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Development of Simple Herbal Syrup of Flavanoids and its Evaluation

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Abstract: *The growing preference for natural remedies has encouraged the development of polyherbal formulations with enhanced therapeutic benefits. This study focuses on formulating and evaluating a polyherbal syrup combining Moringa leaves and curcumin for their synergistic anti-inflammatory effects. Moringa leaves are rich in bioactive compounds that provide antioxidant and anti-inflammatory benefits. The syrup was prepared using these components along with suitable excipients to improve stability, taste, and bioavailability. Evaluation of the formulation included parameters such as pH, viscosity, palatability, stability, and antimicrobial activity. The findings indicate that the combined formulation exhibits improved anti-inflammatory activity compared to individual ingredients, suggesting it as a safe and effective natural alternative for managing inflammation-related conditions.*

Natural antioxidants, widely present in medicinal plants, play a crucial role in protecting the body against oxidative damage. Compounds such as polyphenols and carotenoids exhibit multiple biological activities, including anti-inflammatory, anti-atherosclerotic, and anticancer effects. Antioxidants function by slowing or preventing the oxidation of molecules and neutralizing harmful free radicals, thereby protecting cells from damage. The human body naturally contains endogenous antioxidants that help regulate free radical formation and minimize cellular damage. However, reduced levels of these antioxidants are associated with various diseases, including cancer, diabetes, cardiovascular disorders, and inflammation. Oxidative stress caused by reactive oxygen species (ROS) is now recognized as a key factor in the development of several chronic conditions, including neurodegenerative and immune system disorders..

Keywords: Polyherbal syrup, Moringa leaf, Anti-oxidant, Anti-inflammatory, Immune booster, Digestant, Natural remedies.

I. INTRODUCTION

Herbal remedies are rich in bioactive components they have been used extensively to treat a variety of diseases. However, since these active compounds can easily degrade if not handled properly, their efficacy heavily depends on having a thorough understanding of formulation, processing, and preservation. Traditional herbal medicine has seen a sharp increase in popularity in recent years. In order to increase standardization, safety, efficacy, and patient acceptability, there is an increasing need to transform these traditional treatments into contemporary pharmaceutical forms. An imbalance between the body's antioxidant defense system and the generation of free radicals results in oxidative stress, which is a major contributor to the development of numerous diseases. Free radicals are short-lived, extremely reactive chemicals that can harm vital biomolecules including proteins, lipids, and DNA, resulting in a number of disease disorders. By neutralizing these dangerous chemicals, preventing oxidation reactions, and disrupting chain reactions, antioxidants are essential for the body's defense. As a result, medicinal plants high in antioxidant chemicals are being utilized more frequently as complementary and alternative treatments to lessen oxidative stress-related illnesses. Concerns about the toxicity and adverse effects of synthetic medications have led to an increase in the use of medicinal plants despite advances in modern medicine.[1]

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As part of complementary and alternative medicine, herbal remedies are now frequently used in conjunction with traditional therapies. Medicinal herbs have been prized for ages for their many therapeutic qualities, especially their capacity to boost immunity and general health by acting as antioxidants. Polyherbal syrups have long been used to preserve health and strengthen immunity in some areas, such as Banda Aceh in Indonesia. These mixtures of various plant extracts are said to enhance bodily vitality, particularly in times of health emergencies like the COVID-19 epidemic. Their phytochemical richness, particularly antioxidants that aid in counteracting excessive free radicals, is mostly responsible for their positive effects. Because they are tasty, simple to eat, and have a large commercial potential, polyherbal syrups are very well-liked. Syrup is a thick, sweetened liquid dose form that works well for delivering herbal active ingredients. Therefore, creating antioxidant-rich polyherbal syrups by combining ancient knowledge with contemporary pharmaceutical methods offers a viable strategy for illness prevention, health promotion and increased patient compliance.[2]

