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"Formulation and Physicochemical evaluation of herbal syrup using *Musa paradisiaca* Pseudo stem extract"

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Abstract:
The human gut microbiota plays a vital role in maintaining gastrointestinal, metabolic, and immunological health and is strongly influenced by dietary components. This study explores the comparative potential of conventional syrups and banana stem juice as functional dietary components for modulating gut microbiota. Conventional syrups are generally rich in simple sugars such as sucrose, glucose, and fructose but contain relatively low amounts of dietary fiber. Excessive consumption of sugar-rich products may adversely affect microbial diversity and promote the proliferation of opportunistic or inflammation-associated bacterial populations. Although fruit-derived syrups may contain polyphenols and other bioactive compounds, their limited fiber content may restrict their prebiotic potential. Fermentation of syrups with probiotic microorganisms, particularly lactic acid bacteria, may enhance their nutritional and functional properties and improve their potential for microbiota modulation.

In contrast, banana stem (pseudostem) juice is a traditional plant-based beverage containing dietary fiber, non-digestible polysaccharides, resistant components, potassium, and various phytochemicals. These constituents may serve as substrates for beneficial microbial fermentation and support the growth and metabolic activity of favorable gut microorganisms. Banana stem-derived components have been associated with improved bowel regularity, digestion, and intestinal health, suggesting promising prebiotic potential. Its natural composition may therefore provide a more favorable substrate for gut microbial fermentation than conventional sugar-rich syrups.

The development of fiber-rich functional beverages may offer a simple and cost-effective approach to supporting gut health. Furthermore, incorporating banana stem juice into suitable oral liquid formulations may improve acceptability and ease of administration, particularly for individuals who experience difficulty swallowing conventional solid dosage forms. Overall, banana stem juice represents a promising natural functional ingredient for gut microbiota modulation; however, systematic in vitro, in vivo, and clinical studies are required to establish its efficacy, safety, and mechanisms of action.

Keywords: *Banana stem, Gut microbiota, Prebiotics, Dietary fiber, Microbial fermentation, Probiotics, Intestinal health, Polyphenols, Resistant starch, Functional beverage.*

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I. Introduction

1.1 - Introduction to syrups:

Syrups are concentrated, viscous aqueous solutions of sugar or sugar substitutes, commonly used as oral liquid dosage forms in pharmaceutical preparations. Traditionally, syrups contain a high proportion of sucrose (typically 60–85% w/v), which not only imparts sweetness but also contributes to viscosity and acts as a preservative by reducing microbial growth through osmotic pressure.[1]

Due to their palatable taste and ease of administration, syrups are particularly suitable for paediatric and geriatric patients who may have difficulty swallowing solid dosage forms.[2]

Pharmaceutical syrups can be broadly classified into medicated syrups, which contain active pharmaceutical ingredients (APIs), and non-medicated syrups, which are primarily used as vehicles or flavouring agents. In addition to sucrose, modern formulations may include alternative sweeteners such as sorbitol, glycerine, or artificial sweeteners to accommodate diabetic patients or reduce caloric content.[3]

Other excipients such as preservatives, flavouring agents, colouring agents, and stabilizers are

incorporated to enhance stability, palatability, and overall patient acceptability. The formulation of syrups involves careful consideration of physicochemical and microbiological stability.[4]

High sugar concentration helps inhibit microbial growth; however, dilution or improper storage may lead to contamination and spoilage. Therefore, preservatives such as parabens or benzoates are often added, especially in sugar-free formulations. Additionally, factors such as pH, viscosity, and temperature can significantly influence the stability and efficacy of the syrup formulation.[5]

1.2 - BANANA PLANT INTRODUCTION:

The banana plant, scientifically known as Musa spp., is a widely cultivated tropical crop belonging to the family Musaceae and is valued for its fruit, fiber, and medicinal properties. It is believed to have originated in Southeast Asia, particularly in regions such as Malaysia, Indonesia, and the Philippines, before spreading globally through trade and human migration. Botanically, the banana is a large herbaceous plant rather than a true tree, characterized by a pseudo stem formed from tightly packed leaf sheaths, which can grow up to several meters in height. The plant propagates vegetatively through an underground rhizome that produces suckers, while its large, spiral leaves support efficient photosynthesis. The inflorescence arises from the center of the pseudo stem and develops into a bunch of fruits arranged in hands and fingers. Bananas are nutritionally rich, providing carbohydrates, dietary fiber, vitamins such as B6 and C, and essential minerals like potassium, making them beneficial for digestive Health and widely used in both dietary and traditional medicinal applications. [6]

The banana stem, derived from the pseudo stem of Musa spp. belonging to the family Musaceae, is an important by-product of banana cultivation widely utilized for its nutritional and medicinal properties. The pseudo stem is composed of tightly packed leaf sheaths and is rich in dietary fiber, bioactive compounds, and essential nutrients. Traditionally, banana stem has been consumed in various forms, such as juice and cooked preparations, particularly in countries like India, where it is valued for its role in promoting digestive health and detoxification. It is known to possess diuretic, antioxidant, and anti-inflammatory properties, and is often used in managing conditions such as kidney stones, constipation, and gastric disorders. The high fiber content aids in bowel regulation and supports gut microbiota, making it beneficial for gastrointestinal health. Additionally, banana stem contains phytochemicals like flavonoids and phenolic compounds, which contribute to its therapeutic potential. Due to these properties, it is gaining attention in modern research as a functional food ingredient and a natural remedy for various health conditions.[7]

1.3 - BANANA STEM INTRODUCTION:

The banana stem, derived from the pseudostem of Musa spp. belonging to the family Musaceae, is an important by-product of banana cultivation widely utilized for its nutritional and medicinal properties. The pseudostem is composed of tightly packed leaf sheaths and is rich in dietary fiber, bioactive compounds, and essential nutrients. Traditionally, banana stem has been consumed in various forms, such as juice and cooked preparations, particularly in countries like India, where it is valued for its role in promoting digestive health and detoxification. It is known to possess diuretic, antioxidant, and anti-inflammatory properties, and is often used in managing conditions such as kidney stones, constipation, and gastric disorders. The high fiber content aids in bowel regulation and supports gut microbiota, making it beneficial for gastrointestinal health. Additionally, banana stem contains phytochemicals like flavonoids and phenolic compounds, which contribute to its therapeutic potential. Due to these properties, it is gaining attention in modern research as a functional food ingredient and a natural remedy for various health conditions. [8]

II. MATERIALS AND METHODS:

2.1 -Preparation of Fresh Banana Juice from Banana Stem:

Fresh banana stem was obtained from a local source and washed thoroughly with purified water to remove any dirt or impurities. The outer fibrous layers were carefully removed to expose the soft white inner core. The inner core was then cut into small pieces and blended with a small amount of purified water using a mixer grinder to obtain a smooth mixture. This mixture was filtered through a double layer of muslin cloth to separate the juice from the solid residue. To prevent browning and maintain the quality of the juice, a few drops of dilute citric acid solution were added immediately after filtration. The extracted juice was measured and used fresh for the preparation of the herbal syrup, as fresh juice helps retain the natural phytochemicals and beneficial properties of the banana stem.

Figure 1. Banana stem juice

2.2- Procedure for Preparation of Simple Syrup:

Simple syrup was prepared as the base for the herbal syrup formulation. The required quantity of sucrose was accurately weighed using a digital weighing balance and transferred into a clean, dry beaker. A measured volume of purified water was then added to the beaker. The mixture was heated gently on a water bath at a temperature of approximately 60–70°C while being stirred continuously with a glass rod. Continuous stirring helped the sugar dissolve uniformly and prevented it from settling at the bottom of the container. Heating was continued until all the sucrose had completely dissolved and a clear, homogeneous solution was obtained. Care was taken to avoid boiling the solution, as excessive heating can cause caramelization of sugar, resulting in a darker colour, altered taste, and possible changes in the pH of the syrup. Once complete dissolution was achieved, the beaker was removed from the water bath and allowed to cool naturally to room temperature.

