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Review article on Nutritional and Phytochemical profile of Ashwagandha

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Abstract
Ashwagandha (*Withania somnifera*) are used in many herbal medicines and are known for their health benefits. In this study, proximate analysis and phytochemical screening of Ashwagandha were done to understand what components are present in it. Proximate analysis includes checking moisture, ash value, fiber, protein, fat and carbohydrates, which help to know about the basic composition and quality of the root. Phytochemical screening was carried out to find different chemical compounds like alkaloids, flavonoids, tannin, saponins, and glycosides. These compounds are responsible for many medicinal properties of Ashwagandha like reducing stress, improve immunity and act like anti-oxidant. The results showed that Ashwagandha roots contain useful nutrients and important phytochemical. So, it can be said that Ashwagandha has good medicinal value and proper analysis is important to maintain quality and effectiveness. The finding indicates that Ashwagandha roots possess a balanced nutritional profile along with a rich presence of phytoconstituents, supporting their extensive use in herbal formulation. This study indicates the importance of proper evaluation and standardization of herbal drugs to ensure their safety, efficacy and consistent therapeutic performance.

Keywords: Ashwagandha *(Withania somnifera);* phytochemical screening; proximate analysis; nutritional composition; medicinal plant; bio active compound; pharmacological action

Introduction
Ashwagandha in scientific term known as *Withania somnifera*, it is highly valued medicinal plant in traditional system like ayurveda, where its have adaptogenic, restorative and anti-inflammatory properties. There roots having high prized due to their high concentration of bio active compounds, which is helping to boost the immunity, reducing the stress, and improve general vitality.
Scientific studies have shown that it may improve the sexual hormones profile in both male and female, Evidence suggest that it increase the testosterone level, modulate the cortisol level, the ashwagandha supplementation has been shown to improve the sexual function and hormonal balance in womans too by reducing the stress level, modulate the hormones like (FSH, LH , Estrogen, etc.). There is growing interest in validating these traditional uses through standardized analytical approach. The proper evaluation of herbal drugs is essential that to ensure about consistent therapeutic performance, efficacy, and safety. The primary phytochemical responsible for the therapeutic efficacy of ashwagandha are a group of naturally occuring streroidal lactones known as withanolide D are the most prominent and have been extensively studied for their biological activities. In addition to withanolides, the roots also contain various alkaoids, flavonoids, tannins, and saponins that contribute synergistically to its oveall pharmacological profile.

2. Plant profile
Withania somnifera is also known as Ashwagandha, it is a short perennial shrub belonging to the solanaceae family. It is found abudantly in the sub tropical region of the world, including india, parts of africa, and the middle east country. The plant typically grows to a height of 35-75cm and is characterised by the hair branches, small green bell shaped flower, and orange-red ripe fruits. Because of these its extensively use in the traditional era as an medicine which is used to boost the energy and relieve stress. It is frequently reffered as " indian ginseng". The synonym of this plants are: Ashwagandha, Indian ginseng, Winter cherry, *Physalis somnifera*.

Synonym	• Ashwagandha, • Indian Ginseng, • Winter Cherry, • *Physalis somnifera*
Family	• *Solanaceae*
Biological source	• It is mainly obtained from the dried mature roots of *Withania somnifera lin.*
Geographical condition	• It is mainly found in the sub tropical region like India, Africa, dMiddle East countries.



2.1 Taxonomical classification

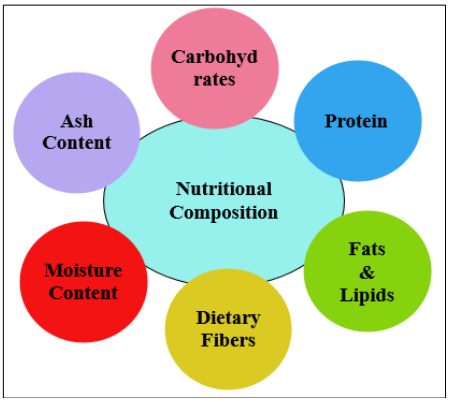
Taxonomical rank	Classification
Kingdom	Plantae
Division	Angiosperm (tracheophyta)
Class	Dicotyledons
Order	Solanales
Family	Solanaceae
Genus	Withania
Species	*Withania somnifera*

2.2 Macroscopic Evaluation

Feature	Description
Color	The outer surface is yellowish-brown to buff gray- yellow The inner region is a creamish-green to white solid mass.
Odor	Strong and characteristic which smells like the horse.
Taste	Bitter and acrid.
Size	The root vary in thickness, generally range from 0.2 to 2 cm in a diameter and are quite stout.
Shape	Cylindrical, relatively, unbranched, woody and hard.
Texture	The outer surface is rough and logitudinally wrinkled, featuring distinct furrows and ridges.