Oral liquid medicinal preparations are generally recommended, especially for individuals who have trouble swallowing solid dosage forms like pills or capsules. One major benefit of liquid formulations is that the medication is already dissolved, making it instantly available for the body to absorb. When opposed to solid forms, this usually leads to a quicker beginning of action and better bioavailability. Herbal syrups, which are made by condensing herbal decoctions and mixing them with sweeteners like sugar or honey and sometimes alcohol, are among these liquid medicines that are frequently utilized. In addition to improving palatability, this also serves as a preservative, guaranteeing the preparation's stability and extended shelf life.The body uses inflammation as a natural defense mechanism to both start the healing process and get rid of dangerous stimuli like viruses, damaged cells, or irritants. Immune cells and chemical mediators that aid in the body's defense and infection prevention are released. However, rheumatoid arthritis, psoriasis, and inflammatory bowel disease are among the major illnesses that can be exacerbated by persistent or dysregulated inflammation. Steroidal and non-steroidal anti-inflammatory drugs (NSAIDs) are the mainstay of conventional therapies for inflammation; these medications are helpful but can have side effects, particularly when used over an extended period of time. Interest in safer, natural substitutes with fewer negative consequences has increased as a result.

Moringa oleifera's medicinal potential and rch phytochemical makeup have drawn a lot of interest. Tannins, triterpenoids, saponins, flavonoids, alkaloids, and phenolic compounds are among the significant bioactive substances found in moringa leaves. Its potent antibacterial, anti-inflammatory, and antioxidant qualities are attributed to these components. In particular, flavonoids are essential for decreasing edema, easing pain and stiffness, and lowering inflammation. By encouraging cellular remodeling and tissue repair, tannins aid in the healing of wounds. Moringa-based formulations can provide a synergistic treatment strategy, increasing anti-inflammatory efficacy while lowering the dangers associated with synthetic medicines because of their combined benefits.[3]

Herbal syrups are liquid pharmaceutical preparations commonly used for oral administration due to their ease of swallowing, improved patient compliance, pleasant taste, and faster absorption. Incorporation of flavonoid-rich Moringa extract into herbal syrup formulation can enhance therapeutic efficacy and provide antioxidant as well as anti-inflammatory benefits. The extraction of flavonoids from Moringa powder is generally carried out using solvents such as ethanol, methanol, or hydroalcoholic mixtures through maceration or Soxhlet extraction methods. The obtained extract is then concentrated and incorporated into syrup base containing sweetening agents, preservatives, flavoring agents, and stabilizers.[4]

The evaluation of herbal syrup formulations is an essential step to ensure their quality, safety, stability, and therapeutic effectiveness. Evaluation parameters generally include physical appearance, color, odor, taste, pH, viscosity, density, stability studies, microbial load, and phytochemical analysis. Determination of total flavonoid content and antioxidant activity is also important to confirm the presence and efficacy of bioactive compounds in the formulation. Advanced analytical techniques such as HPLC, FTIR, and DPPH assays are commonly employed to characterize flavonoid extracts and assess their antioxidant potential. Proper evaluation helps standardize the formulation and ensures consistency in therapeutic performance. Thus, the formulation and evaluation of flavonoid-rich herbal syrup from

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Moringa leaf powder represent an important approach in developing safe, effective, and patient-friendly herbal medicines with significant antioxidant and anti-inflammatory potential. [3]

II. AIM AND OBJECTIVE

Aim

To extract flavonoids from powdered leaves of Moringa oleifera using an appropriate solvent extraction technique and to optimize extraction parameters such as solvent type, temperature, and duration for maximum yield. The study further aims to isolate and concentrate the flavonoid-rich fraction and to analyze it both qualitatively and quantitatively using suitable phytochemical and spectrophotometric methods. The extracted flavonoids will then be incorporated into a herbal syrup formulation using appropriate excipients to enhance stability, palatability, and patient compliance.
Additionally, the formulated syrup will be evaluated for its physicochemical properties including pH, viscosity, and specific gravity, along with phytochemical screening to confirm the presence of bioactive constituents. The total flavonoid content will be determined, and the antioxidant activity will be assessed using standard in vitro methods. Furthermore, the formulation will be subjected to microbiological limit tests to ensure safety and stability studies under different storage conditions to determine shelf life. The anti-inflammatory potential of the syrup will also be evaluated, and its efficacy may be compared with standard formulations to establish its potential as a natural therapeutic agent for managing inflammation and oxidative stress-related conditions.[5]