The cooled syrup was inspected visually to ensure that it was clear and free from any undissolved sugar crystals or foreign particles. If necessary, the syrup was filtered to remove any impurities. The prepared simple syrup served as the vehicle and sweetening agent for the herbal syrup formulation, providing the desired sweetness, viscosity, and stability to the final product. It was used immediately in the preparation of the banana stem herbal syrup formulations.

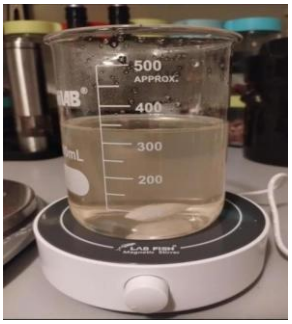

Figure 2. Simple syrup

2.3 - FORMULATION:

Detailed Method for Preparation of F1, F2, and F3 Herbal Syrup Formulations:

Fresh banana stem juice was prepared just before making the syrup to ensure maximum freshness and to prevent oxidation. The outer fibrous layers of the banana stem were carefully removed to obtain the soft white inner core. The inner core was cut into small pieces and blended with a small amount of purified water to form a smooth slurry. This slurry was filtered through a double layer of muslin cloth to obtain clear banana stem juice. To minimize browning and maintain the quality of the juice, a few drops of dilute citric acid solution were added immediately after extraction.

A sugar syrup base was prepared separately for each formulation by dissolving the required amount of sucrose in purified water with gentle heating and continuous stirring. Care was taken to avoid boiling the solution, as excessive heating could affect the quality of the syrup. Once the sugar had completely dissolved, the syrup was allowed to cool before further use.[9] For **F1**, 40ml of freshly prepared banana stem juice was taken in a clean beaker.

The cooled sugar syrup prepared with 65 g of sucrose was added slowly while stirring continuously to ensure uniform mixing. Glycerine (2 ml) was then added, followed by sodium benzoate dissolved in a small quantity of water. Sorbitol solution was incorporated to improve the sweetness and stability of the syrup. Citric

acid solution was added gradually until the desired pH range of 4.0–5.0 was achieved.

A few drops of lemon flavour were added to improve the taste and aroma. Finally, the volume was adjusted to 100 ml with purified water, mixed thoroughly, filtered if necessary, and transferred into an amber-coloured bottle. The bottle was properly sealed and labelled as F1.

Table 1 – Formulation 1

Ingredients	**F1**
Banana stem juice	8ml
Sucrose	13g
Purified water	6ml
Glycerin	0.4ml
Sodium benzoate	0.02g in 0.4ml
Sorbitol (70%)	1ml
Citric acid	0.02g in 0.2ml
Lemon	1-2 drops
Final volume	Make up to 20 ml

For **F2**, the same procedure was followed using 50 ml of banana stem juice and 55 g of sucrose. The amount of glycerine was increased to 3 ml, while all other ingredients and preparation steps remained unchanged. The prepared syrup was similarly filtered, bottled, sealed, and labelled as F2.[10]

Table 2 – Formulation 2

Ingredients	**F2**
Banana stem juice	10ml
Sucrose	11g
Purified water	6ml
Glycerine	0.4ml
Sodium benzoate	0.02g in 0.4ml
Sorbitol (70%)	1ml
Citric acid	0.02 in 0.2ml
Lemon	1-2 drops
Final volume	Make up to 20 ml

For **F3**, the formulation was prepared using 60 ml of banana stem juice and 45 g of sucrose. The quantity of glycerine was increased to 5 ml to improve the consistency of the syrup. All other ingredients and preparation conditions were kept the same. After adjusting the final volume, the syrup was filtered when required, filled into amber-coloured bottles, sealed, and labelled as F3.

