonymous, 2008). Among such drugs, *Asgand* as a single drug and *Habbe-e-Asgand* as a polyherbal drug are also included. According to Alam and Quamri (2020), rigorous researches on *Asgand* and *Habbe-e-Asgand* may be undertaken to use them as alternative options in managing hypothyroidism. Dysfunctional uterine



bleeding (*Istihaza*) is excessively heavy, prolonged or frequent bleeding of uterine origin. *Majun muqawwie reham* which contains *Asgand* to strengthens the uterus and regularize the menstruation as it is known to contain phytohormones, is one of the Unani formulations used for the treatment of *Istihaza* (Khan,2010). A study conducted to evaluate the efficacy of *Majun muqawwie reham* recorded that this formulation is comparable to control drug (Norethisterone acetate-5mg plus Ferrous sulphate) in managing the ailment without any adverse effect (Geetha and Shameem, 2016).

The compound formulation *Halwa-i-Gheekwar* is frequently used by Unani physicians for prophylactic and therapeutic purposes. It contains various single Unani drugs, including *Asgand* which have been reported to possess anti-cancerous, antioxidant and immunomodulatory activities. Therapeutic properties of all the ingredient of *Halwa-i-Gheekwar* has been review by Ahmad and others (2020). Similar kind of analysis of therapeutic activities of different *Murakkab* in which *Asgand* and many other ingredients are used is needed in the light of recent studies on overall therapeutic properties of *Murakkab* and also developing new *Murakkab*.

In single drug or in polyherbal drug, information on their physico-chemical properties is required mainly to assess their therapeutic effects and shelf-life period. However, such studies are scanty in Unani system of medicine, especially when *Murakkab* (polyherbal drugs) are considered; though they are also required for developing standard operating procedures (SOPs) of drugs. In this context, an effort has been made to standardize *Habb-e-Asgand*, a popular Unani compound formulation by Ahmed and others (2015). They prepared *Habb-e-Asgand* by following procedure given in the book *Bayaz-e-Kabir*, Vol. 2. The formulation was subjected to physico-chemical analysis by using a battery of physical parameters, such as pH determination, friability test, ash value, disintegration time, dissolution test, moisture content, thin layer chromatography etc. This work enabled to demonstrate that the finished product was stable over up to 4 months which indicates that the medicine continues to retain its therapeutic value. Another example for almost similar kind of study can be given. *Kushta-e-gaodanti* is another important *Murakkab* with *Asgand* as one of the ingredients. The raw materials,

intermediates obtained during the preparation of Kushta and the final product were characterized using modern analytical techniques like Fourier transform infra-red spectroscopy, X-ray powder diffraction, and thermo-gravimetric analysis (Khan et al., 2012). The study showed that the miner gaodanti (Calcium sulphate dihydrate) is converted into calcium sulphate hemi hydrate on first calcination in earthen pot sealed with the process *gil-e-hikmat*. Further on calcination, this intermediate is transformed to Kushta-e-gaodanti which is orthorhombic α -calcium sulphate anhydride. The study confirmed that the characterization techniques adopted here can be used as quality control methods for characterization of samples in industry to check uniformity of the samples marketed by manufacturer and also help in building confidence in use of such products for medication. Similar kind of physico-chemical analysis and development of SOPs for the preparation of other polyherbal formulations are also needed for getting optimal efficacy of the medicine.

Conclusions

In Unani system of medicine, Asgand is used both as single drug and also as a constituent of polyherbal drugs due its multi-fold therapeutical properties. Centuries of Unani medical experience of using Asgand have revealed that it can be used for several ailments of different body organ systems. Most of the Unani physicians have opined that compound preparations may be preferred to achieve various objectives and to treat the body as a whole. This is because of the fact that the combined effect of a poly-mixture compound preparation is due to pharmacodynamic and pharmacokinetic interactions amongst the various chemical constituents. However, detailed scientific studies on each of the polyherbal formulations are needed to understand the mechanism of correction of toxicities of toxic drugs, pathways of drug absorption, mechanism of treatment of complex diseases etc. Scientific evaluation of physico-chemical properties, therapeutic action of formulations could build further confidence in the Unani medicines.

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Ashwagandha in Homoeopathy System of Medicine

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Introduction

Homoeopathy, founded by Samuel Hahnemann in the late 18th century, is a holistic system of medicine based on the principle of "like cures like." This means that a substance that can produce symptoms in a healthy individual can be used in minute doses to treat similar symptoms in a sick person. The fundamental concept of Homoeopathy revolves around the idea that the body has an inherent ability to heal itself, and the role of the Homoeopathic remedy is to stimulate this vital force.



Human drug proving also known as Homoeopathic Pathogenetic Trial (Mehra *et al.*, 2017) is a meticulous process in Homoeopathy where carefully selected healthy volunteers, called provers, are exposed to a substance to document the physical, mental, and emotional symptoms it induces. These symptoms, meticulously recorded, form the foundation of the remedy's unique symptom picture. The proving process, adhering to Hahnemann's principles of minimal doses and repeated observations, results in potentized remedies. This dynamic approach considers not just the physical properties of the substance but also its energetic aspects, contributing significantly to the expanded and refined understanding of remedies in the Homoeopathic *Materia Medica*.

Unlike conventional medicine, Homoeopathy focuses on individualized treatment, considering not only the physical symptoms but also the mental and emotional state of the patient. Remedies are prepared through a process of potentization, involving serial dilution and succussion, which imparts therapeutic properties while minimizing toxicity.

In India, plants have been the quintessential protagonists, offering humanity a treasury of remedies through different indigenous systems of medicine. For instance, it is estimated that there are around 7,263 medicinal plants species being used in Indian systems of medicine and among them around 460 species are used in Homeopathy (NMPB and FRLHT, 2010). Among the pantheon of botanical healers, *Withania somnifera* or *Ashwagandha*, emerges as a stalwart contributor to the traditional systems of medicine. For instance, in Ayurveda, *Ashwagandha* is bestowed with the title of 'Rasayana', signifying its prowess in promoting health, arresting ageing, and enhancing resilience to adverse environmental conditions. The herb owes its therapeutic potency to steroidal lactones, primarily the Withanolides derived from its roots, which orchestrate a symphony of healing activities. These activities encompass immunomodulation, anti-cancer effects, anti-epileptic properties, anti-ageing benefits, and potent antioxidant activity (Mikulska *et al.*, 2023). It has inhibitory effects on the abnormal growth of the central nervous system, lung, colon, and breast cell ailments. The extract derived from *Withania somnifera* has shown efficacy in preventing tumour development in individuals with cancer (Palliyaguru *et al.*, 2016). Research indicates that

ashwagandha possesses various beneficial properties, including anti-inflammatory, osteoarthritis, antistress, antioxidant, immunomodulatory, hemopoietic, and rejuvenating characteristics (Elgar, 2021). Additionally, it seems to positively impact the endocrine, cardiopulmonary, and central nervous systems (Zahiruddin, 2020). Moreover, it enhances overall health and is recommended as a rejuvenating remedy for the elderly (Joshi and Joshi, 2013). Rooted in ancient wisdom and traversing cultural landscapes, Ashwagandha has not only woven itself into the fabric of Ayurveda but has also found resonance in the realms of Siddha, Unani, Homeopathy, Chinese herbalism and other global healing traditions. It is reported in the revised edition of Homeopathic Pharmacopoeia of India (Anonymous, 2016) that the History and Authority for Ashwagandha is “Drugs of Hindooostan” by Dr. S. C. Ghose (Ghose, 1937).