3. Nutritional Composition

The roots of *Withania somnifera* possess significant nutritional potential. Studies on the ashwagandha indicate the presence of essential macronutrient, including carbohydrate, protein, fibers, and minerals. These component play a crucial role in supporting overall body health, which providing energy, also help in the tissue repairing.



3.1 Carbohydrates
Carbohydrate is the primary source of energy for the human body. Ashwagandha roots contains a significant amount of carbohydrates, which primarily in the form of starch. This makes a good energy providing herb that helps to maintain the daily energy requirement and supporting in the metabolic activity.

3.2 Protein
Protein are essential for the growth of the body, tissue repair, and the formation of enzymes and hormones. Ashwagandha roots contains a moderate amount of high-quality amino acids. When it consumed as a supplement, it supports in the muscle recovery, vitality and body-building.

3.3 Fats and lipids
The overall fat contents in the ashwagandha roots is generally low, making it beneficial for a low-fat diet. Where, it does contains a small amount of essential fatty acids that play an important role in the absoprtion of fat-soluble vitamins, cellular health, and energy storage.

3.4 Dietary fibers
Dietary fibers are the essential for improving the digestion, preventing constipation and maintaining a healthy gastrointestinal tract. The fibers which is present in the ashwagandha roots that helps in the regulation of blood sugar level and promoting a healthy gut microbiome.

3.5 Moisture content
This indicates the amount of water present in the plant material.since ashwagandha, is primarily used as a dried root powder, maintaining the low moisture content is highly important. Proper drying prevents microbial growth, fungal infection and spoilage which improves the shelf life of this herbal drug.

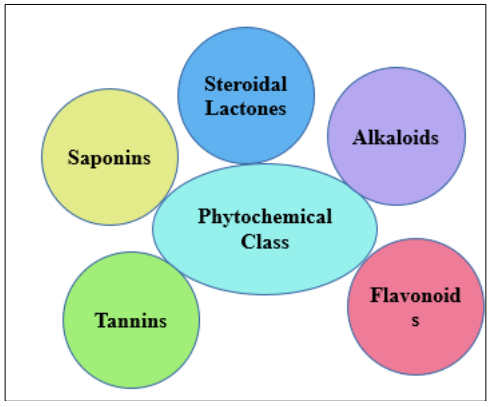
3.6 Ash content
It represents the total minerals content present in the plant after the complete burning of organic matter. Ashwagandha is rich in essential minerals such as iron, calcium, potassium and magnesium. The high iron content is particularly helpful in improving hemoglobin levels, where the calcium and magnesium supports the bone health and nerve function.

4. Phytochemical constituent
phytochemical are naturally occurring bio-active compounds present in plants that are responsible for their medicinal properties. These compounds protect the plant from environmental stress and provide therapeutic benefits when consumed by humans. *Withania somnifera* is a rich wide variety of secondary metabolites, most are steroidal lactones (withanolides) and alkaloids, which are responsible for its adaptogenic, anti-inflammatory, and neuroprotective effect.

The extraction of these chemical constituents are highly depends on the choice of solvent used during the maceration or soxhlet extraction process. Where the methanolic, ethanolic and hydralcholic extracts of ashwagandha roots are prepared for phytochemical screening. The polarity of the sol vents determines which secondary metabolites are successfully isolated where the alcoholic solvents are highly effective for extracting withanolides, alkaloids and flavonoids, while aqueous extracts yield higher amounts of saponins and water- soluble tannin's.

