# Development And Evaluation of Antioxidant and Anti-Inflammatory Tablets from Swieteneia Macrophylla Leaves

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***Abstract*—This study concentrated on the development and assessment of herbal tablets created from Swietenia macrophylla leaf extract for their antioxidant and anti-inflammatory properties. Herbal remedies are commonly utilized today because they are viewed as safer, more affordable, and result in fewer adverse effects compared to synthetic drugs. The leaves of Swietenia macrophylla possess significant phytochemicals including flavonoids, phenolic compounds, tannins, alkaloids, and limonoids, recognized for their antioxidant and anti-inflammatory effects. Fresh leaves of Swietenia macrophylla were gathered, verified, dried in the shade, and ground into powder. The tablets were formulated using the wet granulation technique with appropriate excipients such as lactose, starch, microcrystalline cellulose, talc, and magnesium stearate. Prior to compression, the granules were assessed for pre-formulation metrics such as bulk density, tapped density, angle of repose, Carr's index, and Hausner's ratio to determine their flow characteristics and compressibility. The manufactured tablets underwent additional assessment for a range of quality control metrics including physical appearance, weight variation, hardness, friability, thickness, disintegration time, dissolution, and content uniformity. The findings indicated that all formulations had satisfactory physicochemical characteristics within official standards. The tablets displayed excellent hardness, minimal friability, consistent thickness, acceptable weight variation, and adequate disintegration time. Among all the formulation, batch F4 demonstrated superior hardness and an acceptable dissolution profile in comparison to the other batches. The research determined that leaf extract from Swietenia macrophylla can be effectively developed into stable herbal tablets that possess notable antioxidant and anti-inflammatory properties Consequently, the formulated herbal remedy could serve as an effective natural option for addressing oxidative stress and inflammatory issues, offering enhanced patient adherence and inflammatory issues, offering enhanced patient adherence and reduced side effects.**

## I. INTRODUCTION

Herbal remedies have been extensively utilized in conventional medical systems for the prevention and management of multiple ailments.

Medicinal plants comprise various bioactive phytochemicals that demonstrate therapeutic effects with relatively minimal side effects. In recent times, herbal formulations have received growing interest because of their natural source, safety, improved patient adherence, and wide-ranging pharmacological uses. Consequently, creating herbal drug delivery systems has emerged as a significant focus in pharmaceutical research.

Fig no.1: Swietenia macrophylla leaves

Tablets are the most favored solid dosage forms among different dosage forms due to their precise dosing, stability, convenience of administration, cost-effective

production, and enhanced patient adherence. Herbal tablets merge the healing properties of medicinal herbs with the benefits of contemporary pharmaceutical advancements. The creation of herbal tablets includes pre-formulation research, choosing appropriate excipients, optimizing the formulation, and assessing quality control parameters like hardness, friability, disintegration time, dissolution, weight variation, and stability to guarantee safe and effective products.

Oxidation and oxidative stress

Oxidation is a natural process that continuously takes place in the human body during normal metabolic activities such as cellular respiration and energy production. During this process, unstable and highly reactive molecules called free radicals are formed. These free radicals contain unpaired electrons, which make them highly reactive and capable of interacting with important biological molecules like proteins, lipids, carbohydrates, and nucleic acids in an attempt to achieve stability.[5]

Under normal physiological conditions, the body is able to maintain a balance between the production of free radicals and the action of antioxidant defense systems. Antioxidants help neutralize free radicals and protect cells from damage. However, when free radicals are produced in excessive amounts or when the antioxidant defense system becomes weak, this balance is disturbed, resulting in a condition known as oxidative stress Oxidative stress can damage various cellular components including DNA, proteins, lipids, and cell membranes. Continuous oxidative damage plays a major role in the development of several chronic and degenerative diseases such as cardiovascular disorders, diabetes mellitus, cancer, neurodegenerative diseases, liver disorders, inflammatory conditions, and premature aging.