Uses of Ashwagandha in Homeopathy

Ganguly (1922) reported that Ashwagandha has been employed successfully in all cases of debility, nervousness, brain fatigue, loss of memory, spermatorrhea, problems resulting from masturbation, speedy emissions, and nocturnal emissions.

In Homeopathy Materia Medica, uses Ashwagandha for treating alcoholism, AIDS, Alzheimer's disease, anemia, arthritis, asthma brain fatigue, breathing difficulty, bronchitis, cancer carbuncles, convalescence, coughs, emaciation, emphysema, hyperglycemia, immune disorders, impotency, infertility, insomnia, lumbago, memory loss, nerve weakness, paralysis, rheumatism, sexual debility, spermatorrhea, skin disorders, swollen glands, tuberculosis, tumors, ulcers, and weakness are mentioned.

Some guiding indications for Ashwagandha in Homoeopathic Materia Medica are listed below:

	Symptoms
MIND	Confused. Cannot collect his thoughts. Loss of memory Brain fatigue Indifferent, Sadness, low spirits
BACK	Pain in back
EARS	Whizzing noises
LIMBS	Great debility
EYES	Blue margins around eyes. Painful in the morning. Weak sight
FACE	Pale, flushes of heat
FEMALE	Infertility, Low sex drive
FOOD	Desires sweets, and sugar
HEAD	Dull headache with buzzing in the head
HEART	Palpitation
LUNGS	Respiratory disorders. Emphysema, Asthma, Bronchitis and coughs
MALE	Impotency, Low sex drive, Masturbation, Spermatorrhoea, Emissions at night and stool.
SLEEP	Lascivious dreams with emissions
STOMACH	Pressure as from a load, with drowsiness, nausea, and vomiting.
URINE	Frequent desire to urinate. Burning urination.
VERTIGO	Vertigo on standing or walking

Homeopathic formulation of Ashwagandha

In Homeopathy, roots of Ashwagandha are used to prepare a mother tincture, a form of homeopathic drug preparation. The mother tincture is a liquid extract, which is prepared by the process in which the soluble and active constituents of a drug are extracted with the help of an appropriate solvent (alcohol and distilled water). The method of preparation of Mother tincture and successive dilutions fixed for Ashwagandha by Homeopathic Pharmacopoeia of India (Anonymous, 2016) is follows:

The coarse powder of dried roots of Ashwagandha are used. One hundred gram of the powder is taken in conical flask of suitable size and 250 ml of purified water and 800 ml of strong alcohol are added to make one liter of the mother tincture of drug strength of 1/10. This mother tincture will act as source for preparation potencies. Potency refers to the strength of the homeopathic medicine. The prescribed potencies for Ashwagandha are 2x (1 ml of mother tincture and 99 ml of dispensing alcohol) and higher with dispensing alcohol. These potentialized drugs are used for conditions related to stress, anxiety, fatigue, and overall well-being. However, it is important to note that the specific use may vary based on individual symptoms and constitutional factors.

Homeopathic Pathogenetic Trials of Ashwagandha

In Homeopathy, proving of a drug also termed as Homoeopathic Pathogenetic Trial (HPT) is a unique and important process in which drug substances are put into trial on healthy human volunteers and their pathogenetic effects are observed, noted, and compiled as the first step to introduce the drug in the Homoeopathic Materia Medica. The literature survey indicates that the drug proving studies related to symptomatology of Ashwagandha are lacking (www.provings.com). The first published drug trial of *Withania somnifera* was carried out by Marisa Laidlaw at the Durban University of Technology, as a randomized, double-blind, placebo-controlled study carried out with 30 subjects (Laidlaw, 2017). The proving of *Withania somnifera* 30CH produced a total of 282 symptoms, the majority of which were represented in the MIND, DREAMS, HEAD and GENERALS sections of the repertory. Subsequent to this, Pillay (2017) conducted a study for homoeopathic C4

trituration proving of *Withania somnifera* with a subsequent comparison to the conventional 30CH proving of *Withania somnifera* which was conducted by Laidlaw (2017). The C4 trituration proving yielded 145 rubrics. The majority of the rubrics were produced in the MIND and HEAD sections.

In India, Mehra and others (2017) conducted a multi-centre, randomised, double-blind, placebo-controlled trial at Central Council for Research in Homoeopathy (CCRH). The symptoms and signs manifested during this proving of Ashwagandha trial were noted down by the provers, elaborated by the proving masters and the data compilation at proving-cum-data processing cell of CCRH. The symptoms have been manifested predominantly in 30C potency. It is also reported that the important objective symptoms which can be considered as the effect of the drug are mainly pertaining to upper respiratory tract infection and fever usually occurs due to inflammation. The symptoms related to coryza and cough are the effects of the drug substance and they may be considered as characteristic symptoms. Mehra and others (2017) also recorded that apart from the subjective symptoms, the objective findings reflect that the drug has an effect on the left-sided renal calculi, ovarian cysts, and helminthic invasion. The dissolution of renal concretions and appearance of calcium oxalate and amorphous phosphate crystals in urine during terminal medical examination may be considered as the curative effect in the renal concretions, and pathogenetic effect of the drug in appearance of calcium oxalate and amorphous phosphate crystals. Similarly, in case of ovarian cysts and helminthic invasion, the curative and pathogenetic effect of the drug has been noted. Thus, these effects of the drug have left the clues to explore the utility of this drug in such metabolic disorders and helminthic diseases.

An open clinical study on the efficacy of *Withania somnifera* mother tincture in the management of hyperlipidemia was conducted by Adi and Reddy (2019). The results obtained in this study suggest that *Withania somnifera* has the hypcholesteremic effect and could be mediated through an increased bile acid synthesis for elimination of body cholesterol. Therefore, *Withania somnifera* mother tincture could be considered as a supplement for treatment of dyslipidemia. The increased hepatic antioxidant activities in *Withania somnifera* homoeopathic mother tincture administered people indicate that fiber,

phytosterols, polyphenols, flavonoids. and vitamin C in *Withania somnifera* homoeopathic mother tincture could contribute to amelioration of the hyperlipidemic conditions. However, further researches are required to clarify the mechanism of this effect (Adi and Reddy, 2019).

Pre-clinical works of Homeopathic Ashwagandha formulations

In Homeopathy, there are a number of medicines prepared using different plants are being clinically used/verified for reducing the severity of or completely eliminating a wide variety of ailments on the basis of subjective and objective symptoms of individual patient. In addition, research in Homeopathy has been limited either for its proving in healthy human volunteers or to its clinical verification/clinical efficacy in diseased individuals. However, in medical science, one of the most important fundamental prerequisites for the introduction of a new drug or formulation in clinical practice is to evaluate thoroughly the therapeutic efficacy, mode of action, metabolic pathway, and the level of safety of the drugs in laboratory animals through pre-clinical trials. Thus, to establish a scientific basis for actions of Homeopathic medicines, there is a need for experimental research by conducting a series of experiments both in vitro and in vivo models. In recent years, there has been an increased trend in the number of pre-clinical studies aimed to evaluate the pharmacological activity produced by homeopathic medicines (Gupta et al., 2018). However, only a few such pre-clinical studies related to Ashwagandha are reported. For instance, Navinder and others (2013) conducted a study to pharmacologically screen Homeopathic Ashwagandha formulation for Antidiabetic activity. They used Ashwagandha leaf homeopathic formulation of Potency Q, 30 and 200; and they recorded significant pharmacological effect in animals (Rats). They also reported that *Withania somnifera* shows significantly positive antidiabetic activity when compared with Glibenclamide and Glimepiride as standard antidiabetic drug. According to them the antidiabetic effect of Ashwagandha formulation may be due to increased hepatic metabolism, increased insulin release from pancreatic beta cells and/or insulin sparing effect.