Objective

- To use an appropriate solvent extraction technique to extract flavonoids from powdered Moringa oleifera leaves.
- To maximize the yield of flavonoids by optimizing extraction parameters such as temperature, duration, and solvent type.[6]
- To separate and concentrate the flavonoid-rich fraction from the crude extract.
- To analyze flavonoids in the extract both qualitatively and quantitatively.[7]
- To develop a herbal syrup formulation using the flavonoid extract along with suitable excipients.
- To improve the stability, palatability, and patient compliance of the formulation.[8]
- To evaluate the physicochemical properties of the prepared syrup, including pH, viscosity, and specific gravity.
- To assess the phytochemical constituents present in the formulation.[9]
- To determine the total flavonoid content using spectrophotometric methods.
- To evaluate the antioxidant activity of the formulated syrup.[10]
- To evaluate the formulation's potential for reducing inflammation.
- To conduct microbiological limit tests to ensure the safety of the formulation.
- To carry out stability studies under various storage conditions.[11]
- To evaluate the efficacy of the herbal syrup in comparison with standard formulations (if applicable).
- To demonstrate the formulation's potential as a natural treatment for conditions associated with inflammation and oxidative stress.[12]

III. MATERIAL AND METHODS

Plant Material

Dried Moringa Oleifera leaf powder

Chemicals and Reagents

- Ethanol (70-80 %)

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- Lemon Juice
- Jaggery
- Honey
- Beet Extract
- Glycerine
- Gum Acacia
- Rose Water
- Sodium Hydroxide
- Lead Acetate
- Hydrochloric Acid
- Ethyi Acetate [13]

Equipments

- Analytical Balance
- Beaker and Conical flask
- Iodine flask
- Funnel
- Measuring cylinder
- Morter and Pestle
- pH meter
- Viscometer
- Whatman filter paper [14]

Methods

Extraction (Macerization)

The maceration method is a simple and widely used extraction technique suitable for isolating flavonoids and other phytoconstituents from plant materials under mild conditions.

Step 1: Preparation of Plant Material

Accurately weigh 50 g of dried Moringa oleifera leaf powder using an analytical balance. Ensure that the powder is finely ground and free from moisture or contaminants, as particle size and purity significantly influence extraction efficiency.

Step 2: Transfer to Extraction Vessel

Transfer the weighed powder into a clean, dry conical flask (preferably amber-colored to prevent light degradation of phytochemicals). The flask should be appropriately sized (500 mL or more) to allow proper mixing.

Step 3: Addition of Solvent

Add 250 mL of 70% ethanol to the flask containing the plant powder. Ethanol-water mixture is selected because it effectively extracts flavonoids due to its intermediate polarity. Ensure that the powder is completely submerged in the solvent.

Step 4: Sealing and Maceration

Seal the flask tightly using a stopper or aluminum foil to prevent solvent evaporation and contamination. Keep the flask undisturbed at room temperature for 48–72 hours. During this period, shake the flask intermittently (every 4–6 hours or at least 2–3 times daily) to enhance solvent penetration and facilitate the dissolution of bioactive compounds.

