

# Formulation And Evaluation of Ashwagandha Capsule on Hypertension

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**Abstract-**Ashwagandha (*Withania somnifera*), commonly known as Indian ginseng, is an adaptogenic herb renowned for its stress-reducing, immunomodulatory, and rejuvenating properties. The formulation of ashwagandha capsules aims to deliver its therapeutic benefits in a convenient, standardized dosage form. This study focuses on the development of ashwagandha capsules using high-quality, dried root powder, ensuring optimal bioactive compound content, particularly withanolides.

The formulation process involves selecting appropriate excipients such as microcrystalline cellulose, magnesium stearate, and silica for stability, flowability, and capsule integrity. The capsules are evaluated for physicochemical properties, including size, weight variation, disintegration time, and dissolution rate. Additionally, the formulation undergoes stability testing to the retention of therapeutic potency over time. The final product is characterized for its high-quality standards, safety, and efficacy, providing an effective, natural supplement for stress management and overall well-being.

**Key words:** - Ashwagandha, withania, somnifera, herbal capsules, formulation, standradization, Ayurvedic Medicine, adaptogen, herbal dosage form, capsule evaluation, phytopharmaceuticals.

## INTRODUCTION

### ASHWAGANDHA:

Ashwagandha (*Withania somnifera*, fam. Solanaceae) is commonly known as “Indian Winter cherry” or “Indian Ginseng”. It is one of the most important herb of Ayurveda (the traditional system of medicine in India) used for millennia as a Rasayana for its wide ranging health benefits. Rasayana is described as an herbal or metallic preparation that promotes a youthful state of physical and mental health and expands happiness<sup>[1,2]</sup>



Figure No. 1: Ashwagandha

Ashwagandha is commonly available as a churna, a fine sieved powder that can be mixed with water, ghee (clarified butter) or honey. It enhances the function of the brain and nervous system and improves the memory. It is a small evergreen shrub that grows to roughly four to five feet tall. In India, it is cultivated, on a commercial scale, in the states of Madhya Pradesh, Uttar Pradesh, Punjab, Gujarat and Rajasthan.<sup>[1]</sup>

This plant is used in more than 100 formulations in Ayurveda, Unani and Siddha. Ashwagandha is one of the prime drugs of Ayurveda material medica. Acharya Charaka included it in Balya and Brimhanagana. It is attributed with Balya, Vrishya and Rasayana properties and suggested as substitute of Kakoli and Kshirakakoli.<sup>[2]</sup>

The species name somnifera means 'sleep-inducing' in Latin, indicating that to it are attributed sedating properties, but it has been also used for sexual vitality and as an adaptogen. Some herbalists refer to Ashwagandha as Indian ginseng, since it is used in Ayurvedic medicine in a way similar to that ginseng is used in traditional Chinese medicine.<sup>[2]</sup>

Ethno-medicinally, decoction of the roots is used for colds and chills; and to increase the tone of uterus after miscarriage or birth. An infusion of the root bark has been used for asthma, a use also common to traditional herbal practices in India.<sup>[2]</sup> In Ayurvedic medicine, its root is used as an anti-inflammatory drug for

swellings, tumours, scrofula and rheumatism; and as a sedative and hypnotic in anxiety neurosis.<sup>[2]</sup> Leaf possesses anti-inflammatory, hepatoprotective, antibacterial properties. Fruits and seeds are diuretic, The berries are used as a substitute for rennet, to coagulate milk in cheese making. Studies have proven that the activity of the Withania extract was approximately equal to the activity of the Panax ginseng extract<sup>[3]</sup>

Withania somnifera, however, has an advantage over Panax ginseng in that it does not appear to result in ginseng- abuse syndrome, a condition. characterized by high blood pressure, water retention, muscle tension, and insomnia <sup>[1]</sup>

### HYPERTENSION

Hypertension, also known as high blood pressure, is a long-term medical condition in which the blood pressure in the arteries is persistently elevated. High blood pressure usually does not cause symptoms itself. It is, however, a major risk factor for stroke, coronary artery disease, heart failure, atrial fibrillation, peripheral arterial disease, vision loss, chronic kidney disease, and dementia.<sup>[4,5]</sup>

Hypertension is a major cause of premature death worldwide. High blood pressure is classified as primary (essential) hypertension or secondary hypertension<sup>[5]</sup> About 90–95% of cases are primary, defined as high blood pressure due to nonspecific lifestyle and genetic factors. Lifestyle factors that increase the risk include excess salt in the diet, excess body weight, smoking, physical inactivity and alcohol use. <sup>[4]</sup>

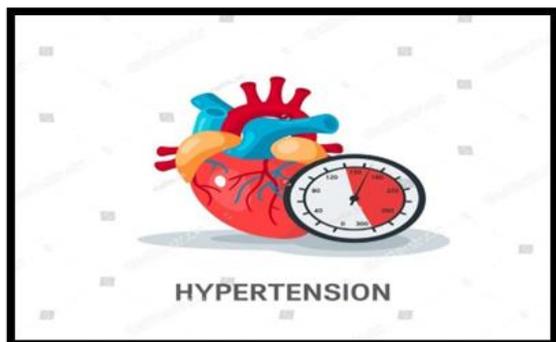


Figure No. 2: Hypertension

The remaining 5–10% of cases are categorized as secondary hypertension, defined as high blood pressure due to a clearly identifiable cause, such as chronic kidney disease, narrowing of the kidney

arteries, an endocrine disorder, or the use of birth control pill.<sup>[5,6]</sup>

Blood pressure is classified by two measurements, the systolic (first number) and diastolic (second number) pressures. For most adults, normal blood pressure at rest is within the range of 100-140 millimeters mercury (mmHg) systolic and 60-90 mmHg diastolic.<sup>[6]</sup>

For most adults, high blood pressure is present if the resting blood pressure is persistently at or above 130/80 or 140/90 mmHg. (567) Different numbers apply to children. Ambulatory blood pressure monitoring over a 24-hour period appears more accurate than office-based blood pressure measurement <sup>[7]</sup>

### HISTORY OF ASHWAGANDHA

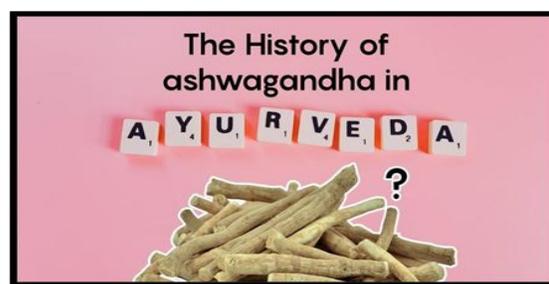


Figure No. 3: History of Ashwagandha

History of Ashwagandha's Research on Hypertension Activity

- Pre-Modern Era (5000 BCE - 1950 CE)
  1. Ayurvedic texts (Charaka Samhita, Sushruta Samhita) mention Ashwagandha's use for stress, anxiety, and fatigue-related disorders.
  2. Unani medicine introduces Ashwagandha for nervous disorders, including hypertension.<sup>[7,8]</sup>
- Early Modern Research (1950-1980)
  1. 1955: Indian Council of Medical Research (ICMR) studies Ashwagandha's pharmacological effects.
  2. 1960s: Isolation of withanolides, Ashwagandha's bioactive compounds.
  3. 1970s: Animal studies demonstrate hypotensive effects<sup>[8,9]</sup>
- Clinical Trials and Research (1980-2010)
  1. 1985: Human clinical trial shows Ashwagandha's efficacy in reducing blood pressure.
  2. 1995: Study on Ashwagandha's antioxidant and anti-inflammatory effects.
  3. 2000: Research on Ashwagandha's vasodilatory effects<sup>[9]</sup>