Table 3 – Formulation 3

Ingredients	**F3**
Banana stem juice	10ml
Sucrose	9g
Purified water	6ml
Glycerine	0.4ml
Sodium benzoate	0,02g in 0.4 ml
Sorbitol (70%)	1ml
Citric acid	0.02g in 0.2ml
Lemon	1-2 drops
Final volume	Make up to 20 ml

All three formulations were prepared on the same day using juice extracted from the same batch of banana stem. This helped ensure consistency and allowed any differences observed during evaluation to be attributed to the formulation composition rather than variations in the plant material. Throughout the preparation process, important parameters such as weights, volumes, and pH values were carefully recorded for further analysis and comparison.[11]

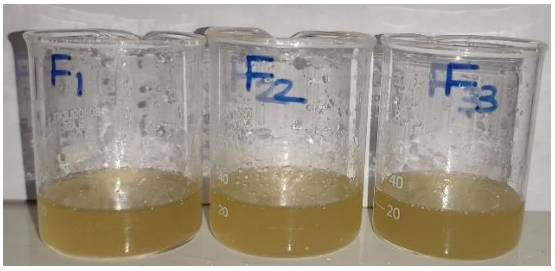

Figure 3. Syrup Formulations

2.4 - Preparation of Final Syrup:

Incubate for 30 minutes at room temperature in dark Read absorbance The herbal syrup was prepared by combining the freshly extracted banana stem juice with the prepared simple syrup base. The required quantity of banana stem juice was measured and taken in a clean beaker. The cooled simple syrup was added slowly to the juice while stirring continuously to ensure proper blending of all ingredients.

Glycerin was then added to improve the consistency and texture of the syrup, followed by the addition of sorbitol solution to enhance sweetness and maintain stability. Sodium benzoate, dissolved separately in a small amount of purified water, was incorporated into the mixture as a preservative to prevent microbial growth.

A solution of citric acid was added gradually while monitoring the pH, and the pH was adjusted to the desired range of 4.0–5.0. To improve the flavour and acceptability of the formulation, a few drops of lemon flavour were added and mixed thoroughly.

The final volume was adjusted to 100 ml using purified water, and the syrup was stirred well to obtain a uniform preparation. If any turbidity or suspended particles were observed, the syrup was filtered through filter paper to achieve better clarity. The finished syrup was then filled into amber-coloured glass bottles, properly sealed, labelled, and stored for subsequent evaluation and stability studies.

2.5- REAGENTS AND INSTRUMENTATION:

For Extraction:

Chemical Purpose Grade Purified Water Solvent for extraction pharmaceutical grade Muslin cloth / filter paper Filtration of juice—Citric acid Prevent oxidation during extraction AR grade

For Formulation:

Chemical Purpose Quantity (per 100 ml)Banana stem juice Active ingredient40–60 ml Sucrose (sugar)Sweetener, preservative, vehicle45–65 g Citric acid pH adjuster, preservative, antioxidant0.1 g Sodium benzoate Antimicrobial preservative0.1gGlycerin Viscosity modifier, humectant2–5 ml Sorbitol (70% solution)Co-sweetener, stabilizer 5ml Sodium CMC (0.3% w/v)Viscosity enhancer (optional)0.3 g Permitted flavour (lemon/mint)Taste masking q.s. Purified water Vehicle q.s. to 100 ml Amber glass bottle (100 ml)Packaging—

For Phytochemical Screening:

Chemical Purpose Mayer's reagent (Potassium mercuric iodide)Alkaloid test Dragendroff's reagent Alkaloid test Ferric chloride ($FeCl_3$)Tannin and phenol test Lead acetate solution Tannin test Fehling's solution A & B Sugar / glycoside test Molisch's reagent (α-naphthol + H_2SO_4)Carbohydrate test Sodium hydroxide (NaOH)Flavonoid test Concentrated sulphuric acid (H_2SO_4)Multiple tests Chloroform Steroid test (Salkowski test)Acetic anhydride Steroid test (Liebermann-Burchard)Froth test (water + shaking)Saponin test Ninhydrin reagent Protein/amino acid test