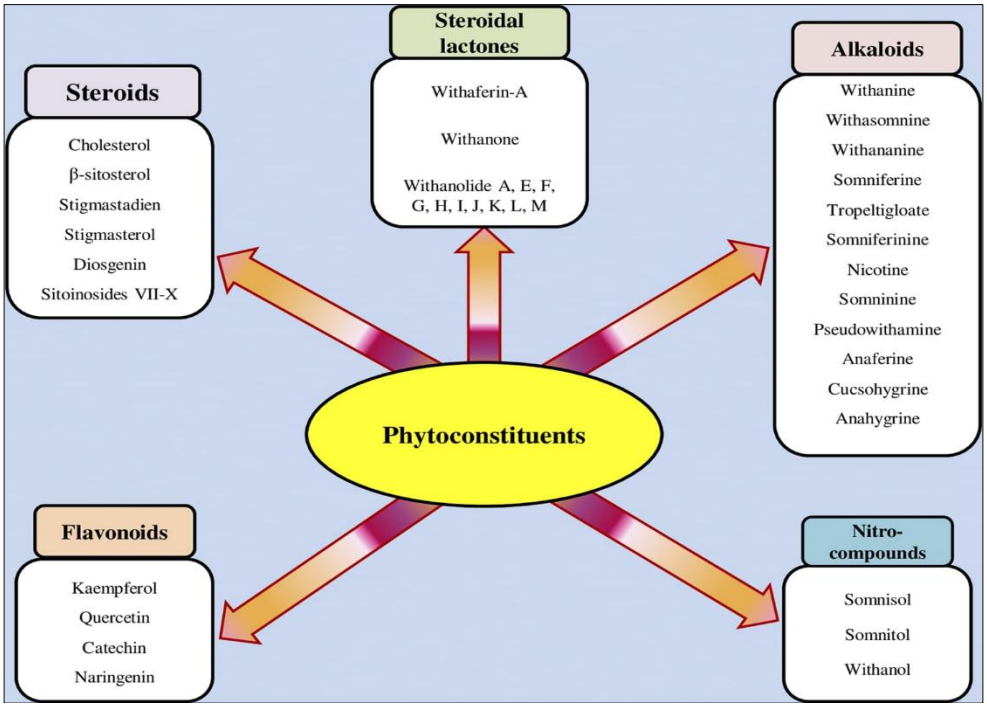
Among the various constituents, the steroidal lactones, collectively known as withanolides, act as the primary marker compounds used for the standardization of ashwagandha formulations. Withaferin A and Withaferin D are the most extensively researched molecules within this group. Structurally, these are complex compounds that unique ly interact with the human body's central nervous system and endocrine system to modulate stress response and supress innflmmatory pathways.

To confirm the presence of this chemical coinsituents the screening tests are performed as per standard laboratory procedures such as Mayer's test, Dragondroff test, Shinodha test, Froth test, which provide the initial confirmation of the plant's chemical profile.



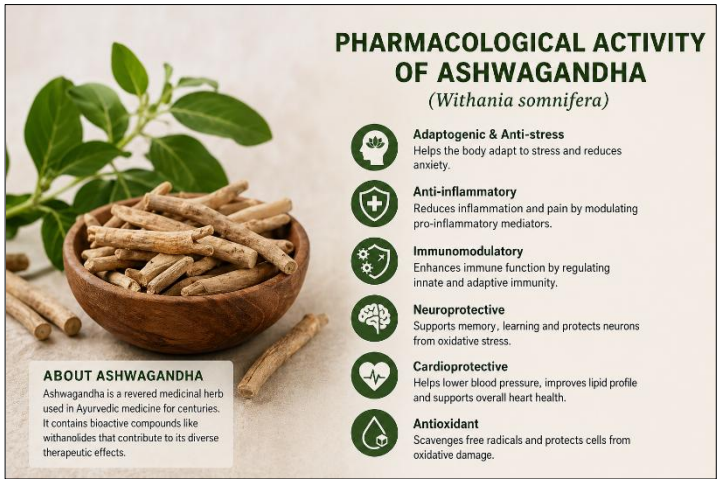
4.1 Phytochemical classification

Phytochemical class	Elucidation	Biological activity	Therapeutic effect
Steroidal lactones (withanolides)	A highly unique class of compounds. (e.g. Withaferin A).	Adaptogenic, anti-cancer, anti-inflammatory	The main active compounds can effect to reduce the stress, boosting the immunity, and fight with the inflammation or foreign paticles
Alkaloids	Nitrogen containing compoud (somniferine, anaferine).	Sedative, analgesic, neuroprotective.	It helps to tresting the anxiety, reducing the pain, and acting as the natural sleep aid.
Flavonoids	Polyphenolic comp[ound with strong antioxidant properties.	Anti-oxidant, anti-inflammatory.	It helps to protect cells from the oxidative stress and free radical damage.
Tannins	Polyphenolic compounds with an astringent taste.	Astringent, antimicrobial.	It helps in the regulation of the peristalsis movement and protect from the infections.
Saponins	Glycosidic compounds that produces foam in the water.	Immune boosting, adaptogenic.	It helps to improve the oevrall immunity and cellular health.