**BOTANICAL DESCRIPTION:-**

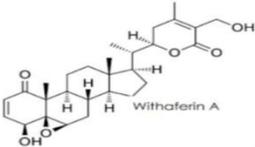
Ashwagandha Kingdom: Plantae  
 Subkingdom: Tracheobionta  
 Division: Magnoliophyta Class: Magnoliopsida  
 Subclass: Asteridae Order: Solanales Family:  
 Solanaceae Genus: Withania Species: W. somnifera  
 Binomial name: Withania somnifera L. [10]



Figure No. 4: Botanical Description

**DRUG PROFILE :-**

Table No. 1: Drug profile

<b>Structure</b>	
<b>Molecular formula</b>	C <sub>28</sub> H <sub>38</sub> O <sub>6</sub>
<b>Molecular Weight</b>	470.6 g/mol
<b>Family</b>	Solanaceae
<b>Uses</b>	Antistress, Depression, Joint pain.
<b>Solubility</b>	Soluble in water
<b>Appearance</b>	Whitish cream fine powder

**CHEMICAL STRUCTURE :-**

- Major chemical constituents: steroidal ads, stridal lactones called withanoides
- 12 alkaloids, 35 withanolides, shoinosides iglucose molecule at C-27)
- Total alkaloid content-0.13-0.31%
- Withanolide A, withanolide B, 27-hydroxy withanolide H, with witherine A along with common steroids like -sitosterol and stigmasterol and their glucosides
- Other compounds are somerin, somniferinine, withananine
- Withanolides serves as important hormone precursors
- Convert human physiologic hormones when needed
- Amphoteric when there is an excess hormone the plant based hormone precursor occupies cell membrane receptor sites so the actual hormone cannot attach and exert its effect.
- If the hormone level is low, plant based hormone exerts small effect<sup>[11]</sup>

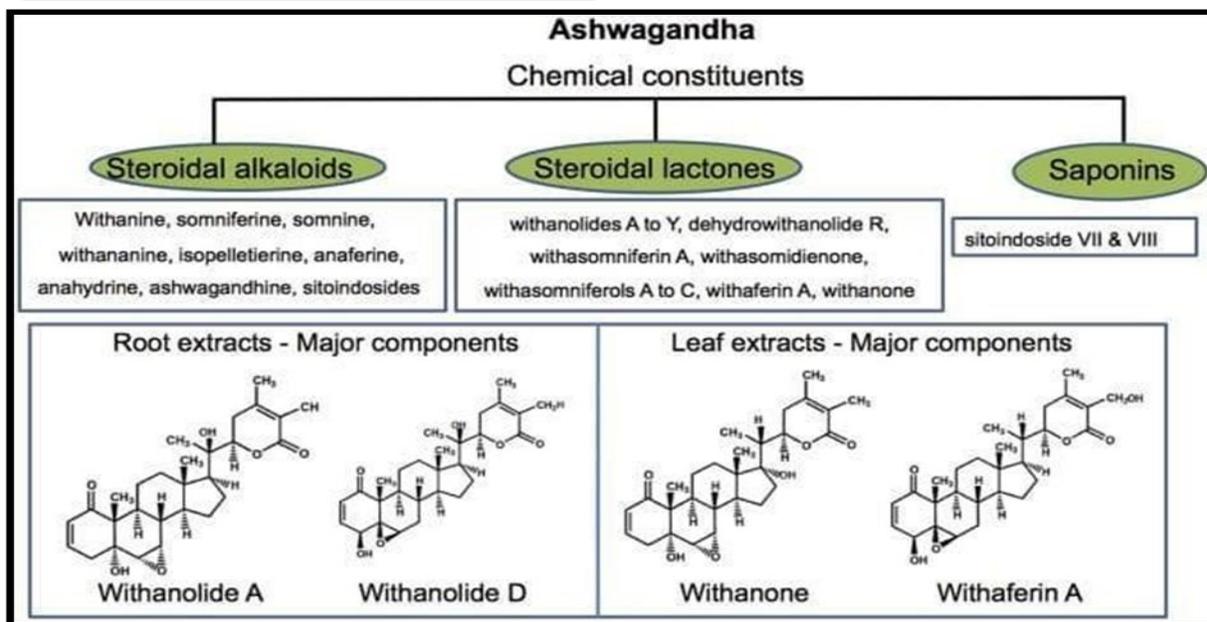


Figure No. 5: Chemical Constituent

Phytochemistry :-

1. Withanolides

These are the primary bioactive compounds in ashwagandha, a group of steroidal lactones. They have antioxidant, anti-inflammatory, and anticancer properties. Withaferin A is the most studied withanolide due to its potent anticancer, anti-inflammatory, and immune-modulating effects.<sup>[12]</sup>

2. Alkaloids

Alkaloids such as anaferine, somniferine, withanine, and tropine are present in the roots and leaves. These contribute to ashwagandha's sedative, antistress, and immune-enhancing properties.<sup>[12]</sup>

3. Saponins

Sitoinosides are a group of saponins found in the roots and leaves. They exhibit antioxidant and anti-stress effects and support immune function.<sup>[12]</sup>

4. Flavonoids

Ashwagandha also contains various flavonoids, which have antioxidant properties and support overall cellular health. These compounds contribute to reducing oxidative stress.<sup>[12,13]</sup>

5. Tannins and Glycosides

These compounds also contribute to the herb's astringent and adaptogenic properties, helping the body resist stressors and inflammation.<sup>[12,13]</sup>

6. Steroidal Compounds

In addition to withanolides, ashwagandha has other steroidal compounds that may have anabolic and rejuvenating effects.<sup>[12,13]</sup>

7. Iron and Essential Fatty Acids

Ashwagandha contains trace amounts of essential minerals like iron, as well as fatty acids that contribute to its restorative and health-promoting qualities.<sup>[12,13]</sup>