The production of free radicals may increase due to several external and internal factors including environmental pollution, exposure to ultraviolet radiation, smoking, alcohol consumption, mental stress, unhealthy dietary habits, infections, inflammation, and toxic chemicals. Therefore, maintaining adequate antioxidant protection is essential for reducing oxidative damage and preserving overall health.[5]

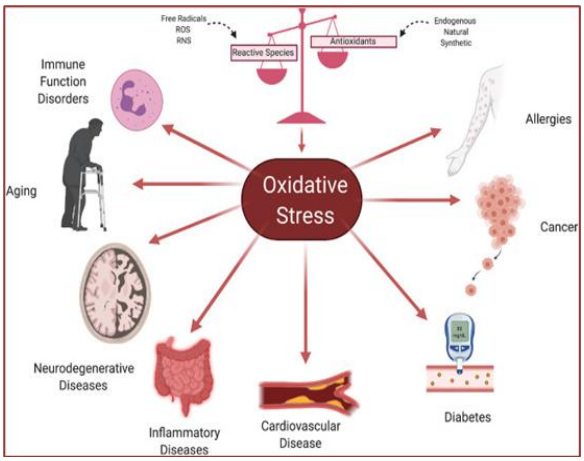


Fig no. 2: Oxidative stress diseases

## II. ANTIOXIDANTS

Antioxidants are substances that help protect the body from harmful damage caused by free radicals and reactive oxygen species (ROS). Free radicals are unstable molecules naturally produced during normal body activities such as respiration, energy generation, inflammation, and immune responses. Because these molecules contain unpaired electrons, they tend to react with nearby biological components including proteins, lipids, carbohydrates, DNA, and cell membranes in order to achieve stability.[5]

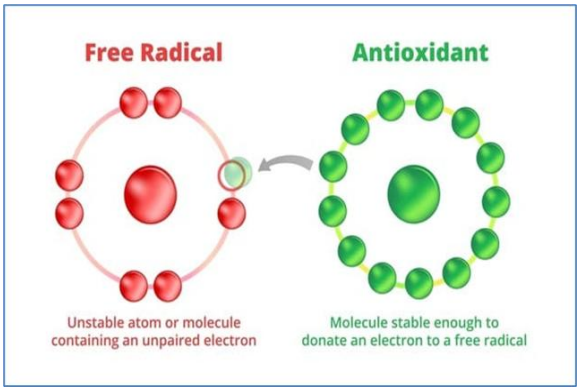


Fig no. 3: Antioxidant reduce Free radical

Mechanism of Action of Antioxidants

Antioxidants protect the body against oxidative stress by acting through several important mechanisms. They help in neutralizing harmful free radicals, protecting cellular structures, and maintaining normal physiological activities. The main mechanisms involved in the antioxidant action

## III. INFLAMMATION

Inflammation is the body's defense mechanism against damage, infection, and detrimental factors. It is categorized as acute or chronic inflammation. Chronic inflammation is linked to conditions such as arthritis, heart diseases, diabetes, cancer, and neurodegenerative diseases.

Inflammation is generally classified into two main types

1.Acute inflammation

This is the reaction of your immune system to a sudden injury or disease. Inflammatory cells move to the location of damage (such as a cut on your finger) or infection and initiate the healing process. [10]

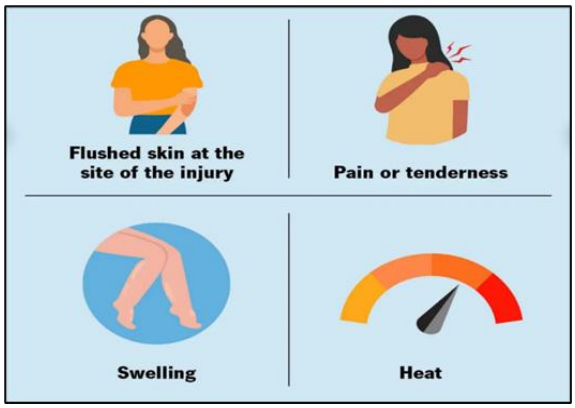


Fig no. 4: Sign of Acute Inflammation

2.Chronic inflammation

Acute inflammation is a short-term and immediate response that occurs soon after injury or infection. It is commonly characterized by redness, swelling, heat, pain, and sometimes loss of function at the affected area. This type of inflammation usually subsides once healing

In contrast, chronic inflammation persists for a longer duration and may continue for months or even years. Long-term inflammation can gradually damage tissues and is associated with the development of several chronic diseases such as arthritis, cardiovascular diseases, diabetes mellitus, cancer, and neurodegenerative disorders.[8]