Dummer (2003) conducted a controlled *in vitro* study to establish the efficacy of *Withania somnifera* in herbal tincture, and 1 X and 6X homoeopathic dilutions (in

62% v/v ethanol) as an antimicrobial agent *Bacillus cereus*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Escherichia coli* and *Staphylococcus aureus*. The results of the experiment showed that *W. somnifera* in herbal tincture, 1X and 6X dilutions was ineffective as an in vitro antimicrobial agent. Dummer (2003) concluded that a less diluted tincture produced could be more effective in screening for antibiotic sensitivity of a plant.



Conclusions

Ashwagandha has long been revered as a superb rejuvenator, a general health tonic, and a treatment for a variety of ailments in Ayurveda, Siddha and Unani systems of medicine; However, their utility in the Homoeopathy system of medicines is underutilized. The signs and symptoms produced in the Human Pathogenetic Trials must undergo comprehensive clinical verification, confirming their therapeutic effectiveness. Also, there is a need for pre-clinical studies to be conducted at a larger

scale. The current studies, although trivial in number, promise a significant potential for future research on Ashwagandha in Homoeopathy. The research areas include the fundamental research topics such as pharmacodynamic actions of potentized dilutions, phytochemical properties, and active ingredients of *Withania somnifera* as well as other clinical research domains such as extensive Homoeopathic Pathogenetic Trials (HPTs) which are the primary source of collection of data in Homoeopathic literature. There is a need for the conduct of quality evidence-based research in this domain.

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Amukuram (*Withania somnifera*) in Naatu Vaidyam (folk medicine) of Kerala State

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Introduction

Traditional medicine includes diverse health practices, approaches and knowledge incorporating plant, animal, and/or mineral-based medicines, manual techniques and exercises, applied singly or in combination to maintain well-being, as well as to treat, diagnose or prevent illness (WHO, 2002). Traditional medicine and practices can be broadly classified into codified systems and non-codified systems (Payyappallimana, 2010). Ayurveda, Siddha, Unani, Chinese and Tibetan systems of



medicine are the examples for codified systems. The body of knowledge of each of these systems are available in documents, such as, pharmacopoeias and ancient scriptures. On the other hand, non-codified systems of traditional medicine represent those transmitted by oral means and is mostly acquired through trial-and-error approaches. The non-codified system of traditional medicine is diverse and varies with geography, local flora and culture. It was developed in accordance with primary needs and locally available resources of a particular region. The system differs from one region to the other and is known by various names like indigenous medicine, ethnomedicine, bush medicine, little traditions, folk/folklore medicine and many more. In Kerala, the Naatu Vaidyars who represent the ancient folk medicine practitioners played a pivotal role in preserving and passing down their invaluable knowledge through generations, ensuring the survival and relevance of locally developed system of medicine in modern times (Unnikrishnan, 2017).

Like in any other system of folk medicine, in Naatu Vaidya system historically the knowledge was transmitted orally from masters to disciples. This method ensured a deep, personalized understanding of principles, practices, and therapies in folk medicine. Many Naatu Vaidyas, also prepared manuscripts of their herbal formulations, treatment techniques and dietary regime and physical exercise, on palm leaves (Thaliyolas). Subsequently, the vast collection of knowledge embedded in thaliyola manuscripts, in some cases, were written or printed in papers; while many remained in Thaliyolas. For instance, there are many renowned traditional texts of indigenous medicines such as Vaidya Manorama (Parameswaran Moosad, 1931), Vastipradipam (Krishnan Vaidyan, 1929)), and Agadam Amrutam (Shine Vaidyar, 2013). In these and many other traditional manuscripts effective medicinal virtues of Ashwagandha (Amukuram) are highlighted. The author himself is possessing a collection of palm-leaf manuscripts written by his grandfather Shri Velayudhan Vaidyar, in which use and mode of usage of Ashwagandha in treatment of different ailments are documented, and some of them are presented in this Chapter.

Therapeutic and remedial uses of Ashwagandha

Ashwagandha holds a highly esteemed place in both folk and tribal healing traditions. Naatu Vaidyars treasured this plant for its effectiveness in alleviating



brain-related disorders, reducing swelling, enhancing immune function, regulating blood pressure, augmenting libido, and treating conditions related to bodily wasting. Nonetheless, it is primarily perceived by many as a restorative and healing remedy. Naatu Vaidyars also use Ashwagandha in the treatment of hysteria, amnesia and tremors. Ashwagandha also has immense use in the Kerala's traditional practices of poison treatment. Like traditional ayurveda practitioners, Naatu Vaidyars use Ashwagandha after purifying. The purification process, crucial for its internal use, involves boiling the roots in milk and then drying before use. This process is important to avoid the potential damage to liver and stomach due to prolonged or excessive intake of Ashwagandha. Conversely, when Ashwagandha is incorporated in formulations intended for external application, this particular purification step is omitted. Some of the single drug and compound formulations of Ashwagandha in Naatu Vaidyam and their uses are listed in Table 1.

Table 1. Use of Amukkara as single drug and compound formulations in Naatu Vaidyam (folk medicine) of Kerala State. (Source: Palm leaf manuscripts of Bhaskaran Vaidyar, now owned by the Author; Shine Vaidyar, 2013) *.

No.	Drug preparation and method of usage	Indication/s or Ailment/s	
1	After removing the inner fibre contents of Ashwagandha roots heat it with cow milk. Apply the warm liquid over the affected area of the patient's back	Relieving back pain associated with disc prolapse	
2	Crush the roots of Ashwagandha and spread it on a white cloth. Then fold the cloth into a shape of a torch, infuse it with a blend of oil and ghee, and then ignite it. Collect the oil that subsequently drips from this setup. Apply the oil on the affected parts	<ul style="list-style-type: none"> Effective for relieving pain due to poisoning and reducing swelling Beneficial for treating epilepsy, whether used internally or externally 	
3	Mix Ashwagandha root powder with milk and drink	<ul style="list-style-type: none"> For body rejuvenation and enhancing immunity For managing high thyroid levels, regulating white blood cells and platelets 	
4	Mix Ashwagandha root powder with honey, and lick or eat it	Reduces excess body fat and aids in shaping the body	
5	Make a powder by fine grinding purified Ashwagandha (1 part) and palm candy (3 parts).	Consume this blend mixed with cow milk in the morning and evening	Helps to treat nerve weakness
		Consume this blend mixed with ghee	Helps in brain development in individuals under forty years of age
		Consume this blend mixed with honey	Improves brain health of individuals above forty years of age
6.	Prepare a blend of ground almonds, Palm candy and Ashwagandha root powder mix it with boiled milk and drink	Promotes good sleep	