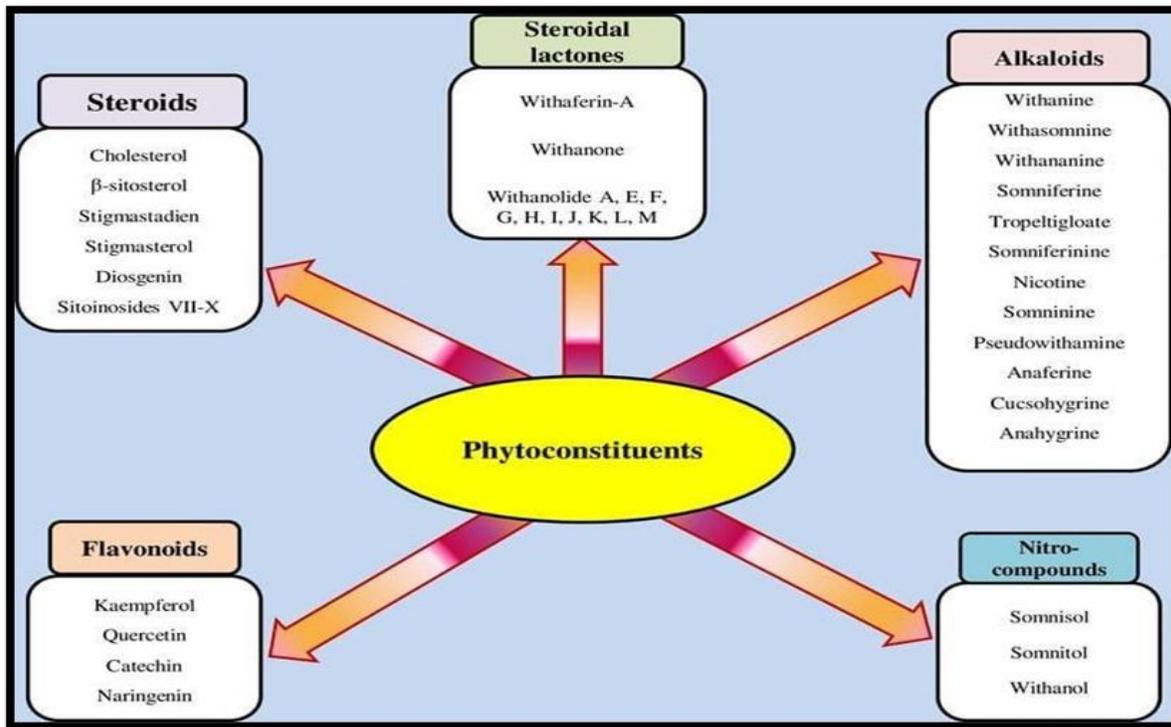


Figure No. 6: Phytoconstituents

Pharmacological Action :-

Ashwagandha (*Withania somnifera*), a renowned herb in Ayurvedic medicine, has been shown to potentially benefit individuals with hypertension through several pharmacological actions. One of its primary effects is its ability to reduce stress. As an adaptogen, ashwagandha helps the body adapt to physical and mental stress, which is a significant contributor to

elevated blood pressure.

By reducing stress levels, ashwagandha can lower sympathetic nervous system activity, which in turn may help decrease blood pressure. Additionally, ashwagandha contains potent antioxidants, such as withanolides, which help reduce oxidative stress. Oxidative stress plays a crucial role in vascular inflammation and endothelial dysfunction, both of

which contribute to high blood pressure<sup>[13,14]</sup>

Another key mechanism of ashwagandha is its ability to regulate cortisol levels.

High cortisol, a stress hormone, is associated with increased blood pressure, and ashwagandha has been shown to lower cortisol levels, helping to mitigate its adverse effects on blood pressure regulation. Furthermore, ashwagandha may improve endothelial function, which supports better vasodilation (widening of blood vessels) and blood flow, thus contributing to lower blood pressure.

Ashwagandha (*Withania somnifera*) has been traditionally used for managing various health conditions, including hypertension, due to its adaptogenic, antioxidant, and anti-inflammatory properties<sup>[15]</sup>

#### 1. Reduction stress of Stress and Cortisol Levels

- Mechanism:-Ashwagandha is known for its adaptogenic properties, meaning it helps the body adapt to by regulating the hypothalamicpituitary-adrenal (HPA) axis. This reduces the production of stress hormones like cortisol, which are closely linked to high blood pressure<sup>[14,15]</sup>
- Effect on Hypertension:- Chronic stress is a well-known contributor to hypertension. By lowering cortisol levels and improving the body's stress response, ashwagandha indirectly helps to maintain normal blood pressure levels<sup>[14,15]</sup>

#### 2. Antioxidant Activity

- Mechanism: The antioxidant compounds in ashwagandha, particularly withanolides, help reduce oxidative stress. Oxidative stress is a key factor in the development of endothelial dysfunction, which can contribute to hypertension<sup>[14,15]</sup>
- Effect on Hypertension: By scavenging free radicals and reducing oxidative damage in the blood vessels, ashwagandha helps improve vascular health, thereby lowering blood pressure<sup>[15,16]</sup>

#### 3. Anti-inflammatory Properties

- Mechanism: Ashwagandha has strong anti-inflammatory effects due to its withanolide content. Inflammation is a contributing factor to the development of hypertension, as it can lead to stiffening and narrowing of blood vessels<sup>[14,15]</sup>
- Effect on Hypertension: By reducing inflammation in the cardiovascular system,

ashwagandha can help improve vascular function and decrease resistance in the blood vessels, which in turn helps lower blood pressure<sup>[16]</sup>

#### 4. Regulation of Nitric Oxide (NO) Production

- Mechanism: Nitric oxide is a vasodilator that relaxes the inner muscles of blood vessels, allowing them to widen, which helps lower blood pressure.

Ashwagandha has been shown to enhance nitric oxide production<sup>[17]</sup>

- Effect on Hypertension: Increased NO levels improve blood flow and reduce vascular resistance, leading to a reduction in blood pressure.

#### 5. Improvement in Lipid Profile

- Mechanism: Some studies indicate that ashwagandha can help lower cholesterol and triglyceride levels, which are often elevated in individuals with hypertension .
- Effect on Hypertension: By improving lipid profiles, ashwagandha reduces the risk of atherosclerosis (narrowing of the arteries), thereby lowering the strain on the cardiovascular system and improving blood pressure control<sup>[17]</sup>

#### 6. Modulation of the Autonomic Nervous System (ANS)

- Mechanism: Ashwagandha may help regulate the balance between the sympathetic (fight or flight) and parasympathetic (rest and digest) branches of the autonomic nervous system. Overactivity of the sympathetic nervous system can lead to elevated blood pressure.<sup>[14,16]</sup>
- Effect on Hypertension: By balancing the ANS, ashwagandha can help reduce the sympathetic overdrive that often contributes to high blood pressure<sup>[17,18]</sup>

#### 7. Direct Hypotensive Effects

- Mechanism: Some studies suggest that ashwagandha may have direct hypotensive (blood pressure-lowering) effects, although the exact mechanism is not entirely understood. It could involve the modulation of blood vessel dilation or interaction with the renin- angiotensin system (RAS), which regulates blood pressure<sup>[15,16]</sup>
- Effect on Hypertension: These direct effects contribute to an overall reduction in both systolic and diastolic blood pressure<sup>[18]</sup>

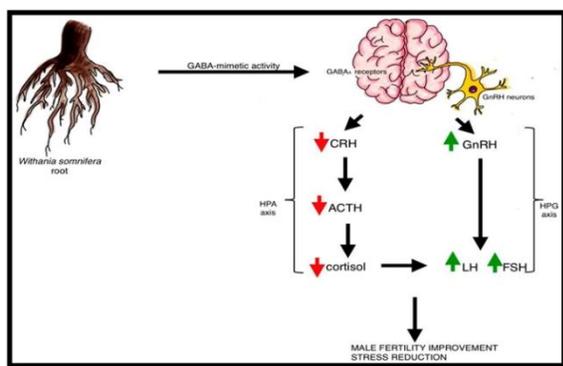


Figure No.7: Pharmacological Effect

## LITERATURE SURVEY

A literature survey for Ashwagandha capsules formulation would encompass several key areas, including its therapeutic potential, traditional uses, extraction methods, and formulation strategies. Below is an outline based on existing literature:

### 1. Introduction to Ashwagandha (*Withania somnifera*):

**Botanical Profile:** Ashwagandha, also known as *Withania somnifera*, is a popular herb in Ayurvedic medicine, known for its adaptogenic properties. It is traditionally used to combat stress, anxiety, improve vitality, and enhance cognitive function.