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Step 5: Filtration

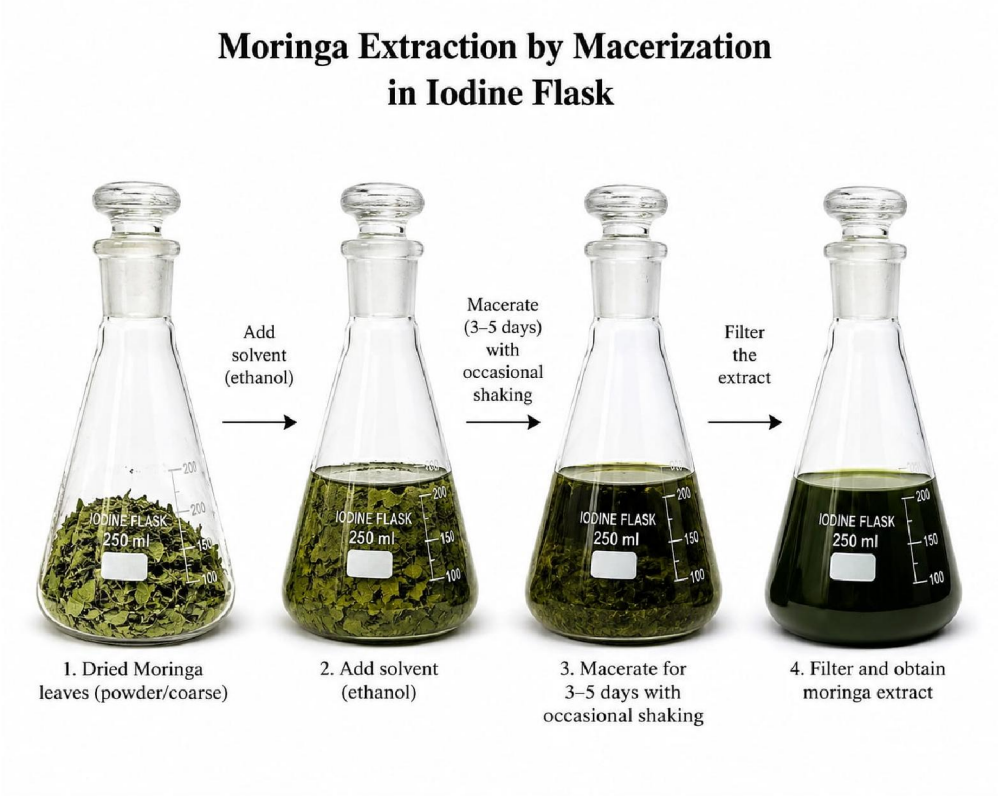
After completion of the maceration period, filter the mixture using Whatman filter paper. Filtration can be done by gravity filtration or vacuum filtration to separate the liquid extract (filtrate) from the solid residue (marc). Ensure complete removal of solid particles for clarity.

Step 6: Concentration of Extract

below 50°C. This low temperature helps prevent thermal degradation of heat-sensitive flavonoids Transfer the filtrate into a clean beaker and concentrate it using a water bath maintained. Continue evaporation until a semi-solid or concentrated liquid extract is obtained.

Step 7: Collection and Storage

Collect the concentrated extract and transfer it into a clean, dry, airtight container (preferably amber-colored glass). Label the container properly with details such as date, batch number, and solvent used. Store the extract in a cool, dry place or under refrigeration (2–8°C) to maintain stability and prevent microbial growth.[15]



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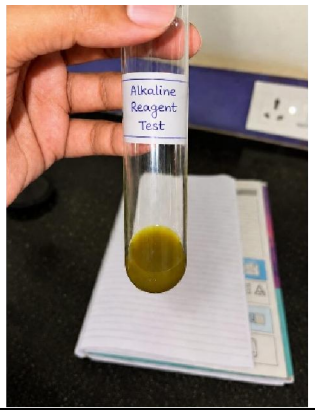
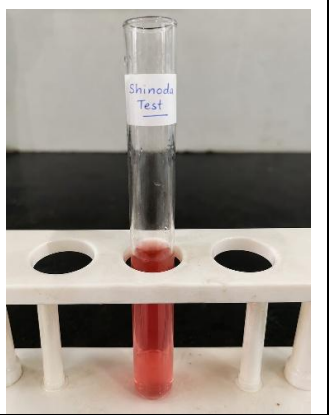
Phytochemical tests for Extraction

Tests	Reagents	Positive Result	Observation
Alkaline Reagent Test	NaOH + HCL	Intense Yellow Colour [16]	
Lead Acetate Test	Lead Acetate	Yellow Precipitate [17]	
Shinoda Test	Magnesium + HCL	Pink/Red Colour [18]	

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Thin Layer Chromatography (TLC) –

1. Preparation of TLC Plate

Take a clean TLC plate (silica gel coated)
Draw a light pencil line about 1–2 cm from the bottom → this is called the baseline
Do not use pen (it will interfere with results)

2. Sample Preparation & Application

Dissolve the sample (fatty acids / plant extract) in a suitable solvent
Take a capillary tube or micropipette
Apply small spots of:
Sample solution
Standard compounds (reference)
Spot on the baseline, keeping distance between spots
Allow spots to dry