7	Mix Ashwagandha root powder (1 part) and crystal sugar or honey (6 parts), and boil with milk, and drink	Controls Parkinson's Tremors
8	Make a blend of root powders of Ashwagandha, Vayal Chulli (<i>Asteracantha longifolia</i>) Kurunthotti (<i>Sida alnifolia</i>), and wild cucumber. Mix this blend with high-quality cow's butter and consume	Manages reduced sperm count
9	Add Ashwagandha root powder in hot milk, cool it, and then curdling it to make curd. Melt the butter obtained from this curd into ghee and consume	Useful in treating ulcers in stomach and intestine, nerve disorders, and mental illnesses
10	Fry Ashwagandha in mustard oil, then grind it into a powder. Consume a spoonful of this powder or mix the powder with milk and use the paste as topical application	Beneficial for breast development and enhancing breast beauty
11	Fry Ashwagandha and sesame seed either in mustard oil or sesame oil and then ground into a powder. Make a paste with milk and apply topically	Promotes breast growth
12	Prepare pills (of gooseberry size) by grinding Ashwagandha root powder, Thippali powder (<i>Piper longum</i>) and induppu (rock salt) together, and consume the pills	Helps in prolonging ejaculation and increasing quantity of semen
13	Mix Ashwagandha root powder with drumstick seed powder, and consume with milk	Helps to increase the size of the male genitalia (penis)
14	Mix Ashwagandha root powder with drumstick seed powder, infuse in oil. Apply the oil on penis	Helps to increase the size of the penis
15	Mix root powders of Ashwagandha and Kurunthotti (<i>Sida alnifolia</i>) with honey, and lick or eat it	Useful as a post-natal care in strengthening vaginal muscles
16	Boil the mixture of the root powder of Ashwagandha and Kurunthotti (<i>Sida alnifolia</i>) and sesame seeds in milk and grind to a fine consistency. Apply the paste to the naval area	Offers effective relief in cases of uterine prolapse or postnatal involuntary urination

17	Prepare a finely ground mixture of roots of Ashwagandha, Kurunthotti (<i>Sida alnifolia</i>) and stem pieces of Chengalam parranda (<i>Cissus quadrangularis</i>) and fry the mixture in ghee. Later add stem bark powder of Neermaruthu (<i>Terminalia arjuna</i>), Kolarakku (lac of Laccifer lacca insect) and purified Guggulu (resin of <i>Commiphora wightii</i>) and make pills and consume	Offers targeted relief for discomfort associated with bone fractures
18	Prepare a blend of root powder of Ashwagandha and earthworm with breast milk. Give this blend to infants to lick	This medicinal blend is known to effectively alleviate various childhood illnesses.
19	Infuse root powder of Amukuram into egg yolk oil to get a medicinal oil. and apply it to the affected parts	Has the rapid healing property and thus effective in treating various conditions resulting from injuries.
20	Grind the roots of Ashwagandha and Palmutukk (<i>Ipomoea mauritiana</i>) together to get a blend. Woman who has recently given birth can consume this blend by mixing with milk	Effective for increasing breast milk
21	Eat daily two or three fresh leaves of Ashwagandha	Helps to reduce excessive body weight
22	Make a paste of the roots of Ashwagandha and Shankupushpi (<i>Clitoria ternatea</i>) and consume it	Helps to reduce mental stress
23	Prepare a mixture of root powder of Ashwagandha, Chukku (dried ginger), fruit powder of Kurumulaku (<i>Piper nigrum</i>) Tippali (<i>Piper longum</i>) and rock salt, and consume	Beneficial for severe cough, chest pain, and mucosal congestion
24	Make a hole in the trunk of a Kanjiram tree (<i>Strychnos nux-vomica</i>) fill it with root powder of Ashwagandha and seal it with wax. After certain stipulated days, take out the Ashwagandha powder from the tree trunk hole and apply externally as an ointment.	Effective in poison treatment, especially for cobra venom.

25	Make a hole in the trunk of a Koovalam tree (<i>Aegle marmelos</i>)/ Ungu tree (<i>Pongamia pinnata</i>) fill it with root powder of Ashwagandha and seal it with wax. After certain stipulated days, take out the Ashwagandha powder which can be taken internally	Effective as an internal medicine in poison treatment, especially for cobra venom
26	Make a hole in the trunk of a Muringa tree (<i>Moringa oleifera</i>) fill it with root powder of Ashwagandha and seal it with wax. After certain stipulated days, take out the Ashwagandha powder which can be taken internally	Effective in poison treatment, particularly to revitalizing the inactive cells
27	Grind equal quantity of roots of Neelayamari (<i>Indigofera tinctoria</i>) and Ashwagandha and mix the powder with milk and administered to the patient	Effective treatment of snake venom
28	Prepare a fine powder of roots of Ashwagandha, dried ginger, black pepper, long pepper, rhizome of Vayambu (<i>Acorus calamus</i>) roots of Vaka (<i>Albizia lebbeck</i>), and trunk of Chandanam (<i>Santalum album</i>), and make a paste using pure water. Administer the paste to the patient.	For treating cobra venom poisoning
29	Prepare a paste of root powder of Ashwagandha and Kolarakku (lac of Laccifer lacca) and apply on the affected parts	For the treatment of spider venom
30	Prepare a fine powder of roots of Ashwagandha and Ishwar mooli (<i>Aristolochia indica</i>). Apply the powder on the affected area	Effective in counteracting poison
31	Prepare a concoction of Karinochi (<i>Vitex negundo</i>) water, root powder of Ashwagandha, and castor oil and boil it. This drug can be taken internally	<ul style="list-style-type: none"> • An effective antibacterial agent • Aids in purging impurities from the stomach, thereby facilitating easy bowel movement

32	Mix root powder of Ashwagandha in virgin coconut oil and sun -dry for seven days. Apply this oil over the affected parts	<ul style="list-style-type: none"> • Effective in treating various skin diseases, notably alleviating itching • Beneficial for conditioning the dry skin
33	Boil together the juice of Thottavadi (<i>Mimosa pudica</i>) leaves, Ashwagandha and turmeric powder. Apply the cooled drug on the affected parts	Useful to treat various skin diseases

* , The medical treatments mentioned here are only for the information, and should not be taken as prescriptions. It is advised to consult the Author.

In summary, the remarkable properties of Ashwagandha, as revealed through this article, underscore the immense multiple potential of this herb in overall health care. The versatile applications of Ashwagandha in Naatu Vaidya system of Kerala, from treating skin conditions to managing the health and functions of other body organs highlight the need for further exploration, scientific evaluation and integration into contemporary medicine. As we continue to uncover the depths of Ashwagandha's benefits documented in traditional systems, we can go deep to treasure out the enduring wisdom of our ancestors in using diverse plants for medicine.

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Crop yield and economics in cultivation of Ashwagandha (*Withania somnifera*): A Review

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Introduction

Ashwagandha (*Withania somnifera*), a popular medicinal herb is witnessing a remarkable surge in demand, propelling rapid growth of its market. With the growing demand for Ashwagandha in sectors such as herbal medicine, pharmaceuticals, cosmeceuticals, and nutraceuticals, it is becoming an opportunity for Ashwagandha growers to capitalize on this trend. It is estimated that the annual requirement in Indian market stands at approximately 7000 tonnes, while India's estimated production is just 1,500 tonnes. Similarly, as per market.us (2024), the global Ashwagandha market is expected to grow at a CAGR (Compounded Annual Growth Rate) of 10.9% from 2022 to 2032. In 2022, Ashwagandha market was valued at 433 million USD which is expected to increase to 1,187 million USD by 2032 (Figure 1).