**Active Compounds:** Key bioactive constituents include withanolides, alkaloids, and sitoindosides, which contribute to its pharmacological effects.

### 2. Therapeutic Benefits of Ashwagandha:

**Adaptogenic Properties:** Helps in reducing stress and anxiety, regulating cortisol levels, and improving overall well-being.

**Antioxidant and Anti-inflammatory Effects:** Ashwagandha exhibits anti-inflammatory effects and is known to combat oxidative stress, which is linked to various chronic diseases.

**Cognitive Enhancer:** It has been studied for its neuroprotective effects and potential to improve memory and cognitive functions.

**Immune System Modulation:** Ashwagandha has been found to support immune health by enhancing white blood cell production.

**Hormonal Balance:** Evidence suggests its potential benefits in regulating thyroid function and improving testosterone levels in men.

### 3. Formulation and Delivery Systems:

**Traditional Uses:** In Ayurvedic practice, Ashwagandha

is often consumed in powder form, mixed with milk or ghee.

**Modern Capsule Formulation:** Capsules offer a convenient and standardized method of delivery, protecting the active compounds from degradation and enhancing patient compliance.

**Challenges in Formulation:** Ashwagandha has low water solubility, and its bioavailability can be improved through various formulation strategies.

### 4. Technological Approaches to Enhance Bioavailability:

**Nanotechnology:** Nanoparticle formulations have been explored to improve the solubility and bioavailability of Ashwagandha. Nanoencapsulation can enhance its therapeutic efficacy by facilitating better absorption in the body.

**Solid Lipid Nanoparticles (SLN):** SLNs are studied as carriers for Ashwagandha to enhance its stability and release characteristics.

**Liposomes and Microparticles:** These carriers can be used to protect Ashwagandha from environmental degradation and improve its bioavailability.

**Self-emulsifying Drug Delivery Systems (SEDDS):** SEDDS are designed to improve the solubility of lipophilic drugs and can be applied to Ashwagandha formulations.

### 5. Stability and Shelf Life Considerations:

**Impact of Storage Conditions:** Ashwagandha extracts are prone to degradation under improper storage conditions. Capsule formulations help mitigate these issues by offering controlled release and protection from environmental factors such as light, oxygen, and moisture.

**Stabilizers and Excipients:** The use of excipients such as cyclodextrins, antioxidants, and stabilizing agents helps in improving the stability of Ashwagandha in capsule formulations.

### 6. Manufacturing Considerations for Ashwagandha Capsules:

**Extraction Methods:** Common extraction methods for Ashwagandha include solvent extraction (e.g., ethanol, methanol), supercritical fluid extraction (CO<sub>2</sub> extraction), and ultrasonic-assisted extraction. These methods aim to isolate the active compounds with minimal loss of efficacy.

**Capsule Types:** Ashwagandha can be formulated into soft or hard gelatin capsules, vegetarian capsules, or plant-based capsules like cellulose to cater to various consumer preferences, including those who prefer

vegan or halal products.

**Formulation Optimization:** The ratio of Ashwagandha extract to excipients needs to be carefully optimized for maximum therapeutic effect, ensuring proper dosage and release characteristics.

#### 7. Clinical Studies and Efficacy:

**Studies on Stress and Anxiety:** Clinical trials have demonstrated the efficacy of Ashwagandha capsules in reducing symptoms of stress and anxiety. For instance, a study published in Indian Journal of Psychological Medicine found that Ashwagandha supplementation reduced stress and anxiety in adults.

**Effect on Cognitive Function:** Research published in Phytotherapy Research indicated that Ashwagandha supplementation could improve cognitive function and memory.

**Safety and Side Effects:** Ashwagandha is generally well-tolerated when consumed in appropriate doses. However, some studies suggest mild gastrointestinal discomfort or drowsiness as potential side effects at higher doses.

#### 8. Regulatory Aspects and Market Trends:

**Regulation of Herbal Supplements:** Ashwagandha-based products are classified as dietary supplements in many countries. Regulatory authorities like the FDA (U.S.) or EMA (Europe) have guidelines for the approval of herbal supplements, ensuring safety and efficacy.

**Market Demand:** The demand for Ashwagandha products has grown due to increased interest in natural supplements for stress relief, sleep improvement, and overall well-being. The market for Ashwagandha capsules is expanding globally, particularly in regions focused on holistic health solutions.

#### 9. Conclusion and Future Directions:

**Future Research:** More clinical trials and studies are needed to explore the full therapeutic potential of Ashwagandha, particularly in areas such as cancer treatment, neurodegenerative diseases, and its potential interactions with other medications.

**Innovative Formulations:** Continued development of Ashwagandha-based formulations with improved bioavailability, such as nanoformulations and SEDDS, holds promise for enhancing its clinical efficacy.

**Consumer Awareness:** As consumer awareness of Ashwagandha grows, it will be important to ensure that formulations are standardized, well-tested for quality, and adhere to regulatory guidelines.

**Aim And Objective:**

#### Aim:

The aim of formulating Ashwagandha capsules is to create a convenient and effective dosage form that delivers the therapeutic benefits of Ashwagandha (*Withania somnifera*), an adaptogenic herb known for its ability to reduce stress, enhance mental clarity, improve stamina, and support overall well-being.

#### Objectives:

1. **Standardization of Dosage:** To provide a consistent and accurate dosage of Ashwagandha extract in each capsule, ensuring uniformity and efficacy.

2. **Enhanced Bioavailability:** To improve the absorption and bioavailability of key active compounds in Ashwagandha, such as withanolides, through suitable formulation techniques.

3. **Convenient Use:** To offer a simple, easy-to-consume capsule form of Ashwagandha for users who prefer or require a non-liquid form of supplementation.

4. **Stability and Shelf Life:** To ensure the stability of the active ingredients over time, extending the shelf life of the product without losing potency.

5. **Safety and Quality Control:** To ensure the formulation adheres to safety standards and quality regulations, providing a safe, contaminant-free product for consumers.

6. **Targeted Health Benefits:** To provide a formulation that supports stress relief, mood balance, improved cognitive function, and enhanced physical performance, as claimed by clinical studies.

7. **Minimal Side Effects:** To minimize potential side effects or adverse reactions, ensuring a tolerable experience for most users.

8. **Cost-Effectiveness:** To develop a cost-efficient product that can be manufactured and sold at an affordable price while maintaining high quality.

These objectives are aimed at maximizing the health benefits of Ashwagandha while making the formulation easy to produce, distribute, and use effectively.

#### Plan of work:-

##### 1. Literature Review and Research (Weeks 1-2)

Review existing research on Ashwagandha, its pharmacological effects, active ingredients (such as withanolides), and safety profiles.

Analyze various capsule formulations already in the

market.

Identify optimal dosages and the best forms of Ashwagandha (powder, extract, standardized extract, etc.) for capsule formulation.