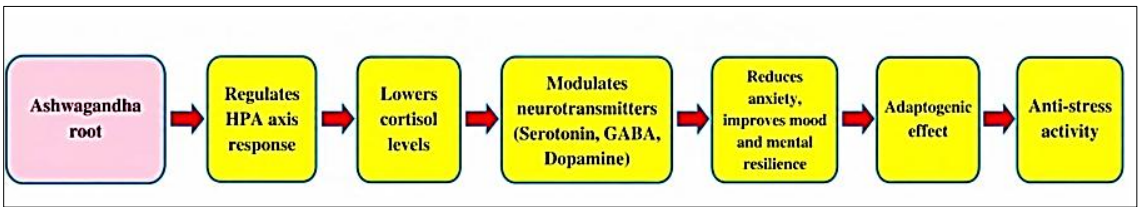
5. Pharmacological Activity

Ashwagandha has a wide range of pharmacological activities due to the presence of many bioactive phytochemical, particularly steroidal lactones, alkaloids, flavonoids, and saponins. These compounds works individually as well as synergistically to produces multiple therapeutic effects.



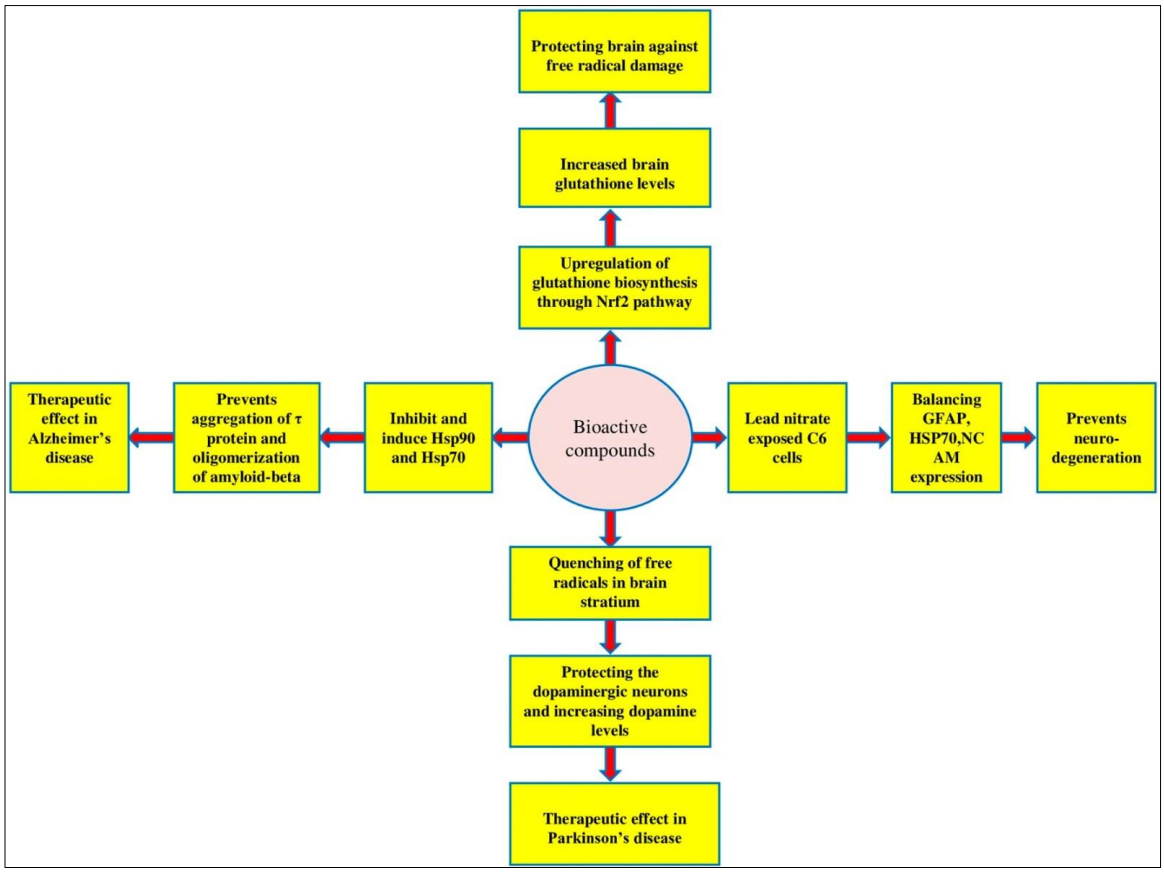
5.1 Adaptogenic and anti-stress activity

Adaptogens are the substance that enhance the body's ability to resist and recover from stress. Ashwagandha is highly renowned for this property. It works by regulation the body's stress response system and reducing elevated cortisol level. This can help the managing anxiety, reducing the mental health and improve overall psychological well being.