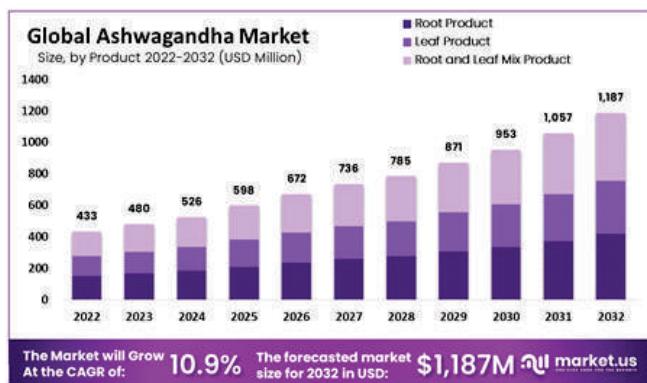


Figure 1. Global Ashwagandha Market trend. (Reproduced from market.us, 2024).

Overall, 97% of Global Ashwagandha products are root based. Recently leaf based Ashwagandha products are also gaining attention in the international market. Ashwagandha processed products are available in the market in various forms such as powder, liquid and capsule. Among these, powder form has the largest market share. The substantial disparity between demand and supply underscores the need to expand Ashwagandha cultivation and adopt new, high-yielding varieties for commercial production to meet the industry's demand. In fact, as early as in 1950s, the need and scope of commercial cultivation of Ashwagandha in India to cater the domestic requirement has been stressed (Kaul, 1957). Since then, various studies have been conducted for standardizing cultivation of Ashwagandha either in sequence/intercropping or as sole crop, optimising spacing, seed rate, fertilizer etc., comparing growth and yield of different varieties of Ashwagandha, assessing crop yield and economics of ashwagandha, analysing market trends, and forecasting internal and global marketing opportunities. The present paper is aimed to review such studies and to provide cultivation practice of Ashwagandha suggested by National Medicinal Plants Board.

Crop yield and economics of sole crop cultivation of Ashwagandha

Ashwagandha is a drought hardy crop, which requires dry climate for better development and winter low temperatures to improve the root quality and yield (Kahar *et al.*, 1991). Therefore, it grows well in dry parts of Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra, and Madhya Pradesh. In forests and other areas of Vindhyan Region of Uttar Pradesh, Ashwagandha is found as wild. Thus, Anand and others (2014) conducted experiments to assess the crop yield and economics of cultivation continuously for six years (2005- 2011) at several sites of the Sonbhadra District of Uttar Pradesh. All these experiments were conducted in Front Line Demonstration (FLD) sites where researchers and farmers jointly involved in planning, execution, and monitoring of the demonstrations in the farmers' field. Broadcast sowing was done with 12 kg per hectare seed rate. JA - 20 and Nagauri varieties were used for the cultivation during 2006-07 and 2007-08, respectively, Whereas, JA- 134 variety was used continuously during next four years (2008-09 to 2011-12). Manual weeding and thinning were done to control the plant population and weeds. Cultivation was done under normal field conditions by the

farmers without any special input (manures, fertilizers, irrigation etc.) and treatment. The overall average dried root and seed yield recorded 414 kg per ha and 51 kg per ha, respectively. The mean cost of cultivation, gross return and net return per ha were Rs. 10,369, Rs. 41,728 and Rs. 31,359 respectively, with B:C ratio of 4.02. These results prompted the project team to conclude that Ashwagandha crop is most suitable for rainfed conditions of district Sonbhadra. It can be grown as a cash crop to get better profit from poor fields with low cost, lesser efforts, and less skill.

Ashwagandha is found as wild in Nagaur, Bikaner and Kota Districts of Rajasthan. It is also cultivated in these region where sandy loam or light red soil having a pH of 7.5 to 8.0 with good drainage is prevailing. Ashwagandha being a *kharif* crop (monsoon/autumn crop) its sowing is done from mid-July to mid-August. Field preparation is done in the month of June in which 2-3 deep ploughings are essential. According to Sharma (2016), in these area the average seed rate was found to be 20-25 kg per hectare; use of the higher seed rate was a risk mitigation technique of farmers in cases of low or untimely rainfall. Sharma (2016) worked out the economics of cultivation of Ashwagandha in Ramganj Mandi, Kota district. According to him, the net return was Rs. 20,760 per ha. The cost of cultivation and gross return were d Rs. 14,240 per ha, Rs. 35,000 per ha respectively, with B:C ratio



of 2.46. Based on this study, Sharma (2016) concluded that cultivation of Ashwagandha in Kota District of Rajasthan can help farmers in rain-fed areas to earn a decent level of profit. In addition, the commercial cultivation of Ashwagandha can be promoted as a potential agri-business viable option if proper facilities of processing and market linkages could be developed in the region.

Choudhary and others (2020) reported that the average yield of Ashwagandha roots obtained by 100 growers in Kurnool and Anantapur Districts of Andhra Pradesh was 691 kg per ha. and seeds 201.8 kg per ha. According to them, the total cost of cultivation, gross return and net return were Rs. 28,749 per ha, Rs. 1,17,185 per ha and Rs. 88,436 per ha respectively, with B:C ratio of 3.08. From this study, they concluded that cultivation of Ashwagandha is a profitable venture for the farmers of the study area. The cultivation may also open up new avenue for agri-entrepreneurship by promoting the processing of Ashwagandha roots into powder and extraction of chemical alkaloids for export market. The cultivation of Ashwagandha also promotes conservation of natural resources, as it can be easily cultivated in rain-fed condition.

In Begusarai District of Bihar, farmers are getting attracted to large-scale cultivation of Ashwagandha due to ease of its cultivation and high price of the Ashwagandha root (Das et al., 2021). A comparative study for economics of Ashwagandha over major cereal crops in Bihar showed that the percentage of net return of Ashwagandha cultivation is 38.60%, 51.28% and 44.27% higher than that of rice, wheat and maize respectively. The benefit-cost ratio of Ashwagandha cultivation is 2.62 suggesting its higher profitability. Ashwagandha cultivation is also economically viable with 17.56%, 24.05% 27.10% higher B:C ratio in comparison to the existing crops like rice, wheat and maize respectively. Thus, according to Das and others (2021) little efforts and investment help the farmers of Bihar to fetch good yield (625 kg per ha) and net profit (Rs. 58,017 per ha) from Ashwagandha cultivation.