2. Selection of Raw Materials (Weeks 2-3)

Ashwagandha Source: Choose a reliable supplier for Ashwagandha powder or extract. Ensure the raw material is standardized for key active compounds (like withanolides).

Excipients: Select appropriate excipients such as binders (e.g., microcrystalline cellulose), fillers (e.g., magnesium stearate), and capsule shells (vegetarian or gelatin, based on market demand).

Stability Testing: Test raw materials for moisture content, purity, and microbial contamination.

3. Formulation Development (Weeks 3-5)

Develop initial capsule formulations with different concentrations of Ashwagandha extract. Ensure the desired bioavailability by selecting optimal excipients that enhance absorption. Incorporate stabilizers to preserve the active ingredients and improve shelf life.

Conduct preliminary batch tests to assess uniformity of content, dissolution, and release properties.

4. Pre-formulation and Laboratory Testing (Weeks 5-6)

Pre-formulation Studies: Conduct compatibility tests between Ashwagandha and chosen excipients to ensure no chemical interactions that could degrade the active ingredients.

Formulation Adjustments: Make adjustments based on initial stability and bioavailability tests.

Dissolution Testing: Perform in vitro dissolution testing to assess the release profile of the active ingredients from the capsule.

5. Pilot Batch Manufacturing (Weeks 6-8)

Manufacture a small-scale pilot batch of Ashwagandha capsules based on the finalized formulation.

Ensure accurate weighing, mixing, and filling techniques.

Assess the uniformity of capsule weight and the

consistency of active ingredient dosage across the batch.

6. Quality Control and Stability Testing (Weeks 8-10)  
Quality Control Testing: Conduct tests for the uniformity of content, disintegration time, hardness, and dissolution rate of the capsules.

Stability Studies: Place the capsules under various conditions (temperature, humidity, and light) to evaluate their long-term stability and shelf life.

Microbial Testing: Test for microbial contamination to ensure the product is safe for consumption.

7. Efficacy Testing and Clinical Trials (Weeks 10-12)

If feasible, conduct clinical or preclinical trials to verify the claimed health benefits of the Ashwagandha capsules, such as stress reduction, cognitive function enhancement, or physical performance improvement. Gather feedback from a small group of participants for real-world efficacy and safety evaluations.

8. Packaging Development (Weeks 12-14)

Develop suitable packaging that ensures the product remains stable and intact. Packaging should be tamper-proof, moisture-resistant, and user-friendly.

Labeling should include dosage instructions, health claims, ingredients list, manufacturing details, and any regulatory information.

9. Regulatory Approval and Compliance (Weeks 14-16)

Submit the product for approval from relevant regulatory bodies (e.g., FDA, FSSAI) depending on the market.

Ensure compliance with local guidelines for herbal supplements, including labeling, claims, and ingredient standards.

10. Mass Production and Market Launch (Week 16 onwards)

Scale up production for commercial manufacturing.

Final quality checks before shipment to ensure consistency and safety.

Launch the product through suitable distribution channels (e.g., pharmacies, online platforms)

Role of Ingredients Used In The Formulation:-

INGREDIENT AND THEIR ROLE :-

Sr. No	INGREDIENT	ROLE
1	ASHWAGANDHA	REJUVENES MIND & BODY
2	LACTOSE	DILUENT, BINDER
3	MAGNESIUM STEARATE	LUBRICANT
4	TRAGACANTH	BINDER

5	CARBOXYMETHYL CELLULOSE	DISINTEGRANT
6	TALC	GLIDANT

Table No. 2: Ingredient and their role

Material And Their Quantity :-

Table No. 3: Material and thier quntity

Sr.No	Ingredient	F1 (gm)	F2(gm)	F3(gm)
1	ASHWAGANDHA	400	400	400
2	LACTOSE	64	64	64
3	MAGNESIUM STEARATE	6	12	8
4	TRAGACANTH	6	6	6
5	CARBOXYMETHYL CELLULOSE	18	12	6
6	TALC	6	6	6

Method of Preparation :-

For granulation:-

Wet granulation method :-

1. Pass all the ingredients through sieve no. 80.
2. Mix Ashwagandha, Crospovidone, Tragacanth & Magnesium stearate.
3. Prepare separately Lactose solution with water (Q.S).
4. Add the solution to the mixture to form a damp coherent mass.
5. Pass the coherent mass through sieve no.12 to form granules.
6. Dry the granules at 50-60°C for 1 hour in hot air oven.
7. Pass the dried granules through sieve no.16 or 18.
8. Add Talc and mix thoroughly.
9. Evaluate the preparation for preformulation<sup>[19]</sup>

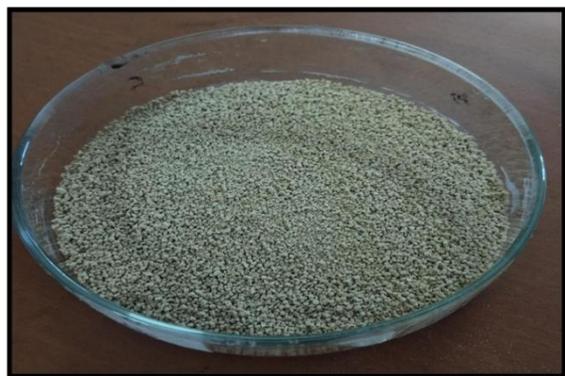


Figure No. 8: Granules

Capsule Filling Process :-

1. Manual Capsule Filling Process (SmallScale):

Materials Needed:

- Empty gelatin or HPMC capsules (size 0 or size 00)
- Ashwagandha powder (or other active ingredient)

- Excipients (e.g., microcrystalline cellulose, magnesium stearate, silica)
- Mortar and pestle or grinder
- Sieve
- Spatula
- Capsule filling tray (optional)
- Clean, dry surface

Step-by-Step Procedure:

1. Preparation of the Powder:

Dry and grind the ashwagandha root into a fine powder. Sieve the powder to ensure uniform particle size. Mix the powder with excipients (like microcrystalline cellulose and magnesium stearate) for uniform flow and ease of filling.

2. Preparation of Capsules:

Open the capsules carefully, separating the larger body from the smaller cap. Place the capsules on a clean tray, with the body part facing up.

3. Filling the Capsules:

Place the mixed powder onto the capsule filling tray. Use a spatula or small spoon to fill the capsule bodies with the powder. Tap the tray gently to settle the powder and remove air pockets. Add more powder if needed to achieve the desired weight.

4. Closing the Capsules:

Once filled, carefully place the caps back onto the capsules. Apply gentle pressure to seal them securely.

5. Quality Check:

Check for uniformity in weight and content.

Inspect for any damaged or improperly sealed capsules.

6. Packaging:

Store the filled capsules in airtight, moisture-free containers<sup>[20]</sup>

#### Evaluation Test :-

When evaluating the formulation of ashwagandha capsules, several critical factors need to be assessed to ensure the product is effective, safe, and of high quality. Here's an outline of the evaluation tests commonly performed:

Evaluation of Quality Control Parameters for Finished Product (Capsule)

##### a) Description

Size, shape, colour etc were evaluated (Lachman et al., 1987).

b)Uniformity of weight: Test for uniformity of weight was performed as per Indian pharmacopoeia, 1996.

c)Determination of Ph: The test was performed same as earlier in the case of pH determination for extract. Here powder of one capsule was used.

d)Disintegration test for capsule: Disintegration test was performed using the digital microprocessor based disintegration test apparatus by VEEGO.