3. Development of TLC Plate

Prepare mobile phase (solvent system)
Pour solvent into developing chamber
Place TLC plate inside carefully (baseline above solvent level)
Close chamber and allow solvent to rise upward

4. Removal & Drying

When solvent reaches 1–2 cm below the top, remove plate
Immediately mark the solvent front with pencil
Allow plate to dry completely

5. Visualization of Spots

Since spots may be invisible, use visualization method such as UV light
Spots will appear as colored or dark patches

6. Observation (Rf Value Calculation)

Formula:
Rf value = Distance treavelled by compound / Distance travelled by solvent front
Measure distance from:
Baseline → spot (compound)
Baseline → solvent front

7. Identification

Compare Rf values of sample with Rf of standard compounds
If Rf values match → compound is likely present
Helps in identifying fatty acids / phenolic compounds [19]

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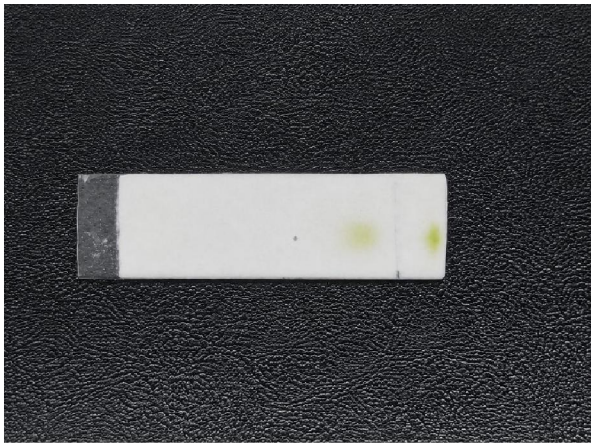

Fig. TLC Plate

Parameter	Observation
Mobile phase	Ethyl acetate:Formic acid:Acetic acid:Water
No. of spots	1
Rf Value	0.68
Detection	UV Chamber

Formulation Table (for 30 ml)

Ingredients	Quantity	Role
Moringa extract	2.5 ml	Main ingredient
Jaggery	5 ml	Sweetner
Glycerin	5ml	Humactant
Honey	6ml	Preservative
Gum Acacia	2ml	Viscosity enhancer
Lemon juice	2.5ml	pH adjustifier, Source of vit. C
Beet extract	1ml	Coloring agent
Rose water	1ml	Flavoring agent
Distilled water	q.s	Solvent / Vehicle

[20]

Preparation Procedure – Herbal Syrup

Jaggery syrup base:

Take 30g jaggery + 20mL water. Heat 70°C till dissolved. Filter hot through muslin to remove dirt. Cool to 40°C. This gives ~67% syrup strength – self-preservative.[21,22]

Incorporate of Flavanoid extract:

Measure 2.5 ml previously prepared flavonoid extract. Add the extract slowly into the cooled syrup base. Stir continuously using glass rod.

Addition of Excipients:

Add 2.5 ml lemon juice to adjust the pH and taste.

Add gum Acacia and Glycerin to enhance the viscosity.

Add Honey as a preservative to prevent the microbial growth and enhance shelf life.

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Add Beet extract and Rose water as coloring and flavoring agent.[23,24]

Volume Adjustment:

To volume adjustment transfer the mixture into measuring cylinder.

Add distilled water gradually to make up the final volume to 30 mL.

Stir the final preparation continuously to obtain a homogeneous syrup.

Packaging and Storage:

Transfer the prepared syrup into clean and dry amber-colored glass bottle.

Amber bottles protect the formulation from light-induced degradation.

Label properly with formulation name, date and batch details.