Crop yield and economics of Ashwagandha under intercropping system

Intercropping is an agricultural system that improves land use efficiency through simultaneous cultivation of different crops in the same field using functional

complementarity to increase resources utilization, and nutrient-use efficiency (Snapp *et al.*, 2010). With a view to study different intercrops with ashwagandha and its effect on growth and yield, Ahirwar and others (2019) conducted an experiment during Kharif season at the Research farm, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur in Madhya Pradesh. The component crops selected were red gram [*Cajanus cajan* (L) Millspp], green gram (*Vigna radiata* Wilczek), sesame [*Sesamum indicum* (L)], niger [*Guizotia abyssinica* (L.F.)] and soybean [*Glycine max* (L.) Merr.], and they were used with ashwagandha in the intercropping experiments. The variety of Ashwagandha, red gram, green gram, soybean, sesame and niger were JA-134, ICPH-2671, K-851, JS 97-52, TS 8, and JNC-1 respectively. The seed rate was Ashwagandha (5 kg per ha) red gram (10 kg per ha) green gram (25 kg per ha), soybean (50 kg per ha), sesame (2 kg per ha) and niger (2 kg per ha). Experiment was also designed with two intercropping systems. The first system was with three rows Ashwagandha followed by one row intercrops, and the second system was four rows Ashwagandha followed by one row intercrops, with spacing 30 x 15 cm between sole and intercrops. Based on two years mean data, sole crop of Ashwagandha produced significantly higher yields of root (518 kg per ha) and seed (86 kg per ha) over other intercropped stands. Based on data of two years, Ashwagandha + red gram intercropping system



led to record Ashwagandha Equivalent Yield (AEY) of 627 kg per ha and 625 kg per ha in 3:1 and 4:1 row proportion, respectively which were numerically higher than sole Ashwagandha stand (609 kg per ha). Amongst the intercropping systems of Ashwagandha with red gram gave the maximum net income up to Rs. 1,29,760 per ha with B:C ratio 5.81 in 3: 1 row ratio and Rs 1,29,037 per ha with 5.74 in 4:1 row ratio. This was followed by sole Ashwagandha Rs 1,24,140 per ha with 5.42 B:C ratio (Ahirwar *et al.*, 2019). The Investigators concluded that Ashwagandha and red gram intercropping system is ideal as there is mutual co-operation between the crops for their co-existence and due to higher market value of red gram.

Crop yield and economics of Ashwagandha in Agroforestry system

Agroforestry is practiced by small and marginal farmers in the Western Himalayas. Where as in the recent past inclusion of medicinal and aromatic plants in agroforestry land use system has increased due to increased demand by pharmaceutical industries. Commercial cultivation of ashwagandha is restricted to plains only. However, considering the increasing trend of demand for ashwagandha by pharmaceutical and nutraceutical sectors, and economic benefits of cultivation ashwagandha to the farmers, Verma and Thakur (2010) carried out a study in mid hills of Western Himalayas to find out the potential returns from Ashwagandha based agroforestry systems involving fruit, fodder, and grass component. Ashwagandha was grown in association with *Prunus persica* (Peach), *Grewia optiva*, *Morus alba* and *Setaria sphacelata*. The tree-crop combinations (agroforestry systems) formed were, Peach + Grewia + Setaria + Ashwagandha, Peach + Morus + Setaria + Ashwagandha, Peach + Setaria + Ashwagandha, Grewia + Setaria + Ashwagandha, Morus + Setaria + Ashwagandha, and Ashwagandha as sole crop. Ashwagandha was cultivated following recommended agrotechnological practices. Ashwagandha root yield and financial returns in different crop combinations are given Table 2. The maximum root yield, net returns, and BC ratio (Benefit-cost ratio) of Ashwagandha were obtained in Morus+ Setaria+ Ashwagandha agroforestry, and is followed by Grewia+ Setaria+ Ashwagandha agroforestry system. Thus, the investigator concluded that cultivation of Ashwagandha as intercrop under Morus, Grewia and Seteria based agroforestry systems under rain fed areas could be profitable for farmers.



Table 2. Dry root yield and economic returns from Ashwagandha in different agroforest systems and as sole crop. (Based on Verma and Thakur, 2010).

Tree-crop combinations	Dry root yield (kg ha ⁻¹)	Cost of cultivation (Rs. ha ⁻¹)	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	BC Ratio
Peach + Grewia + Setaria + Ashwagandha	364	9,007	27,651	18,644	3.07
Peach + Morus + Setaria + Ashwagandha	363	9,007	28,101	19,094	3.12
Peach + Setaria + Ashwagandha	347	9,007	29,093	20,086	3.23
Grewia + Setaria + Ashwagandha	332	9,007	32,155	23,148	3.57
Morus + Setaria + Ashwagandha	385	9,007	34,857	25,850	3.87
Ashwagandha as sole crop	331	9,007	27,561	18,554	3.06

Crop yield and economics of Ashwagandha under varying plant density

Ashwagandha grows profusely up to one m height and spreads fairly under natural conditions in suitable locations. However, when it is cultivated as a crop, it is necessary to optimize its plant population for enhancing the productivity and quality of its roots. Few experiments have been conducted to optimize the plant spacing in *Ashwagandha* by researchers to establish it as a winter crop and to cultivate under rainfed conditions (Farooqui *et al.*, 2001; Aggarwal *et al.*, 2004). For instance, Singh and others (2003) compared the dry root yield, net economic return and BC ratio value for Ashwagandha planted at planting density of 20,600 plants per ha and 10,300 plants per ha, and found that the values for all the parameters are higher in the plots where planting density was 20,600 plants per ha (Table 3).

Table 3. Dry root yield and economic returns from Ashwagandha at different planting density under rainfed conditions of sub-tropical North India. (Based on Singh *et al.*, 2003).

Planting density (plants/ ha)	Dry root yield (kg per ha)	Cost of cultivation (Rs. per ha)	Gross return (Rs. per ha)	Net return (Rs. per ha)	BC ratio
10,300	390	8,000	19,500	11,500	1.44
20,600	600	9,000	30,000	21,000	2.33

In another experiment conducted in fields with rainfed conditions in Northern Dry Zone of Karnataka, Kubsad and others (2009) found that Ashwagandha planted in wider spacings produced significantly higher yield and economic returns, which was mainly due to better resource availability and reduced interplant competition in the community (Table 4). There was significantly higher dry root yield (1415 kg per ha) of ashwagandha at closer spacing (15x 10 cm) with 9.0, 35.7 and 51.4 per cent higher than in 15x5 cm, 30x10 cm and 45x 10 cm spacings respectively. The closer spacing of 15x 10 cm realized the highest net returns of Rs. 46,814 per ha due to maximum dry root yield. This was followed by 15x5 cm which gave a net returns of Rs. 41,471 per ha. Maximum benefit :cost ratio (5.76) was recorded at 15x 10 cm spacing which was significantly higher than in other spacings (Table 4).

Table 4. Dry root yield and economics of Ashwagandha as influenced by spacings planted under rainfed conditions of Northern Dry Zone of Karnataka. Values for a given parameter with different letter on the superscript are significantly different (P=0.05). (Source: Kubsad *et al.*, 2009)

Spacing	Plant density (plants per ha)	Dry root yield (kg per ha)	Net Return (Rs. Per ha)	BC Ratio
15x5 cm	13,33,333	1,288 ^b	41,471 ^b	5.13 ^b
15 x10 cm	6,66,667	1,415 ^a	46,814 ^a	5.76 ^a
30x10 cm	3,33,333	910 ^c	26,741 ^c	3.77 ^c
45x10 cm	2,22,222	687 ^d	17,836 ^d	2.85 ^d

Kaur and others (2021) conducted a field experiment at CSIR-CIMAP, Lucknow, Uttar Pradesh by sowing the seeds of *Poshita* cultivar of Ashwagandha in different line spacings to achieve various plant populations. The experiment comprised of eight plant populations. The root yield and economic returns of Ashwagandha cultivation as influenced by plant populations were estimated (Table 5). The dry root yield (1,030 kg per ha) and net return (Rs. 88,452 per ha) were significantly higher at plant population of 4,00,000 plants per ha. The plant population of 4,00,000 plants per ha also indicated the highest (2.51) B:C ratio, which was closely followed by 5,00,000 plants per ha (2.47) while, 10,00,000 plants per ha registered minimum (0.97) B:C ratio. Therefore, the investigators recommended to use plant population of 4,00,000 plants per ha for getting high productivity and profitability of Ashwagandha grown under subtropical plains of north India.