One capsule was introduced into each tube and added a disc to each tube. The assembly was suspended in the water in a 1000 ml beaker. The volume of water was such that the wire mesh at its highest point is atleast 25 mm below the surface of the water, and at its lower point was at least 25 mm above the bottom of the beaker.

The apparatus was operated and maintained the temperature at  $37.0 \pm 0.2$ °C. Noted down the time require to all capsules to disintegrate and pass through wire mesh (Anonymous, 1996).

Dissolution test for capsule: The dissolution test was performed for capsule using USP dissolution apparatus 2 by VEEGO.

The 900 ml of the 5 N HCl as dissolution medium was introduced into the vessel of the apparatus. The dissolution medium was warmed to 36.50-37.50°C. For the capsules basket typed is solution apparatus was used. The apparatus was operated immediately at the speed of 50 rpm for two hrs<sup>[16]</sup>

After two hrs a 25 ml specimen was withdrawn from a zone midway between the surface of the dissolution medium and top of the rotating blade or basket, in evaporating dish. Filter and evaporate the specimen. For the each of the capsule tested, the amount of dissolved active ingredient in the solution was calculated as a percentage dissolved in two hrs (Anonymous, 1996).<sup>[20]</sup>



Figure No. 9: Capsules

#### Description of an Ashwagandha Capsule :-

An ashwagandha capsule is a convenient, easy-to-swallow dosage form containing standardized extract of *Withania somnifera* (commonly known as ashwagandha), which is a renowned adaptogenic herb in Ayurvedic medicine. The active compounds in ashwagandha are primarily withanolides, known for their stress-reducing, anti-anxiety, and immune-boosting properties.

#### Physical Description:

- Form: Hard gelatin or hydroxypropyl methylcellulose (HPMC) capsule (suitable for vegetarian/vegan options).
- Color: Typically light-colored (white, off-white, or cream) depending on the formulation.
- Size: Standard capsule size, usually ranging from , with a uniform shape and smooth finish.
- Texture: Smooth outer shell with a consistent fill of fine, free-flowing powder or granules.
- Decription :-
  1. Size :- 2 cm.
  2. Shape :- Cylindrical
  3. Colour :- Reddish Brown
  4. Texture :- free-flowing powder or granules<sup>[21]</sup>

#### (1) Weight Variation Test for Capsules (10 Capsules)

The weight variation test is a critical quality control procedure to ensure uniformity in capsule content, which is essential for maintaining consistent dosage and therapeutic efficacy. This test is typically conducted according to pharmacopeial guidelines such as the USP (United States Pharmacopeia), EP (European Pharmacopoeia), or IP (Indian

Pharmacopoeia).

**Objective:**

To determine the uniformity of capsule weights and ensure they fall within the specified limits, reflecting consistent fill weight for the active pharmaceutical ingredient (API) and excipients.

**Materials Required:**

- Precision balance (with accuracy up to 0.001 g)
- Tongs or forceps (to avoid contamination)
- Clean, dry weighing dishes or containers
- Sample capsules (at least 10 capsules, preferably more for statistical reliability)

**Procedure:**

1. Preparation:

- Select 10 capsules randomly from the batch.
- Ensure the capsules are intact and not damaged.

2. Weighing:

- Weigh each capsule individually using a precision balance.
- Record the weight of each capsule to the nearest 0.001 g.
- Note the average weight of all capsules.

3. Calculation:

- Determine the average weight of the 10 capsules.
- Calculate the percentage deviation for each capsule using the formula:

$$\text{Percentage Variation} = \left( \frac{\text{Individual Capsule Weight} - \text{Average Weight}}{\text{Average Weight}} \right) \times 100$$

4. Acceptance Criteria (Based on Pharmacopoeial Standards)

- For capsules weighing more than 300 mg:
- The individual capsule weight should not vary by more than ±5% from the average weight.

5. Interpretation:

- If all capsules meet the specified limits, the batch

passes the weight variation test.

- If one or more capsules fall outside the acceptable range, the batch fails, and further investigation is needed<sup>[22]</sup>



Figure No. 10: Weighing Machine

Digital weighing machines are popular for their accuracy and ease of use. They use electronic sensors to measure weight and display the result on a digital screen. A digital weighing machine is an electronic device used to measure the weight of objects or individuals with high accuracy. Unlike traditional mechanical scales that rely on springs, digital weighing machines use sensors, such as load cells, to detect weight changes.

These sensors convert the force of the weight into electrical signals, which are then processed by a microprocessor to display the measurement on a digital screen.

Digital scales offer precise readings, often down to fractions of a gram, and are commonly used in households, gyms, hospitals, and industries. They typically feature additional functionalities like tare (zeroing), auto-calibration, and units conversion (kilograms, pounds, etc)<sup>[23]</sup>

**Calculation:-**

(a) For first batch (F1):-

Table No. 4: calculation of F1

Capsule	Weight (gm)	Weight of shell (gm)	Net weight(gm)	% of Deviation
1	0.625	0.098	0.527	1.54
2	0.623	0.099	0.524	0.96
3	0.618	0.101	0.517	-0.38
4	0.615	0.098	0.517	-0.38
5	0.625	0.102	0.523	0.77

6	0.628	0.100	0.528	1.73
7	0.610	0.099	0.511	-1.54
8	0.608	0.098	0.510	-1.73
9	0.610	0.097	0.513	-1.15
10	0.625	0.098	0.525	1.15
		Average wt	0.519	

(b) For second batch (F2) :-

Table No. 5: Calculation of F2

Capsule	Weight (gm )	Weight of shell (gm)	Net weight(gm)	% of Deviation
1	0.620	0.099	0.521	-0.76
2	0.623	0.097	0.526	0.19
3	0.625	0.101	0.524	-0.19
4	0.624	0.096	0.529	0.77
5	0.625	0.099	0.526	0.19
6	0.623	0.101	0.522	-0.54
7	0.624	0.099	0.525	0
8	0.626	0.098	0.528	0.58
9	0.622	0.099	0.523	-0.39
10	0.625	0.098	0.526	0.19
		Average wt	0.525	

(a) For third batch (F3) :-

Table No. 6: Calculation of F3

Capsule	Weight (gm )	Weight of shell (gm)	Net weight(gm)	% of Deviation
1	0.625	0.098	0.527	0.77
2	0.623	0.099	0.524	0.19
3	0.618	0.101	0.517	-1.15
4	0.615	0.098	0.517	-1.15
5	0.625	0.102	0.523	0
6	0.623	0.101	0.522	-0.19
7	0.624	0.099	0.525	0.39
8	0.626	0.098	0.528	0.97
9	0.622	0.099	0.523	0
10	0.625	0.098	0.526	0.58
		Average wt	0.523	

Weight Variation Criteria for Capsules (According to USP & Ph. Eur.):

For capsules containing  $\leq 300$  mg:

The individual capsule weight must not deviate by

Table No. 7: Acceptance Criteria:

more than  $\pm 10\%$  of the average weight. For capsules containing  $> 300$  mg:

The deviation limit is  $\pm 5\%$  of the average weight<sup>[24]</sup>

Acceptance Criteria:

Capsule Weight Range	Allowed Deviation per Capsule	Maximum Capsules Outside Limit (out of 20)	Absolute Limit (No Capsule Should Exceed)
$\geq 300$ mg	$\pm 7.5\%$	2	$\pm 15\%$
$< 300$ mg	$\pm 10\%$	2	$\pm 20\%$

b) Disintegration test :-

Disintegration test is a quality control test used to evaluate how quickly a solid dosage form (like a tablet or capsule) breaks down into smaller fragments in a specific liquid medium under standardized conditions. It's crucial because it affects the bioavailability and efficacy of the drug or supplement.