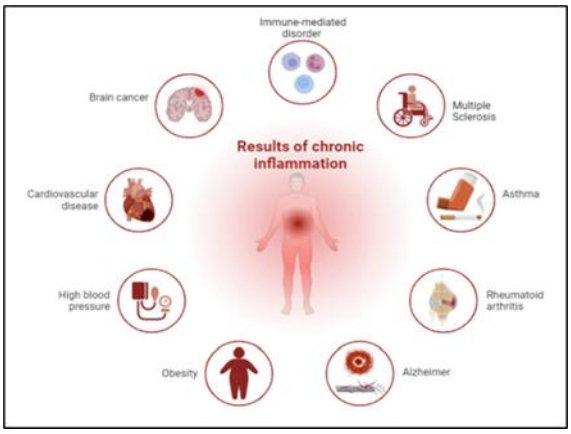


Fig no.5: Chronic Inflammation

## IV. ANTI-INFLAMMATORY

Anti-inflammatory drugs decrease inflammation by blocking inflammatory mediators like prostaglandins, leukotrienes, cytokines, and histamine. While synthetic anti-inflammatory medications are effective, long-term use can lead to negative side effects. Thus, herbal anti-inflammatory compounds are attracting interest because of their safety and extra antioxidant and immunomodulatory effects.

Mechanism of Herbal Anti-inflammatory Compounds

- Suppression of prostaglandin production
- Inhibition of leukotriene production
- Decrease in cytokine secretion
- Antioxidant effectiveness

## V. MATERIALS AND METHODS

Synonyms: Big-leaf Mahogany, Honduran Mahogany, Swietenia macrophylla King

Family: Meliaceae

Chemical Constituents: Hydrochloric acid (HCL), Sodium hydroxide (NaOH), Lactose, Starch, Magnesium sterate, Talc, Sodium starch glycolate, Distilled water, Phosphate buffer pH

Application of swieteneia macrophylla leaves:

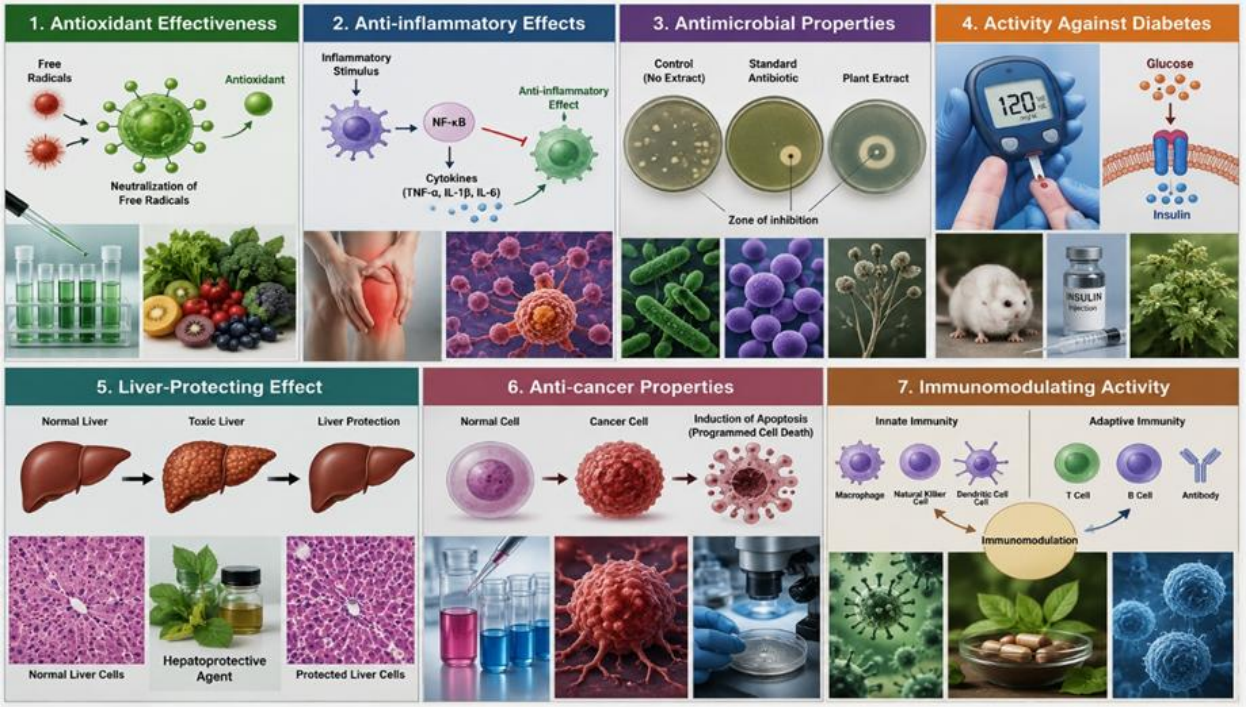


Fig no. 6: Application of Swieteneia macrophylla leaves

1.Materials Used:

Table no.1: Materials used for this study.

| SR.NO | CHEMICAL |
|---|---|
| 1 | Hydrochloric acid (HCl) |
| 2 | Sodium hydroxide (NaOH) |
| 3 | Lactose |
| 4 | Starch |
| 5 | Magnesium stearate |
| 6 | Talc |
| 7 | Sodium starch glycolate |
| 8 | Distilled water |
| 9 | Phosphate buffer pH 6.8 |

2.Equipment used:

Table No 2: List of equipment used

| No. of Equipment | Name of Equipment |
|---|---|
| 1 | Hot air oven (drying studies) |
| 2 | Sieve set and sieve shaker (particle size analysis) |
| 3 | Bulk density apparatus |
| 4 | Tapped density apparatus |
| 5 | Glassware (beakers, conical flasks, measuring cylinders) |
| 6 | Mortar and pestle (hand mixing) |
| 7 | Spatula |
| 8 | Beaker and glass rod (binder solution preparation) |
| 9 | Single punch tablet compression machine (lab scale tablet press) |
| 10 | Monsanto hardness tester (crushing strength) |
| 11 | Friabilator (Roche friability apparatus) |
| 12 | Disintegration test apparatus (tablet break-up time) |
| 13 | Dissolution test apparatus (USP apparatus I or II) |
| 14 | Vernier Scale (Vernier Caliper) |

## VI. COLLECTION, IDENTIFICATION AND AUTHENTICATION OF PLANT MATERIAL

The healthy and disease-free plants of Swietenia macrophylla had their fresh leaves gathered from the local area in the early morning hours. The plant specimen was verified by Dr. Vishal R. Marathe, a botanist and Professor in Botany at the Plant Taxonomy Research Lab within the Department of Botany. N.E.S. Science College. Nanded. The gathered leaves were rinsed with distilled water to eliminate dust and impurities, air dried in the shade for 7–10 days, and subsequently ground into coarse powder with a mechanical grinder. The powdered substance was kept in a sealed container for subsequent phytochemical and pharmacological research.

## VII. METHODS

Collection and preparations of plant material:

- Leaves that are fresh, disease-free, and fully developed are chosen from healthy trees.
- Leaves are typically gathered in the early morning when weather conditions are ideal.

- Leaves that are damaged, infected, dried, or affected by insects are neglected.
- The gathered leaves are thoroughly rinsed with clean water to eliminate dust, dirt, and other impurities.
- Excess moisture is eliminated, and the leaves are dried in the shade at ambient temperature to maintain heat-sensitive phytoconstituents.
- Drying continues until a stable weight is reached.
- The dried leaves are ground using a grinder and filtered through an appropriate sieve to achieve a consistent particle size.
- The powdered substance is kept in sealed containers shielded from moisture, light, and impurities until it is needed.

Preparation of Tablet from swietenia macrophylla leaves:

Fresh and healthy leaves of Swietenia macrophylla are gathered, rinsed thoroughly with clean water to eliminate dust and contaminants, and air-dried in the shade at room temperature for a number of days

Pre-formulation studies:

The prepared extract undergoes assessment for:

- Color
- Odor
- Solubility
- Moisture content
- Flow Properties
- Phytochemical analysis

These investigations assist in choosing appropriate excipients and formulation techniques.

Study on Drug–Excipient Compatibility

- Conducted to assess the compatibility of Swietenia macrophylla leaf extract with excipients. Inactive ingredients included: microcrystalline cellulose, lactose, starch, sodium starch glycolate, talc, and magnesium stearate.
- Physical observations encompassed alterations in color, changes in odor, clumping, melting, and aggregation.
- FTIR analysis was performed to identify chemical interactions.
- No notable alterations in FTIR peaks were detected.
- Findings verified the lack of physical and chemical incompatibility.