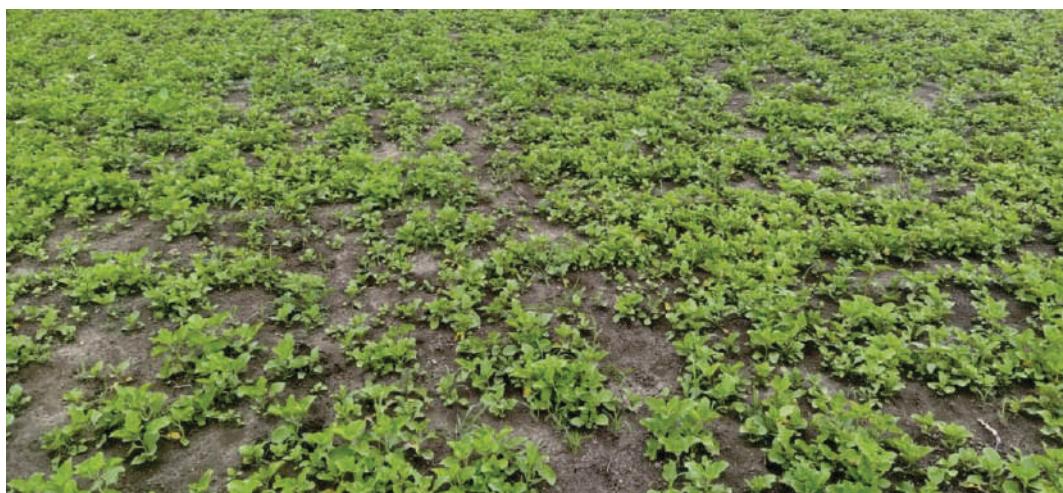


Table 5. Dry root yield and economic returns of Ashwagandha cultivated with different plant populations in sub-tropical plains of North India.
 (Source: Kaur *et al.*, 2021).

Plant population (plants ha ⁻¹)	Spacing (in cm)	Dry root yield (kg ha ⁻¹) [*]	Cost of cultivation (Rs. ha ⁻¹) [*]	Gross return (Rs. ha ⁻¹) [*]	Net return (Rs. ha ⁻¹) [*]	Benefit-cost ratio [*]
1,66,666	30x20	610 ^e	33,969 ^a	73,215 ^e	39,246 ^f	1.16 ^e
2,00,000	25x20	690 ^d	34,340 ^a	82,803 ^d	48,463 ^e	1.41 ^d
2,50,000	20x20	810 ^c	34,712 ^a	97,223 ^c	62,511 ^d	1.80 ^c
3,33,333	15x20	890 ^b	34,935 ^a	1,06,812 ^b	71,877 ^b	2.06 ^b
4,00,000	25x10	1,030 ^a	35,158 ^a	1,23,610 ^a	88,452 ^a	2.51 ^a
5,00,000	20x10	1,020 ^a	35,307 ^a	1,22,421 ^a	87,114 ^a	2.47 ^a
6,66,666	15x10	850 ^b	35,530 ^a	1,01,980 ^b	66,451 ^c	1.87 ^b
10,00,000	10x10	590 ^e	35,976 ^a	70,836 ^e	34,786 ^g	0.97 ^f

^{*}, Values with different letter on the superscript are significantly different (P=0.05)

Jat and others (2015), in the Extension Bulletin on Good Agricultural Practices for Ashwagandha suggested that the seeds sown by broadcasting or in the line in furrows should be thinned out by hands at 25-30 days after sowing to maintain a plant population of about 3 to 6 lakh plants per hectare.

Crop yield and economics in cultivation of different cultivars of Ashwagandha in India

In India, various research institutes and universities, such as CSIR-CIMAP, AAU, Anand; ICAR-DMAPR, Anand; RVSKV, Gwalior; IIHR, Bengaluru; CSIR-RRL, Jammu; KNK-College of Horticulture, Mandsaur have developed new, improved, high-yielding cultivars for large-scale commercial cultivation to meet the increasing demand for Ashwagandha. The comparative dry root yield of thirteen cultivars is given in Kabhiya and others (2023) (Table 6). All these cultivars vary in root yield; morphological features such as the colour of the fruits, plant height, leaf morphology, stem branching, capsule morphology, etc.; secondary metabolite content such as total alkaloid, total phenolics, total flavonoids, total tannins, Withanolide, and Withaferin-A (Kabhiya *et al.*, 2024).

Table 6. Dry root yield of different cultivars/varieties of Ashwagandha. (Source: Khabiya *et al.*, 2024).

	Cultivars	Dry root yield (kg per ha)
1.	CIMAP-Pratap	3,495
2.	NIMITLI-101	2,300
3.	Poshita	2,199
4.	NMITLI-118	1,500
5.	Rakshita	1,400
6.	CIMAP-Chetak	1,177
7.	Arka- ashwagandha	1,000
8.	CIM-Pushti	900–1,000
9.	Jawahar Ashwagandha134 (JA-134)	600–800
10.	Raj Vijay Ashwagandha (RVA100)	600–700
11.	Gujarat Anand Ashwagandha1 (GAA-1)	650
12.	Jawahar Ashwagandha20 (JA-20)	500–600
13.	VA-1	589

The 'Nagori Ashwagandha' is a local variety/ landrace, naturally grows in Nagaur district, and the boundary areas (Sikar, Jhunjhnu, Jodhpur, Bikaner and Churu) of Rajasthan State. The dry root yield of 'Nagori Ashwagandha' is around 1,520 kg per ha (Saran, 2023).

Pandey (2022) conducted a study in Jawaharlal Nehru Krishi Vishwa Vidyalaya at Jabalpur, Madhya Pradesh State to estimate crop yield and economics of cultivation of three cultivars of Ashwagandha (Table 7). The estimated dry root yield was more from Poshitha than from JA20 and JA134. The BC ratio of crop cultivation was more than 3.0 in all three cases, with higher value for Poshitha.

Table 7. Crop yield and economic returns of three different cultivars of Ashwagandha in Jabalpur, Madhya Pradesh. (Source: Pandey, 2022).

	Ashwagandha cultivars		
	JA20	JA134	Poshitha
Seed rate (broadcasting) (kg per ha)	7	7	7
Spacing	30cmx30 cm	30cmx30 cm	30 cmx30cm
Plant population (plants per ha)	1,10,000	1,10,000	1,10,000
Dry root yield (kg per ha)	700	680	920
Seed yield (kg per ha)	154	150	216
Cost of cultivation (Rs. per ha)	39,000	39,000	51,000
Gross monetary return (Rs. per ha)	1,63,100	1,58,500	2,16,400
Net return (Rs. per ha)	1,24,300	1,19,500	1,65,400
BC Ratio	3.18	3.06	3.24

It may be mentioned here that the crop yield and production of active chemical constituents may be affected by climate. Thus, multilocation studies for systematic scientific evaluation and validation of the released high-yielding cultivars of Ashwagandha in terms of crop yield, phytochemistry and pharmacological activities in different agroclimatic zones of India to determine the best suitable variety(es) for any particular geographical location are needed.