For Ashwagandha Capsules, the disintegration test would typically involve: Purpose:

To ensure that the capsule shell breaks apart within a specific time (usually within 30 minutes for herbal capsules) so that the Ashwagandha powder inside is released and available for absorption.

Procedure (as per pharmacopoeial standards):

1. Apparatus: USP disintegration test apparatus.
2. Medium: Typically water or simulated gastric fluid (usually at  $37^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ).
3. Time Limit:

For hard gelatin capsules, the general acceptable disintegration time is within 30 minutes, unless otherwise specified.

4. Steps:

Place one capsule in each of the six tubes of the apparatus. Use a disc in each tube.

Operate the apparatus for the prescribed time.

Observe if the capsules disintegrate completely (i.e., no solid residue remains except for fragments of the shell).

Considerations for Ashwagandha:

Ashwagandha root powder or extract might swell slightly or form a residue, so interpretation should account for that.

If the capsules use modified release technology (e.g., enteric-coated), the test parameters will differ<sup>[25]</sup>

Disintegration Test, especially tailored for Ashwagandha Capsules

1. Objective:

To determine the time required for Ashwagandha capsules to disintegrate under specified conditions. This ensures the capsule breaks down adequately in the body for proper absorption and therapeutic effect.

3. Equipment & Materials:



Figure No. 11: Disintegration tester

- Disintegration Test Apparatus (as per USP/BP/IP standards)
- Thermostatic Water Bath (to maintain temperature at  $37 \pm 2^{\circ}\text{C}$ )
- Beakers (1000 mL capacity)
- Discs (provided with the apparatus)
- Ashwagandha Capsules (sample to be tested)
- Disintegration Medium (typically one of the following):
- Purified water
- Simulated Gastric Fluid (SGF) – without enzymes
- 0.1N HCl – commonly used for acidic stomach simulation<sup>[26]</sup>

3. Test Conditions (As per USP <701>):

- Temperature:  $37 \pm 2^{\circ}\text{C}$
- Number of Samples: 6 capsules
- Medium Volume: 800–900 mL
- Apparatus Movement: Up and down motion at a rate of 28–32 cycles per minute
- Maximum Time Allowed:
- 30 minutes for hard gelatin capsules unless otherwise specified

4. Procedure:

1. Preparation:

Switch on the disintegration apparatus and set the water bath to  $37^{\circ}\text{C}$ . Fill the beaker with 900 mL of the disintegration medium.

Place the beaker in the apparatus.

2. Capsule Placement:

Place one Ashwagandha capsule into each of the six tubes of the basket rack assembly. Insert the plastic disc over each capsule (prevents floating).

3. Start the Test:

Lower the basket into the disintegration medium.  
Start the apparatus to begin the vertical movement.

4. Observation:

Observe the capsules for complete disintegration at regular intervals.

A capsule is considered disintegrated if no residue remains other than fragments of the shell (if it's a hard capsule), and the contents have been released.

5. Completion:

Note the time when each capsule disintegrates.

If all 6 capsules disintegrate within 30 minutes, the batch passes the test. If 1 or 2 capsules fail, test 12 more capsules:

If at least 16 out of 18 capsules disintegrate within the time limit, the batch passes.

6. Special Considerations for Ashwagandha Capsules:

Ashwagandha powder might form a cloudy or fibrous suspension in water—this is acceptable as long as the capsule shell breaks apart and the powder is released [27]

If using Ashwagandha extract, the medium may become colored; ensure proper visibility or use filtration post-disintegration to verify.

For enteric-coated or delayed-release capsules, disintegration should be conducted first in SGF for 2 hours (no disintegration should occur), then transferred to simulated intestinal fluid (pH 6.8) for further testing.

6. Acceptance Criteria:

As per pharmacopoeial limits:

Hard gelatin capsules: Must disintegrate within 30 minutes, unless otherwise specified. Modified-release forms must meet conditions per USP <2040> or appropriate monograph.

7. Documentation:

Include the following in my record:

1. Time of test:
  - Batch F1 : 4.31 minutes
  - Batch F2: 4.10 minutes
  - Batch F3: 4.39 minutes
2. Temperature maintenance : 37°C
3. Final result: (Pass) [28]

(c) Dissolution test :-

The dissolution test is a critical quality control procedure in the pharmaceutical industry that measures the rate and extent to which the active pharmaceutical ingredient (API) is released from a

dosage form (like tablets or capsules) into solution. This test simulates the drug release in the gastrointestinal tract and helps predict the drug's bioavailability.

*Dissolution Test for Ashwagandha Capsules*

Ashwagandha (*Withania somnifera*) is a herbal product used for its adaptogenic, anti-inflammatory, and stress-reducing properties. Standardized Ashwagandha extracts often contain withanolides as marker compounds.

*1. Purpose in Ashwagandha Capsules*

Since Ashwagandha is a herbal formulation, the dissolution test ensures that: The active constituents (primarily withanolides) are released from the capsule. The product delivers consistent and effective dosage.

4. *Equipment*



Figure 12 Dissolution Test Apparatus

USP Dissolution Apparatus I (Basket) or II (Paddle): Paddle is more common for capsules. Dissolution Tester: Maintains controlled temperature and stirring. UV-Vis Spectrophotometer or HPLC: For quantifying released withanolides

3. *Test Conditions*

Typical test conditions (can vary based on specific formulation and pharmacopoeial standards):

Note: Specifics may vary if the capsule is designed for delayed or extended release.

4. *Sampling & Analysis*

At each time point, withdraw samples (e.g., 5 mL), filter, and analyze. Replace the withdrawn sample with fresh medium.

Analyze using UV-Vis or HPLC, targeting the

withanolides content.

#### 5. *Evaluation Criteria*

At least 80% of withanolides should be released within 45–60 minutes for immediate-release capsules (unless otherwise specified).

The dissolution profile should match reference standards if available.

#### 6. *Challenges Specific to Herbal Formulations*

Standardization: Natural variation in plant material.

Solubility: Withanolides may have variable solubility, requiring optimized media. Matrix Effects: Fibers and other plant components can affect release. [20]

#### 7. *Regulatory Considerations*

Pharmacopoeial Guidelines: Reference standards like USP, Ayurvedic Pharmacopoeia of India, or WHO guidelines.

Marker-Based Testing: Use of withanolide A, withaferin A, or total withanolides as marker compounds.

#### 8. *Formulation Considerations Impacting Dissolution*

The dissolution behavior of Ashwagandha capsules depends heavily on the formulation design:

##### a. *Type of Extract Used*

Aqueous extract: Generally easier to dissolve.

Hydroalcoholic or alcoholic extract: May contain more withanolides but could have lower solubility in water-based media.

##### b. *Excipient Selection*

Disintegrants (e.g., sodium starch glycolate, croscarmellose): Help the capsule contents disperse quickly in the medium.