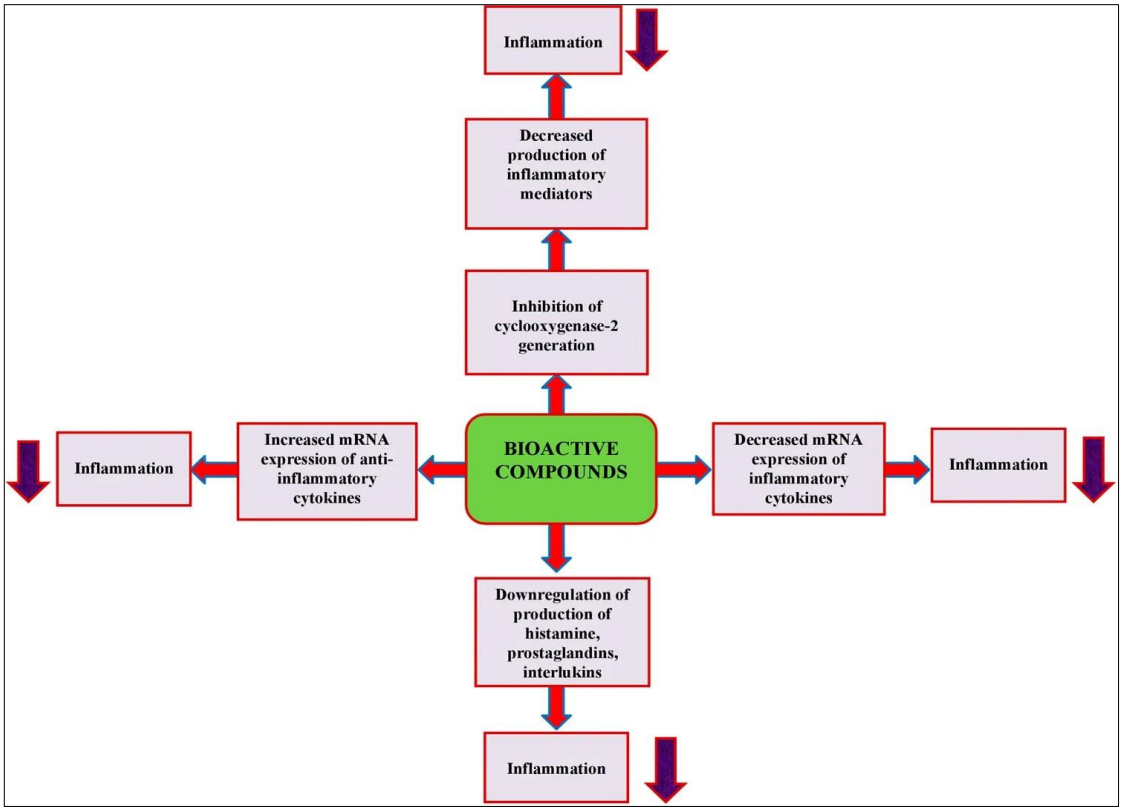
5.2 Neuroprotective activity

This plant have an neuroprotective property, it helping to protect the brain cells from damage and degeneration's. This withanolides promote the growth of nerve cells and protect against oxidative stress in the brain. This make it high useful to improving the memory, enhancing cognitive functions, and managing the neurogenerative conditions like Alzheimer's and Parkinson's disease.



5.3 Anti inflammatory and anti-arthritic activity

Inflammation in the body response to Injury, but chronic inflammation lead to disease. The Withanolide present in the Ashwagandha have potency of anti-inflammatory property. Where it help to reduce the swelling and pain by inhibiting inflammatory mediators. It's highly beneficial in the conditions like rheumatoid arthritis and osteoartheritis. The root extract has shown decreased m RNA expression of inflammatory cytokines such as interleukin 2 (IL-2), interleukin 8 (IL-8), and tumor necrosis factor (TNF), whereas increased the m RNA expression of anti-inflammatory cytokines transforming growth factor (TGF) in a human keratinocyte cell line.