Crop yield and economics in Ashwagandha under integrated nutrient management

Integrated nutrient management system has vital significance for the maintenance of soil productivity and crop yield (Kafle *et al.*, 2019). In this management system, inorganic, organic and biological nutrient sources are used in optimum condition to achieve and sustain optimum yield without harming the soil ecosystem and environment (Verma *et al.*, 2005). Organic manure, particularly farmyard manure (FYM) is an important components of integrated nutrient management system, and they supply macronutrients, and micronutrients, for improving crop yield and physical, chemical and biological properties of soil (Dejene and Lemlem, 2012). Many researchers are attempting to formulate integrated nutrient management for increasing the productivity and production of Ashwagandha. For instance, Kumar and others (2009) performed a study to determine the effects of inoculation of *Azotobacter chroococcum* and *Pseudomonas putida* along with organic manure (OM) on yield and economic parameters of Ashwagandha (Rakshita cultivar) in a



farmer's field in Meerut District, Uttar Pradesh, India. In general, crop yield, net economic return and BC ratio increased significantly in response to organic manure application (Table 8). This response was enhanced further with bacterial inoculation. The combined effect of incorporation of organic manure ($2,000 \text{ kg ha}^{-1}$) and inoculation of *A. chroococcum* and *P. putida* resulted in the highest root yield ($1,185.6 \text{ kg ha}^{-1}$), net return Rs. $53,272 \text{ ha}^{-1}$ and BC ratio (3.32) followed by treatment where 1000 kg ha^{-1} of organic manure and *A. chroococcum* and *P. putida* are applied (Table 8). Thus, microbial inoculants can be used as an economical input to increase crop productivity, to maintain soil sustainability, and to increase economic return from crop cultivation.

Table 8. Crop yield and economic returns of Ashwagandha in response to integrated nutrient management. (Source: Kumar *et al.*, 2009).

Treatments	Root yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Net return (Rs. ha^{-1})	BC ratio
Control	778.90	130.76	6,188	1.40
Organic manure (OM): 1000 kg ha^{-1}	885.06	148.16	7,465	1.46
OM: 2000 kg ha^{-1}	905.90	154.23	2,068	2.24
OM 2000 kg ha^{-1} + <i>Azotobacter chroococcum</i>	1081.33	181.66	23,468	2.36
OM 2000 kg ha^{-1} + <i>Pseudomonas putida</i>	1100.66	184.56	34,040	2.69
OM 2000 kg ha^{-1} + <i>A. chroococcum</i> + <i>P. putida</i>	1185.60	208.13	53,272	3.32
OM 1000 kg ha^{-1} + <i>A. chroococcum</i>	1080.40	175.66	10,846	1.84
OM 1000 kg ha^{-1} + <i>P. putida</i>	1083.60	179.66	20,162	1.96
OM 1000 kg ha^{-1} + <i>A. chroococcum</i> + <i>P. putida</i>	1104.30	184.06	44,763	2.94

At the College of Agriculture, Jabalpur a study was conducted during Kharif season to assess the effect of integrated nutrient management on the yield parameters and cost economics of *Withania somnifera* (Cultivar JA-134) planted at a spacing $30 \text{ cm} \times 10 \text{ cm}$ (Kumar and Sahu, 2013). Based on this study, they reported that with the application of fertilizers ($40 \text{ kg N} + 20 \text{ kg P}_2\text{O}_5 + 20 \text{ kg K}_2\text{O ha}^{-1}$), the benefit-cost ratio of Ashwagandha cultivation is 2.3. On the other hand, the profitability was highest (BC

ratio: 2.66) under the treatment receiving 100% recommended dose of NPK fertilizers + 250 kg ha⁻¹ vermi-compost + 500 kg ha⁻¹ FYM + 20 kg ha⁻¹ ZnSO₄, followed by 50% recommended dose of NPK fertilizers + 250 kg ha⁻¹ vermi- compost + 500 kg ha⁻¹ FYM + 20 kg ha⁻¹ ZnSO₄, where the BC ratio was 2.46. Similarly, in another study conducted at the College of Agriculture, Tikamgarh, Madhya Pradesh, India by planting Jawahar Ashwagandha-20 (JA-20), Chaurasia and Singh (2022) concluded that 50% NPK ha⁻¹ + 500 kg FYM ha⁻¹ + 3 kg Azotobacter ha-1 + 3 kg PSB ha⁻¹ + 5 kg Zn ha⁻¹ treatment was found to be a better integrated as the root yield (629.69 kg ha⁻¹) and BC ratio (3.1) were significantly more as compared to the recommended dose (N: P:K; 50:30:30 kg ha⁻¹) of fertilizer application (root yield: 414.56 ka ha⁻¹; BC ratio: 2.74).

The effect of different organic sources of nutrients on quality and economics of Ashwagandha was assessed during *Kharif* in the College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Gujarat (Patel *et al.*, 2023). They applied recommended dose of nitrogen (RDN) in the form of farm yard manure, vermi compost, neem cake and poultry manure, and biofertilizers, such as, *Azotobacter*, potassium solubilizing microorganisms (KSM) and phosphate solubilizing bacteria (PSB) in different combinations and quantities. Based on the study, they concluded that the application of 80% RDN through poultry manure+ *Azotobacter* + KSM + PSB is found beneficial for obtaining higher yield of better quality roots (dry root yield: 558.96 kg ha⁻¹) and economic returns (BC ratio: 3.52) in Ashwagandha.

Conclusions

The growing demand for Ashwagandha in sectors such as herbal medicine, pharmaceuticals, cosmeceuticals, and nutraceuticals both at national and international level, is an opportunity for ashwagandha growers. Studies conducted by different researchers in different parts of India reveal that the benefit-cost ratio of Ashwagandha cultivation ranges from 2.3 to 5.8, suggesting its higher profitability, and that Ashwagandha can be cultivated both as a sole crop, and as mixed or intercrop with agriculture and horticulture crops. In India, over 13 cultivars of Ashwagandha have been developed. However, the crop yield and production of

active chemical constituents may vary with site factors and cultivars used. Thus, multilocation studies for systematic scientific evaluation and validation of the released high-yielding cultivars of Ashwagandha in terms of crop yield, phytochemistry in different agroclimatic zones of India to determine the best varieties for any particular geographical location are needed. Integrated nutrient management system has vital significance for the maintenance of sustainability and crop yield. Many studies recommended the integrated nutrient management by using organic manures along with inorganic fertilizers and biofertilizers both for improving physico-chemical and biological properties of soil and provide all the nutrients in available form to crop plants. The Integrated nutrient management also significantly contribute for enhancing better growth and finally the yield and quality parameters of Ashwagandha. By incorporating new research data on cultivation and crop management of Ashwagandha, preparation of a revised package of practices for Ashwagandha is to be considered for the benefit of Ashwagandha farmers of the country.



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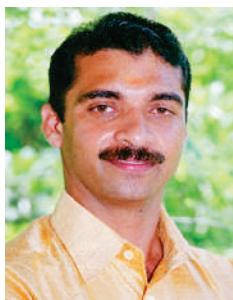
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