Fillers (e.g., MCC, lactose): May influence release rate.

Lubricants/Glidants (e.g., magnesium stearate): Too much may cause hydrophobicity and delay dissolution.

##### c. *Capsule Shell Type*

Gelatin capsules: Dissolve readily in gastric fluid.

HPMC capsules: Can have slower dissolution depending on medium pH.

#### 9. *Optimization of Dissolution Medium*

Since Ashwagandha's withanolides have poor water solubility, choosing the right medium is crucial:

- Simulated Gastric Fluid (SGF) without enzymes (pH ~1.2)
- Simulated Intestinal Fluid (SIF) (pH ~6.8)
- Water with surfactant (e.g., 0.5% SLS): Helps improve solubility.
- Buffers (e.g., phosphate buffer pH 6.8): Mimics intestinal pH.

- Media selection should ensure sink conditions— i.e., the drug should not saturate the medium [20]

#### 10. *Analytical Method Development*

##### a. *Marker Compounds*

Withanolide A, Withaferin A, Total Withanolides  
Standard reference materials should be used for quantification.

##### b. *Detection Techniques*

UV-Vis Spectroscopy:  
Wavelength: Usually between 220–240 nm for withanolides. Requires validation for specificity and interference.

HPLC (High Performance Liquid Chromatography):

Preferred for better accuracy and specificity.

Use C18 column, suitable mobile phase (acetonitrile:water with acid), and detection at 227 nm or optimized wavelength.

More precise for herbal actives.

##### 11. *Validation of Dissolution Method*

According to ICH and regulatory norms, the method should be validated for:

- Specificity (no interference from other components)
- Linearity
- Accuracy and Precision
- Robustness
- Limit of Detection (LOD) and Limit of Quantitation (LOQ)

##### 12. *Regulatory Guidelines and Monographs*

USP (United States Pharmacopeia): May provide a general guideline for botanical supplements.

Ayurvedic Pharmacopoeia of India: Contains monographs for Ashwagandha root and powder.

WHO Monographs on Selected Medicinal Plants: Also helpful for herbal standardization.

If there's no official dissolution monograph, use biomarker-based dissolution testing, targeting a representative phytochemical (like withanolide A)

##### 13. *Sample Dissolution Profile Table (Hypothetical)*

Target: NLT 80% in 45 minutes (Immediate release spec).

##### 14. *Summary Flow for Dissolution Testing*

1. Prepare the Ashwagandha capsules batch.
2. Choose dissolution medium (based on solubility studies).
3. Run test using USP Apparatus II (Paddle), 900 mL medium, 37°C, 50–100 rpm.
4. Sample and filter at specific time intervals.
5. Analyze using UV or HPLC against withanolide

standards.

6. Plot release profile and compare with reference standard or previous batches<sup>[28,29]</sup>

15. *Documentation:*

Include the following in my record:

1. Time of test:

- Batch F1 : 7.21 minutes
- Batch F2: 7.42 minutes
- Batch F3: 7.34 minutes

2. Temperature maintainance : 37°C

3. Final result : (Pass)

Advantages & Disadvantages :-

Formulating ashwagandha (*Withania somnifera*) into capsules has several advantages and disadvantages. Here's a breakdown:

Advantages:

1. Standardized Dosage

Accurate dosing: Each capsule contains a specific, measured amount of ashwagandha extract or powder, ensuring consistency.

Ease of titration: Helps healthcare professionals and users adjust dosage as needed.

2. Convenience and Compliance

Easy to consume: Capsules are tasteless and odorless, unlike raw powder, which can have a bitter or earthy flavor.

Portable and discrete: Capsules are easier to carry and consume, increasing compliance.

3. Enhanced Stability and Shelf Life

Protection from light/moisture: Encapsulation helps protect the ashwagandha from oxidation and degradation.

Extended shelf life: Formulated capsules are generally more stable than loose powder or decoctions.

4. Customizable Formulations

Add complementary ingredients: Capsules can be combined with other adaptogens, vitamins, or bioenhancers like black pepper extract (piperine) to enhance absorption.

Controlled release options: Possibility of designing sustained or delayed-release formulations for better therapeutic effect.

2. Physicochemical Evaluation

5. Market and Branding Advantages

Professional appearance: Capsules are perceived as more “modern” and credible than powders or traditional preparations.

Wider market appeal: Appealing to consumers who prefer supplements over herbal teas or powders.

6. Regulatory and GMP Benefits

Easier compliance with GMP: Capsule manufacturing processes are standardized and regulated, making it easier to meet quality assurance standards.

Batch traceability: Easier to maintain documentation and traceability for each batch produced<sup>[29]</sup>

Disadvantages:

1. Slower Onset of Action:

Compared to tinctures or powders, capsules take longer to digest and absorb.

2. Lower Customization:

Fixed dosages may not suit everyone; powders or decoctions allow more flexible use.

3. Cost:

Capsules can be more expensive due to processing, encapsulation, and packaging.

4. Excipients and Fillers:

Some formulations may include additives, binders, or fillers that aren't always desirable.

5. Capsule Material Sensitivities:

Gelatin capsules are unsuitable for vegetarians or vegans; some may be allergic to capsule ingredients.

6. Limited Use in Some Populations:

People with difficulty swallowing pills (e.g., elderly or children) may struggle with capsule forms<sup>[30]</sup>

Results:-

The Ashwagandha capsule formulation was successfully developed using standardized Ashwagandha root extract. The following results were obtained:

1. Organoleptic Characteristics

The formulated capsules were uniform in color (light brown), odor (characteristic of Ashwagandha), and taste (bitter). The capsule shell showed no signs of brittleness or leakage.

Table No. 8: Physicochemical Evaluation

Parameters	Result		
	F1	F2	F3
Formulation			
Average weight of Weight variation test (mg)	0.519	0.525	0.523
Disintegration time (min)	4.31	4.10	4.39
Dissolution time (min)	7.21	7.42	7.34

## CONCLUSION AND DISCUSSION

### Conclusion

Ashwagandha capsules were successfully formulated with desirable physicochemical properties and demonstrated stability under accelerated conditions. The formulation process ensured uniformity in drug content, good flowability, and appropriate disintegration time. These results support the potential of the developed formulation for use as a reliable and effective herbal supplement. Further studies involving in vivo efficacy and long-term stability are recommended to confirm the clinical benefits and shelf-life of the product.

### Discussion

The present study successfully formulated Ashwagandha capsules using a standardized root extract and evaluated their physicochemical properties. The organoleptic characteristics of the capsules remained consistent, and the disintegration time was within pharmacopeial limits, indicating good performance of the capsule shell.

The flow properties of the granules prior to encapsulation were found to be satisfactory, as indicated by the values of Carr's index and Hausner ratio, ensuring uniform filling during encapsulation. The moisture content was well within acceptable limits, reducing the risk of microbial contamination and ensuring shelf-life stability.

Drug content uniformity testing confirmed that the capsules contained the appropriate amount of Withanolides, demonstrating accurate dosing and homogeneity. Furthermore, the formulation remained stable under accelerated conditions over a three-month period, suggesting that the product is likely to maintain its quality during storage.

Overall, the formulation exhibited acceptable physical and chemical characteristics and complied with standard pharmacopeial requirements, making it suitable for therapeutic use.

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