5.4 Immunomodulatory activity

Ashwagandha helps in regulating and boosting the immune system. It enhances the proliferation of white blood cells and increases the activity of macrophages, which are essential for fighting off pathogens. This helps in building general immunity and protecting the body against various infections and diseases.

5.5 Reproductive and Sexual health activity

The plant is traditionally and scientifically validated for improving reproductive health. In men, it enhances testosterone levels, improves sperm quality, and supports fertility. In women, it helps in regulating reproductive hormones, reducing stress-induced hormonal imbalances, and improving overall sexual function.

5.6 Antioxidant property

Antioxidants protect the body from cellular damage caused by free radicals. Ashwagandha contains strong natural antioxidants that scavenge these unstable molecules. This activity helps in preventing chronic diseases, reducing cellular aging, and protecting organs from oxidative stress.

5.7 Others property

Additional pharmacological effects reported for this plant include anti-diabetic (lowering blood sugar levels), anti-tumor (inhibiting cancer cell growth), and cardio-protective activities.

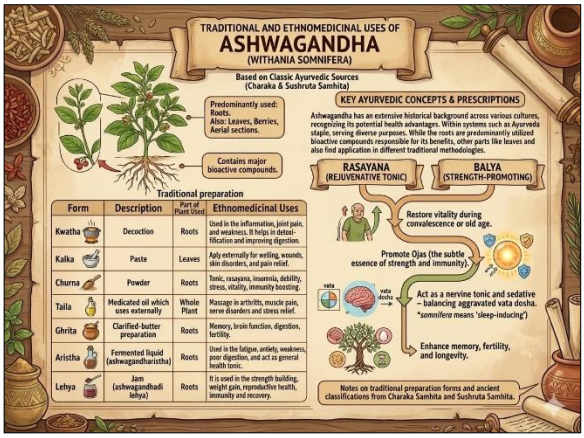
6. Traditional and Ethnomedicinal uses

Ashwagandha has an extensive historical background across various cultures, with traditional practices recognizing its potential health advantages. Within systems such as Ayurveda and Unani, it has been a staple, serving diverse purposes. While the roots are predominantly utilized and hold the majority of bio-active compounds responsible for its benefits, other parts like leaves, berries and aerial segments also find application in different traditional methodologies.

In classical Ayurveda the Charaka Samhita and Sushruta Samhita ashwagandha is classified as a Rasayana (rejuvenative tonic) and Balya (strength-promoting) herb. It is traditionally prescribed to:

- Restore vitality during convalescence or old age
- Promote Ojas (the subtle essence of strength and immunity).
- Act as a nervine tonic and sedative—balancing aggravated vata dosha.
- Enhance memory, fertility, and longevity.

The species name somnifera("sleep-inducing") reflects its popular Ayurvedic application as a sleep aid.