Store in a cool, dry place away from direct sunlight.[25,26]

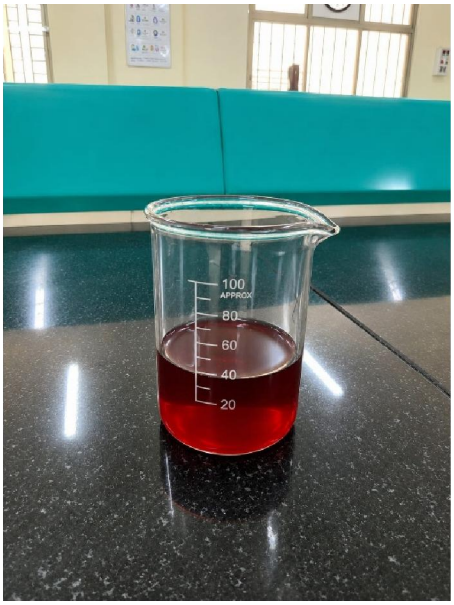

Fig. syrup formulation

Fig. Syrup with Labelled container

Evaluation tests for syrup

Organoleptic properties:

Colour - Reddish

Odour - Aromatic

Taste – slightly Bitter

pH test:

Using pH meter 4-6.5 approx.

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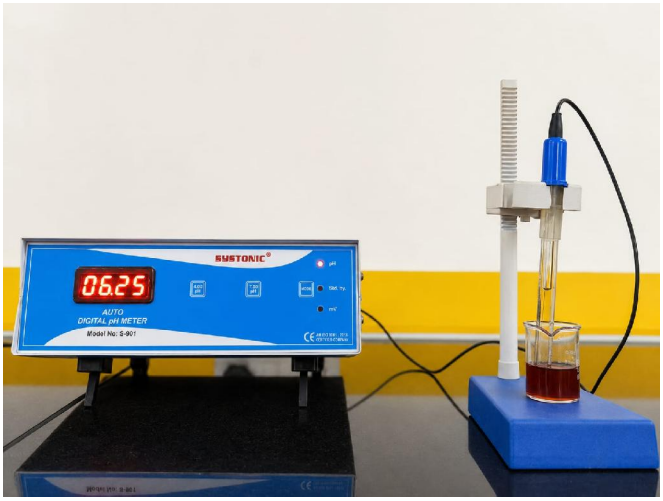

Fig. pH Meter

Density:
Empty cylinder = 38.98
Cylinder with syrup (10 mL) = 50.64
Mass = 50.64 – 38.98
= 11.66 g
Density = Mass / Volume [27]
= 11.66 / 10
= 1.16 g/mL

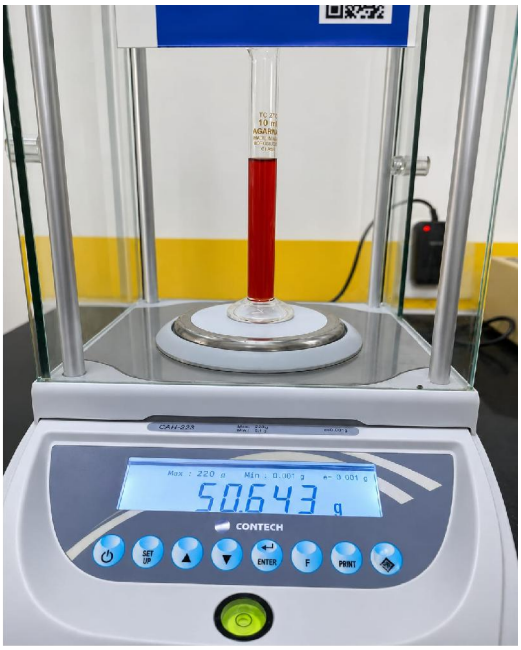

Fig. Density Measurement

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Viscosity:

The viscosity of flavonoid herbal syrup using Ostwald viscometer is generally calculated by comparing the flow time and density of syrup with distilled water.

Formula –

$N2 = N1 \times P2T2 / P1T2$

Where,

N2 = Viscosity of syrup

N1 = Viscosity of water

P1 = Density of syrup

P2 = Density of water

T1 = Flow time of syrup

T2 = Flow time of water [28]

$N2 = 0.89 \times 1.20 \times 95 / 1 \times 50$

$= 2.03$ cp

Fig. Ostwald's Viscometer Apparatus

II. RESULT AND DISCUSSION

The formulated herbal flavonoid syrup prepared from Moringa oleifera powder showed satisfactory physicochemical and phytochemical characteristics. The syrup appeared as a clear to slightly greenish-brown viscous liquid with a pleasant odor and acceptable sweet taste. No phase separation, precipitation, or microbial growth was observed during the study period, indicating good formulation stability.