For Quantitative Estimation:

Chemical Purpose Folin-Ciocalteu reagent Total phenolic content Gallic acid (standard)TPC calibration Aluminium chloride ($AlCl_3$) Total flavonoid content Quercetin (standard)TFC calibration Sodium carbonate (Na_2CO_3) TPC assay Sodium nitrite ($NaNO_2$) TFC assay Methanol Solvent for estimation

For Evaluation:
pH meter, pH measurement, Ostwald's viscometer, Viscosity Specific gravity bottle (pycnometer)Density & specific gravity Refractometer, Refractive index, Water bath + crucible Total solid content Brookfield viscometer, Viscosity Hot air oven (40°C/75% RH) Stability study Nutrient agar, Savoured agar Microbial limit test McFarland standard Microbial count reference
Fresh Banana Stem, Purified Water, Sucrose, Citric Acid, Sodium Benzoate, Glycerine, Sorbitol (70%), Lemon Flavour.

2.6 – QUALITATIVE PHYTOCHEMICAL SCREENING PROTOCOL:

i. Test for Alkaloids (Mayer's Test):

A small quantity of the banana stem juice obtained from Musa paradisiaca was treated with Mayer's reagent (potassium mercuric iodide solution). The formation of a cream or white colored precipitate indicated the presence of alkaloids in the extract.

ii. Test for Alkaloids (Dragendroff's Test):

The extract was treated with Dragendroff's reagent. The appearance of an orange-red precipitate confirmed the presence of alkaloidal constituents.

iii. Test for Tannins (Ferric Chloride Test):

To a portion of the extract, a few drops of ferric chloride solution were added. The development of a blue-black or greenish coloration indicated the presence of tannins and phenolic compounds.

iv. Test for Tannins (Lead Acetate Test):
The extract was treated with lead acetate solution. The formation of a white precipitate confirmed the presence of tannins.

v. Test for Flavonoids (Alkaline Reagent Test):
The extract was treated with sodium hydroxide solution, which produced an intense yellow coloration. This coloration disappeared upon the addition of dilute hydrochloric acid, indicating the presence of flavonoids.

vi. Test for Phenols:

A few drops of ferric chloride solution were added to the extract. The formation of a blue, green, or black coloration confirmed the presence of phenolic compounds.

vii. Test for Saponins (Froth Test):

The extract was shaken vigorously with distilled water in a test tube. The formation of stable and persistent froth indicated the presence of saponins.

viii. Test for Carbohydrates (Molisch's Test):
To the extract, Molisch's reagent was added, followed by careful addition of concentrated sulphuric acid along the sides of the test tube. The formation of a violet or purple ring at the junction of the two liquids indicated the presence of carbohydrates**.**

ix. Test for Reducing Sugars (Fehling's Test):

The extract was treated with Fehling's solution A and B and then heated in a water bath. The formation of a brick-red precipitate confirmed the presence of reducing sugars.

x. Test for Steroids (Salkowski Test):

The extract was mixed with chloroform, followed by the addition of concentrated sulphuric acid. The appearance of a red coloration in the lower layer indicated the presence of steroids.

xi. Test for Steroids (Liebermann–Burchard Test):

The extract was treated with acetic anhydride and concentrated sulphuric acid. The development of a green or bluish coloration confirmed the presence of steroidal compounds.

xii. Test for Proteins and Amino Acids (Ninhydrin Test):

The extract was treated with ninhydrin reagent and heated. The appearance of a violet or purple coloration indicated the presence of proteins and amino acids.

xiii. Test for Glycosides (Borntrager's Test):

The extract was subjected to Borntrager's test. The formation of a pink or red coloration in the ammoniacal layer confirmed the presence of glycosides.