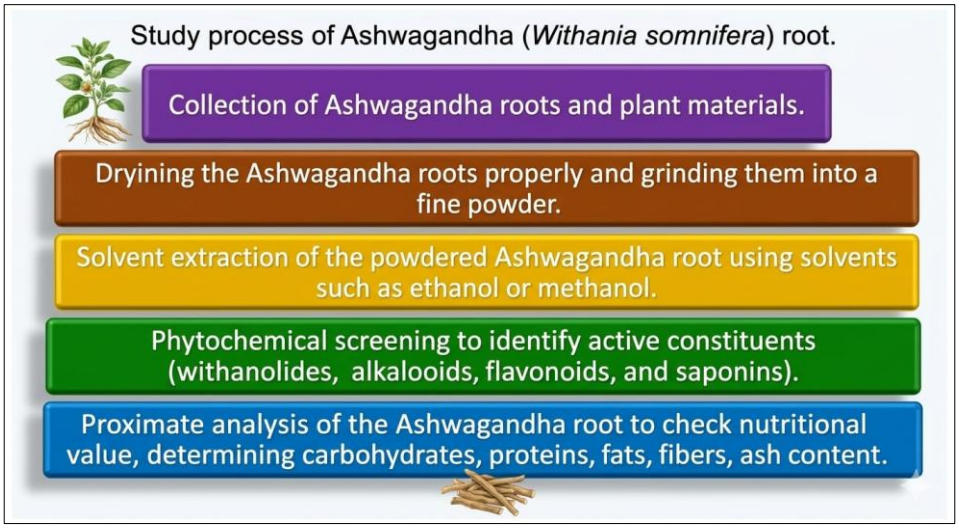


6.1 Traditional preparation

Form	Description	Enthomedicinal Uses
Kwatha	Decoction	Used in the inflammation, joint pain, and weakness. It helps in detoxification and improving digestion.
Kalka	Paste	Aplly externally for welling, wounds, skin disorders, and pain relief.
churna	Powder	Tonic, rasayana, insomnia, debility, stress, vitality, immunity boosting.
Taila	Medicated oil which uses externally	Massage in arthritis, muscle pain, nerve disorder, and stress relief.
Ghrita	Clarified-butter preparation	Memory, brain function, digestion, fertility.
Aristha	Fermented liquid (*ashwagandharistha*)	Used in the fatigue, anxiety, weakness, poor digestion, and act as general health tonic.
Lehya	Jam (*ashwagandhadi lehya*)	It is used in the strength building, weight gain, reproductive health, immunity and recovery.

7. Discussion

Withania somnifera, commonly known as Ashwagandha, stands out as a highly valued plant in both traditional medicine and nutritional science. Its remarkable array of phytochemicals, particularly its unique steroidal lactones (withanolides) and various alkaloids, underpins its wide range of biological actions. These include its well-known adaptogenic, neuroprotective, anti-inflammatory, andimmunomodulatory properties. While traditional Ayurvedic medicine provides substantial historical endorsement and a growing body of scientific research confirms its therapeutic promise, there is a clear and ongoing need for more extensive, meticulously designed clinical trials. Crucially, the consistent standardization of Ashwagandha extracts and the thorough collection of comprehensive safety data are paramount. These steps are essential for its seamless and confident integration into modern, evidence-based therapeutic protocols.



Aspects	Strenghts	Limitation
Phytochemcial study	Presence of highly active compound (withanolids)	Requires more quantitative standardization of extracts
Pharmacological studies	Shows robust adaptogenic and neuroprotective activity	Efficacy heavily depends on extraction methods and plant origin
Traditional use	Widely used and accepted globally as a rasayana	Lack of scientific standardization in traditional dosing
Nutritional value	It indicates a good nutrient and essential mineral profile	Limited detailed data compared to its medicinal focus

8. Future perspective

On the increasing global interest in herbal medicaments, *Withania somnifera* holds strong potential for the future development in the pharmaceutical and neutraceutical industry. On the isolation and quantifying exact active compounds, withferin A, can lead to highly targeted futuristic therapeutic approach. Conduction of rigorous toxicological and human clinical trials is cruicial to evaluate its long term safety, establish standardized dosage guidelines, and prevent the adverse effect. Developing modern, bioavailable formulation will also be key to maximizing its clinical efficacy, allowing this traditional medicines to be consumed safely and effectively in suitable mordern dosage forms.

Research area	Purpose	Result
Isolation of the compounds	Identification of the specific active chemical constituent present.	Development of new targeted drugs
Quantitative analysis	Measure the exact compound levels .	Standardization of herbal extract
In vivo studies	Test on animals.	Confirmation the biological activity and specific targets
Toxicological studies	Evaluation about safety.	Safe dose level determination
Clinical trials	Test on humans.	Medicinal validation and establishing pharmaacokinetics
Formulation development	Creates the optimized herbal products.	Tablets, standardized capsules, nano-emulsions.

9. Conclusion

The oucome of the study is the beneficial role of ashwagandha roots extracts for the both significant nurtional value and pharmcological value. It consist of a wide variety of chemical constituents, most withanolides, alkaloids, flavonoids, and saponins which are responsible for its diverse therapeutic properties. This plant shows highly important biological activity, including adaptogenic, neuroprotective, anti-inflammatory and immunomodulatory effects. Where it has nutritional composition which have carbohydrates, proteins, fibers and minerals which can help in the increament of the potential of overall health. The finding of this study ashwagandha roots extract aphrodisiac effect on sexual well-being in adult men and womens. The mechanism by which ashwagandha helps to improve male sexual health could be due to an increse in serum testostreone. The ashwangandha may utelized to aid enhancement of male sexual function. Where it including the wellness of cardiopulmonary, nervous and endocrine system too. On the basis of analysis it concluded that supplementation of the ashwagandha with the milk is more effective in treatment of hypertension where it doest not effect on the body mass index and weight.

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