Phytochemical screening confirmed the presence of flavonoids, phenolic compounds, tannins, and glycosides in the extract. The positive Shinoda test indicated successful extraction of flavonoids from Moringa powder. Previous studies

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also reported that Moringa leaf extracts contain quercetin, kaempferol, and other flavonoid compounds responsible for antioxidant and anti-inflammatory activities.[29]

The pH of the syrup was found within the acceptable acidic range suitable for oral herbal preparations, which helps maintain stability and palatability. The viscosity of the syrup was appropriate for easy pouring and administration. The formulation showed good homogeneity without crystallization of sugar during storage.

The antioxidant activity of the flavonoid syrup was significant due to the presence of phenolic and flavonoid constituents. Moringa extracts are reported to exhibit strong free radical scavenging activity in DPPH and ABTS assays, which supports the antioxidant potential of the prepared syrup.[30]

The formulation also demonstrated promising anti-inflammatory potential. Flavonoids present in Moringa are known to inhibit inflammatory mediators and reduce oxidative stress. Studies have shown that ethanolic extracts of Moringa possess significant anti-inflammatory activity comparable to standard drugs in vitro.[31]

During stability testing, the syrup remained stable without significant changes in color, odor, pH, or viscosity. This suggests that the selected excipients and preservative system were effective in maintaining formulation stability. Similar findings have been reported in polyherbal syrup formulations containing Moringa extracts.[32]

Overall, the study indicates that the formulated herbal flavonoid syrup from Moringa powder possesses acceptable pharmaceutical properties along with potential antioxidant and anti-inflammatory activities. The formulation may serve as a safe and effective herbal preparation for therapeutic use, although further pharmacological and clinical studies are required for confirmation.

III. CONCLUSION

The formulated herbal flavonoid syrup prepared from Moringa oleifera leaf powder was successfully developed using a suitable extraction and formulation approach. The extraction process effectively isolated flavonoid-rich fractions, primarily containing bioactive compounds such as quercetin and kaempferol, which are widely recognized for their potent antioxidant, anti-inflammatory, and free radical scavenging properties. The use of an appropriate solvent system ensured maximum yield of phytoconstituents without significant degradation.

The prepared syrup formulation exhibited satisfactory physicochemical characteristics, including acceptable color, clarity, homogeneity, viscosity, and pH within the desirable range for oral liquid preparations. The addition of excipients such as sucrose, citric acid, and sodium benzoate contributed to improved taste, stability, and microbial safety of the formulation. The palatability and ease of administration make the syrup a suitable dosage form, especially for pediatric and geriatric patients who may have difficulty swallowing solid dosage forms.

Evaluation parameters such as viscosity measurement using an Ostwald viscometer, pH determination, and stability testing under different storage conditions indicated that the formulation remained stable with no significant changes in physical appearance or phase separation. The stability results suggest that the syrup retains its efficacy and quality over a reasonable shelf life when stored under recommended conditions.

From a therapeutic perspective, the presence of flavonoids in moringa contributes to multiple health benefits, including reduction of oxidative stress, modulation of inflammatory pathways, and potential support in managing chronic conditions such as arthritis, cardiovascular disorders, and metabolic diseases. The antioxidant activity of the formulation helps in neutralizing reactive oxygen species, thereby protecting cellular components from damage.

Moreover, the development of this herbal syrup aligns with the increasing global interest in plant-based and natural medicines. Compared to synthetic drugs, herbal formulations are generally considered safer, more economical, and associated with fewer side effects when used appropriately. This makes the moringa flavonoid syrup a promising candidate for complementary and alternative therapy.

In conclusion, the formulated herbal flavonoid syrup from Moringa oleifera demonstrates good pharmaceutical qualities, stability, and potential therapeutic efficacy. It can be considered a viable natural formulation for antioxidant and anti-inflammatory applications. However, further detailed pharmacological investigations, toxicity studies, and

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clinical trials are recommended to validate its safety, efficacy, and dosage regimen for large-scale use and commercialization.

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