## VIII. PRE-FORMULATION STUDIES:

The pre-formulation study of Swietenia macrophylla leaf extract tablets involve the systematic characterization of the material's physicochemical and mechanical properties to guarantee the creation of a stable, safe, and effective solid dosage form. Due to the intricate nature of herbal extracts, this essential stage is vital for addressing issues linked to batch-to-batch inconsistencies and making certain the extract aligns with required pharmaceutical excipients

Pre-formulation research encompasses the assessment of characteristics like:

1) Organoleptic Properties of Tablets:

Organoleptic qualities are the traits of tablets that can be assessed using the sensory organs, including sight, smell, taste, and touch. These characteristics are essential for identification, patient acceptance, quality assurance, and the general appearance of the tablet formulation

Organoleptic Evaluation Parameters of Tablets:

Table no. 3 Organoleptic Evaluation Parameters of Tablets

| Parameter | Description | Importance |
|---|---|---|
| Colour | Visual appearance of the tablet | Helps in identification and patient acceptance |
| Odour | Smell of the tablet | Detects degradation or contamination |
| Taste | Sensory taste of the tablet | Important for chewable and dispersible tablets |
| Shape | Physical shape such as round, oval, or capsule-shaped | Helps in product identification |
| Size | Thickness and diameter of the tablet | Ensures uniformity and easy swallowing |

## IX. FLOW PROPERTY EVALUATION

1.Angle of Repose (θ):

The angle of repose is a crucial pre-formulation factor utilized to assess the flow characteristics of powders and granules. It is characterized as the largest angle

created between the surface of a powder mound and the horizontal plane.
The angle of repose refers to the angle created between the flat surface and the slope of the pile formed when powder flows easily through a funnel.

2.Bulk Density:
Bulk density is a crucial pre-formulation factor that indicates how well a powder can be packed. It is described as the mass of the powder divided by the entire bulk volume filled by the powder, including the gaps between the particles
Bulk density is the ratio of the weight of powder to its bulk volume before tapping.

3.Tapped Density:
Tapped density serves as a crucial pre-formulation metric that reflects the packing capacity and compressibility of a powder following mechanical tapping. It is defined as the mass of the powder divided by the volume occupied following tapping
Tapped density is the ratio of the weight of powder to the tapped volume obtained after mechanically tapping the measuring cylinder containing the powder.

4. Carr's Compressibility Index:
Carr's index, or the Compressibility Index, is a key pre-formulation factor utilized to assess the flow characteristics and compressibility of powders and granules. It is determined by utilizing values for bulk density and tapped density.

5.Hausner Ratio:
Hausner's ratio is a crucial preformulation factor utilized to assess the flow characteristics of powders and granules. It is established from the connection between bulk density and tapped density

## X. FORMULATION OF TABLET

Tablet formulation involves creating compressed solid dosage forms that incorporate active pharmaceutical ingredients (API) along with appropriate excipients. The procedure consists of multiple stages to guarantee consistency, reliability, and potency of the tablets
1.Weighing of Ingredients
All components are carefully measured according to the formulation guidelines.

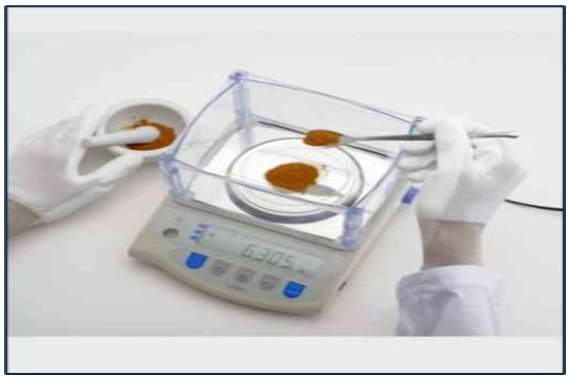

Fig no. 7: Weighing ingredient

2.Sieving: Powders are sifted through appropriate mesh screens.

Fig no.8:Sieving

3.Mixing:
The drug and excipients are combined well with appropriate mixing tools (such as mortar and pestle, blender, or ribbon mixer).

Fig no.9: Mixing

4.Preparation of Binder Solution
Starch paste serves as a frequently utilized binding agent in the process of wet granulation.
It assists in binding powder particles to create granules.

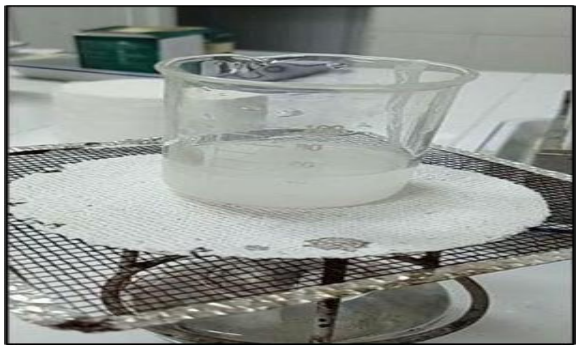

Fig no. 10: Preparation of Binder Solution

5.Wet Massing (Addition of Binder Solution):
Wet massing is a phase in the wet granulation procedure where a binding solution is mixed with the powder blend to create a unified moist mass appropriate for granule production.