2.7 – PHYSICOCHEMICAL ESTIMATIONS;

1. pH determination:

pH determination was carried out using a calibrated pH meter. The electrode was immersed in the syrup, and stable readings were recorded. Maintaining pH within the range of 4.0–5.5 is important because it supports stability, improves taste, and enhances the effectiveness of preservatives like sodium benzoate.

- Calibrate pH meter with standard buffer solutions (pH 4.0 and 7.0)
- Dip electrode in the syrup
- Record Ph
- Acceptable range: 4.0 – 5.5 for oral herbal syrups. [12]

Figure 4. Auto digital pH meter

2. Viscosity:

Viscosity measurement was done using an Ostwald viscometer to study the flow behaviour of the syrup. The time taken for the syrup to flow through the capillary tube was compared with water, and viscosity was calculated. This parameter is important because it affects thickness, mouthfeel, and pourability of the syrup.

- Use Ostwald's viscometer
- Measure flow time (t) of sample and water
- Calculate using formula: $\eta_2 = \eta_1 \times (\rho_2 \times t_2) / (\rho_1 \times t_1)$, where η = viscosity, ρ = density, t = flow time Semantic Scholar
- Express in centipoise (cP)
- Expected range: 150–400 Cp. [13]

Table 4. viscosity limits:

Viscosity	**Interpretation**
<50	Very thin
50-100	Thin syrup
100-500	Standard medicinal syrup
500-1000	Thick syrup
1000	Very thick syrup

Figure 5. Ostwald viscometer

3. *Specific gravity:*

Specific gravity was determined using a pycnometer. The weight of the syrup was compared with the weight of water to determine its density. This helps in checking batch uniformity and ensuring consistent formulation quality.

- Weigh empty pycnometer (W1)
- Fill with purified water, weigh (W2)
- Empty, fill with syrup, weigh (W3)
- Specific Gravity = (W3 – W1) / (W2 – W1)
- Expected specific gravity for herbal syrups is approximately 1.3–1.4 g/ml Pharmed.[14]

Figure 6. Gay Lussac Pycnometer

4. *Refractive index:*

Refractive index was measured using a refractometer by placing a drop of syrup on the prism. This test gives an idea about the concentration of dissolved solids like sugar and plant extract, and also indicates formulation consistency.

- Place a drop of syrup on refractometer prism
- Measure and record refractive index
- Expected refractive index value is approximately 1.4–1.45 Pharmed.

Figure 7. Abbe Refractometer

5. Total solid content:

Total solid content was estimated by evaporating a known quantity of syrup and weighing the residue left behind. This value reflects the total dissolved and suspended matter in the formulation and helps in comparing different batches (F1, F2, F3). Take 5 ml syrup in pre-weighed crucible.

- Evaporate on water bath to dryness
- Dry in hot air oven at 105°C for 1 hour
- Weigh and calculate
- Total solids (%) = (Weight of residue / Volume taken) × 100
- Expected total solids content is approximately 70–80% for sucrose-based syrups Pharmed.[15]

Figure 8. Moisture Analyzer

6. Microbial limit:

Microbial limit testing was performed to ensure safety. The syrup was tested for total bacterial count and fungal count, and product is safe for oral consumption.

Procedure:

- Prepare 1:10 dilution of the syrup in sterile saline
- Make serial dilutions up to 10^{-4}

Pour plate method:

- Nutrient agar plates → Total Aerobic Count (TBC)
- Savoured dextrose agar plates → Total Fungal Count (TFC)

- Incubate at 37°C for 48 hours (bacteria) and 25°C for 5 days (fungi)
- Count colonies and express as CFU/ml
- Acceptable limits (as per IP/WHO):
- Total aerobic count: ≤ 10^2 CFU/ml
- Total fungal count: ≤ 10^1 CFU/ml
- E. coli: Absent
- S. aureus: Absent [62]
- Make serial dilutions up to 10^{-4}.[16]

Figure 9. Microbial count

Table 5. Microbial contamination limits:

Parameter	Standard limit
Total aerobic microbial count (TAMC)	NMT 10^2 CFU/ ml
Total yeast and mould count (TYMC)	NMT10^1CFU/ ml
Escherichia. coli	Absent in 1ml
Salmonella spp.	Absent in 10ml

CFU=Colony forming units

III. RESULTS AND DISCUSSION:

3.1- PHYTOCHEMICAL SCREENING:

Table 6. Phytochemical evaluation

S. No	Phytoconstituent	Test Used	Reagent	Positive Result
1	Alkaloids	Mayer's test	Mayer's reagent	Cream/white precipitate
2	Alkaloids	Dragendroff's test	Dragendroff's reagent	Orange-red precipitate
3	Tannins	Ferric chloride test	$FeCl_3$ solution	Blue-black / green colour
4	Tannins	Lead acetate test	Lead acetate solution	White precipitate
5	Flavonoids	Alkaline reagent test	NaOH + dilute HCl	Yellow colour that fades
6	Phenols	Ferric chloride test	$FeCl_3$ solution	Blue/green/black colour
7	Saponins	Froth test	Distilled water	Persistent foam formation
8	Carbohydrates	Molisch's test	Molisch reagent + H_2SO_4	Violet ring at interface
9	Reducing sugars	Fehling's test	Fehling's A & B	Brick-red precipitate
10	Steroids	Salkowski test	Chloroform + H_2SO_4	Red colour in lower layer
11	Steroids	Liebermann–Burchard test	Acetic anhydride + H_2SO_4	Blue/green colour
12	Proteins	Ninhydrin test	Ninhydrin reagent	Purple/violet colour
13	Glycosides	Borntrager's test	Organic solvent + NH_3	Pink/red colour

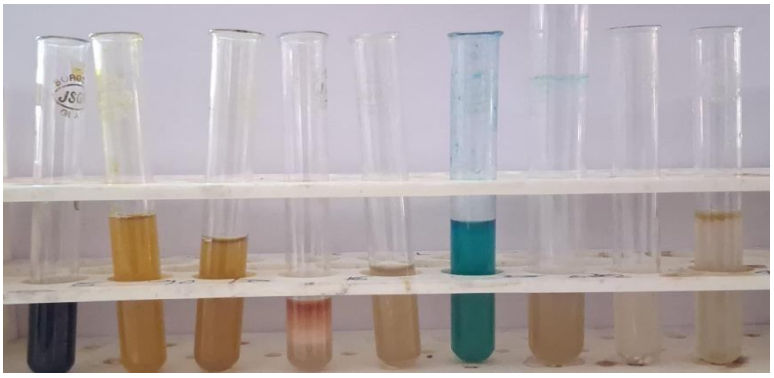

Figure 10. Phytochemical tests

Fresh Musa paradisiaca pseudostem was successfully collected, cleaned, and processed to obtain fresh juice. The extraction process yielded a light-coloured juice with a characteristic Odor and slightly sweet taste. The juice was free from visible impurities and was immediately utilized for syrup preparation to preserve its phytochemical constituents and prevent oxidation. The addition of dilute citric acid effectively minimized enzymatic browning and maintained the quality of the extract. Three formulations (F1, F2, and F3) were successfully prepared using different concentrations of banana pseudostem juice and sucrose. The formulations were clear, homogeneous, and free from sedimentation or phase separation. The prepared syrups possessed acceptable consistency and were easy to pour.

Formulation	Banana Stem Juice	Sucrose
F1	Lower concentration	Higher concentration
F2	Moderate concentration	Moderate concentration
F3	Higher concentration	Lower concentration

The incorporation of glycerine and sorbitol improved viscosity and sweetness, while sodium benzoate acted as an effective preservative. Lemon flavour enhanced palatability and improved consumer acceptability.
Preliminary phytochemical analysis of banana pseudostem juice revealed the presence of several biologically active constituents.
Detected Phytoconstituents

1. Alkaloids
2. Tannins
3. Flavonoids
4. Phenolic compounds
5. Saponins
6. Carbohydrates
7. Reducing sugars
8. Proteins
9. Glycosides
10. Steroidal compounds

The presence of these constituents confirms the medicinal and nutritional significance of Musa paradisiaca pseudostem and supports its use in herbal formulations.