Fig no.11: Wet massing

6.Granulation (Passing Through Sieve):
Granulation is the wet granulation process in which the prepared wet mixture is pushed through a sieve to create consistent wet granules. This stage transforms the unified wet mass into granules appropriate for drying and compression.

Fig no. 12: Granulation

7.Granule Drying:
The drying of granules is a phase in the wet granulation process where moisture is eliminated from wet granules post-granulation to achieve dry, stable, and free-flowing granules suitable for tablet compression.

8.Sizing / Screening of Dried Granules:
Sizing or screening refers to the method of passing dried granules through a sieve to achieve consistent granule size prior to tablet compression.
It eliminates large granules and fine particles

9.Lubrication (Inclusion of Glidants & Lubricants):
Lubrication is the phase in tablet formulation during which lubricants and glidants are incorporated into dried granules prior to compression to enhance flow and avoid sticking during tablet production.

10.Tablet Compression
Compression represents the last phase in tablet production, where lubricated granules or powder are pressed into tablets utilizing a tablet compression machine.

Fig no.13: Compressed Tablet

## XI. EVALUATION OF TABLETS

The developed herbal tablet formulations with Swietenia macrophylla leaf extract as an antioxidant and anti-inflammatory agent were assessed for different physicochemical characteristics to ascertain their quality, stability, and appropriateness for oral use. The assessment examinations featured organoleptic characteristics, thickness analysis, weight fluctuation assessment, hardness evaluation, friability analysis,

disintegration assessment, dissolution investigation, and uniformity of drug content.

1.Organoleptic Properties:

The formulated tablets were assessed for sensory attributes including color, smell, form, look, and surface feel. Tablets chosen at random were visually inspected under standard lighting conditions. The tablets' color and smell were noted, and they were inspected for cracks, capping, or surface imperfections. Organoleptic assessment aids in assessing the physical appeal and refinement of the tablet formulation.

2.Thickness Test

The thickness of the tablets made was measured with a Vernier caliper. Individually measured the thickness of tablets that were selected at random. The mean thickness was measured and documented. Even thickness of tablets signifies effective compression during production and guarantees uniformity in tablet dimensions.

3.Weight Variation Test

The weight variation test was performed to confirm consistency in tablet weight. A random selection of twenty tablets was made, and each was weighed separately with a digital scale. The typical weight of tablets was determined and contrasted with the weights of each tablet. Consistent tablet weight signifies an even distribution of the herbal extract and excipients in the formulation.

4.Hardness Test

The hardness of the manufactured tablets was assessed using a Monsanto hardness tester. Tablets chosen at random were inserted between the jaws of the hardness tester, and the force needed to fracture the tablet was noted in kg/cm². Hardness assessment aids in evaluating the mechanical strength of tablets and their capacity to endure handling and transport.

5.Friability Test

The friability test was conducted with a Roche friabilator to assess the tablets' resistance to wear and fracture. Pre-weighed tablets were positioned in the friabilator and spun at 25 rpm for 4 minutes. Upon finishing the test, the tablets were taken out, cleaned of dust, and weighed once more. The weight loss percentage was determined. Tablets showing less than 1% friability were deemed acceptable.

6.Disintegration Test

The disintegration test was conducted utilizing a USP disintegration device. Tablets were positioned in the disintegration tubes filled with distilled water kept at 37 ± 2°C. The duration needed for the tablets to completely break down into smaller particles was noted. This assessment aids in evaluating the capability of tablets to dissolve post-administration for effective drug release.

7.Dissolution Study:

The dissolution test was conducted with a USP dissolution apparatus to assess the release of active ingredients from the tablets. The tablets were immersed in a dissolution medium held at 37 ± 0.5°C and rotated continuously at a steady speed. Samples were collected at designated time intervals and examined with a UV-visible spectrophotometer. Dissolution testing assists in identifying the drug release characteristics of the formulation.

8.Drug Content Uniformity:

The uniform distribution of the herbal extract in the tablets was assessed by determining drug content uniformity. Tablets were ground into a powder, and a precisely measured amount corresponding to one tablet dose was dissolved in an appropriate solvent. The solution was analyzed and filtered with a UV-visible spectrophotometer. The drug amount was determined and contrasted with the standard value. Consistent drug composition guarantees precise dosing and therapeutic effectiveness.

9.Stability Study:

The stability investigation was conducted to assess the stability of the tablets formulated under storage conditions. The tablets were kept under heightened temperature and humidity conditions and assessed regularly for physical appearance, hardness, friability, disintegration time, and drug content. Stability studies assist in identifying the storage conditions and shelf life of the formulation.

## XII. RESULT AND DISCUSSION

Formulation study:

Table no.4.Formulation Study

| Ingredients | F1(200mg) | F2(250mg) | F3(300mg) | F4(350mg) |
|---|---|---|---|---|
| API | 5 | 6.25 | 7.5 | 8.75 |
| Microcrystalline Cellulose | 5 | 3.75 | 3 | 2.25 |
| Lactose | 1.7 | 1.75 | 1.25 | 0.75 |
| Sodium Starch Glycolate | 0.5 | 0.5 | 0.5 | 0.5 |
| Magnesium Sterate | 0.125 | 0.125 | 0.125 | 0.125 |
| Talc | 0.125 | 0.125 | 0.125 | 0.125 |

Tablet formulation is all about carefully choosing and balancing the drug (API) and other supporting ingredients to get the desired effect and quality. The API is the main component that provides the therapeutic action, while excipients help in making the tablet stable, easy to manufacture, and effective.

Excipients like lactose act as fillers, microcrystalline cellulose helps in binding, sodium starch glycolate ensures the tablet breaks properly, and magnesium stearate and talc improve flow and prevent sticking during compression.

In this study, different batches (F1–F4) were prepared by increasing the drug amount step by step. At the same time, the amount of fillers was adjusted to keep the tablet weight consistent. The disintegrant and lubricants were kept the same in all batches to maintain uniform performance.

This method helps us understand how changing the drug concentration affects tablet properties like hardness, disintegration, and drug release.

## XIII. PRE-FORMULATION STUDY

Table no 5: Pre-formulation study

| Sieve No. (#) | A (44) | B (60) | C (80) | D (100) |
|---|---|---|---|---|
| Bulk Density(g/cm)$^3$ | 0.33 | 0.31 | 0.29 | 0.28 |
| Tap Density(g/cm3) | 0.4 | 0.37 | 0.34 | 0.33 |
| Carr's Index (%) | 17.5 | 16.2 | 14.7 | 15 |
| Hausner Ratio | 1.2 | 1.193 | 1.17 | 1.17 |
| Angle of Repose (°) | 41 | 39 | 39 | 32 |
| Ash Value (%) | 50 | 56 | 79 | 60 |

Pre-formulation research was conducted to assess the physicochemical characteristics and flow properties of the powder and granules derived from Swietenia macrophylla leaves prior to tablet production. These evaluations facilitated the selection of appropriate excipients and contributed to the creation of a stable, efficient, and manufacturable herbal tablet formulation.

1.Organoleptic Evaluation:

The ground leaves of Swietenia macrophylla were examined for their color, odour, taste, and texture.

Discussion:

The organoleptic evaluation serves as a crucial initial identification method for herbal materials. The distinct greenish-brown hue and bitter flavor affirmed the typical characteristics of Swietenia macrophylla leaves. The lack of any abnormal odor or discoloration suggested that the plant material is of high quality, free from microbial contamination or adulteration.

2. Bulk Density and Tapped Density:

Bulk density and tapped density are key factors for assessing the packing capability and compressibility of powders. The recorded values showed moderate packing properties of the leaf powder. The gap between bulk and tapped density indicated that granulation would enhance flow and compressibility prior to tablet compression.

3.Carr'sIndex:

Carr's index assesses the compressibility and flow characteristics of powder mixtures. A value under 20% suggests acceptable to good flow characteristics. The results obtained indicated good compressibility and appropriateness of the granules for tablet manufacturing.

4.Hausner Ratio:

The Hausner ratio analyzes the flow properties of powders further. A value less than 1.25 suggests excellent flowability. The findings validated that the fabricated granules had suitable flow characteristics essential for consistent compression

5.Angle of Repose:

The angle of repose reflects the flow characteristics of powders. The value obtained below 30° indicated excellent flowability of granules, which is advantageous for consistent die filling during tablet

compression. Excellent flow characteristics minimize weight fluctuation issues throughout production.

6.Ash Value:
Total ash signifies the overall quantity of inorganic substances found in the plant material. The obtained value suggested the existence of physiological ash from plant tissue and a minor quantity of non-physiological ash. The outcome indicated satisfactory purity and low levels of contamination with debris or external substances.

7.Solubility of Tablet
Increased solubility in alkaline environments indicated the existence of acidic phytochemicals like phenolic compounds, flavonoids, and tannins, which easily dissolve in basic solutions. The enhanced solubility of fraction B could result from improved surface area exposure and particle distribution.
The decreased solubility seen in finer fraction D could be due to particle clumping, which hinders effective solvent infiltration.

## XIV. PHYSICAL APPEARANCE

Table no. 6: Physical Appearance of Tablet

| Parameter | Observation |
|---|---|
| Colour | Greenish |
| Shape | Round/circular |
| Surface texture | Smooth and non-sticky |
| Odour | characteristic herbal odour |
| Test | Slightly bitter |
| Appearance | Free from cracks, chipping, capping, and mottling |
| Hardness appearance | Tablet should remain intact without breaking easily |

The tablets had a greenish hue because of the natural occurrence of chlorophyll and various plant components in the leaf extract. Every tablet was round, ensuring consistency and making them easy to manage. The tablet surfaces were smooth and not sticky, indicating effective ingredient blending and good compression during the manufacturing process.

## XV. EVALUATION PARAMETER OF TABLET

1.Average Weight
The average weight of all tablet batches was found to be within the acceptable range, with values varying from 495.6 ± 24.78 mg to 501.2 ± 25.06 mg. Only slight variation was observed among the batches, indicating proper mixing of the powder blend and uniform filling during tablet compression. This uniformity ensures accurate dosing of the herbal formulation.

Table no. 7: Average Weight (mg)

| Evaluation Test | Average Weight (mg) |
|---|---|
| Batch F1 | 495.6 ±24.78mg |
| Batch F2 | 499.4± 24.97mg |
| Batch F3 | 498.2 ± 24.91mg |
| Batch F4 | 501.2±25.06 mg |

2.Hardness
The hardness of the tablets ranged between 5.52 ± 0.33 and 5.76 ± 0.18 kg/cm². All batches showed sufficient mechanical strength and were able to withstand normal handling without breaking. Among the formulations, batch F4 exhibited slightly higher hardness, which may be due to better particle binding during compression.

Table no.8: Hardness Test

| Evaluation Test | Hardness (kg/cm2) |
|---|---|
| Batch F1 | 5.52±0.33 |
| Batch F2 | 5.56±0.33 |
| Batch F3 | 5.60±0.21 |
| Batch F4 | 5.76±0.18 |

3.Friability test:
The friability values of all formulations were found below 1%, ranging from 0.63% to 0.68%. These low values indicate that the tablets had good resistance to abrasion and mechanical stress. The results suggest that the prepared tablets possessed satisfactory

physical stability and were less likely to crumble during handling.

Table no.9: Friability Test

| Evaluation Test | Friability(%) |
|---|---|
| Batch F1 | 0.63 |
| Batch F2 | 0.68 |
| Batch F3 | 0.64 |
| Batch F4 | 0.63 |

4. Thickness

The thickness of the tablets ranged from 3.45 ± 0.04 mm to 3.50 ± 0.05 mm. Very little variation in thickness was observed among the batches, showing that the compression process was uniform and properly controlled. Uniform thickness also contributes to consistent tablet appearance and quality.

Table no.10: Thickness

| Evaluation Test | Thickness (mm) |
|---|---|
| Batch F1 | 3.45 ± 0.04 |
| Batch F2 | 3.47 ± 0.04 |
| Batch F3 | 3.50 ± 0.05 |
| Batch F4 | 3.48 ± 0.03 |

6.Disintegration Time

The disintegration time of all batches was found between 4.6 ± 0.3 and 5.2 ± 0.3 minutes, which falls within the acceptable range for uncoated tablets. Batch F4 showed the fastest disintegration, whereas batch F2 required slightly more time. Rapid disintegration is important because it helps in faster release and absorption of the active constituents.

Table no.11: Disintegration time

| Evaluation Test | Disintegration Time (min) |
|---|---|
| Batch F1 | 4.9 ± 0.2 |
| Batch F2 | 5.2 ± 0.3 |
| Batch F3 | 4.8 ± 0.2 |
| Batch F4 | 4.6 ± 0.3 |

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