3.2 – PHYSICOCHEMICAL EVALUATION:

Table 7. Physicochemical evaluation

Parameter	F1	F2	F3	Standard	Observation
pH	4.2	4.5	4.8	4.0–5.5	Within acceptable range
Viscosity (cP)	180	220	260	100–500	Good consistency
Specific Gravity	1.32	1.35	1.38	1.3–1.4	Uniform density
Refractive Index	1.41	1.43	1.45	1.40–1.45	Proper sugar content
Total Solid (%)	72	75	78	70–80%	Adequate solids
Appearance	Clear	Clear	Clear	Clear	No turbidity
Colour	Light brown	Light brown	Slightly dark	Uniform	Acceptable
Odour	Pleasant	Pleasant	Pleasant	Characteristic	Acceptable
Taste	Sweet	Balanced	More herbal	Palatable	Acceptable
Microbial Limit	Within	Within	Within	IP/WHO	Safe

i. pH

pH indicates the acidity or alkalinity of the syrup. A pH between 4.0 and 5.5 helps maintain chemical stability, improves preservative effectiveness, and minimizes microbial growth. The obtained values

(4.2–4.8) are within the acceptable range, indicating good stability and suitability for oral administration.

ii. Viscosity

Viscosity measures the flow behaviour of the syrup. Values of 180–260 cP indicate good pourability while ensuring uniform dosing and pleasant mouthfeel.

iii. Specific Gravity

Specific gravity represents density relative to water and reflects uniform formulation. Values of 1.32–1.38 confirm proper concentration.

iv. Refractive Index

Refractive index estimates dissolved sugar and solids. Values of 1.41–1.45 indicate proper sugar concentration and batch consistency.

v. Total Solids

Total solids represent dissolved and suspended constituents responsible for body, sweetness, and stability. Values of 72–78% fall within the desired range.

vi. Appearance

Clear appearance without turbidity indicates absence of precipitation or contamination and good formulation stability.

vii. Colour

Uniform light brown to slightly dark colour is expected from herbal extracts and indicates acceptable product consistency.

viii. Odour

A pleasant characteristic odour confirms acceptable sensory quality without signs of spoilage.

ix. Taste

Taste affects patient compliance. Sweet to balanced herbal taste indicates good palatability while retaining herbal characteristics.

x. Microbial Limit

Microbial testing ensures the product is free from harmful microorganisms. Results within IP/WHO limits demonstrate safety and adequate preservation.

IV. CONCLUSION :

The present investigation successfully achieved the formulation and physicochemical evaluation of a herbal syrup containing Musa paradisiaca pseudo stem extract. The study demonstrated that banana pseudo stem, which is often discarded as agricultural waste, can be effectively utilized as a valuable source of bioactive compounds for herbal formulation development.

Fresh banana pseudo stem juice was successfully extracted and incorporated into syrup formulations. The prepared formulations showed good organoleptic properties, including acceptable colour, pleasant Odor, desirable taste, and attractive appearance. No evidence of sedimentation, crystallization, or phase separation was observed during the study period.

Phytochemical screening confirmed the presence of important medicinal constituents such as flavonoids, phenols, tannins, alkaloids, glycosides, carbohydrates, proteins, and saponins. These phytoconstituents contribute significantly to the therapeutic potential of the formulation. Physicochemical evaluation revealed that all formulations possessed satisfactory pH, viscosity, specific gravity, refractive index, and total solid content. These parameters complied with acceptable standards for oral herbal syrups and indicated good formulation quality.

Microbial evaluation demonstrated that the formulations were microbiologically safe and free from harmful contamination. Stability studies further confirmed that the syrups maintained their quality characteristics throughout storage.

Among all formulations, F2 was identified as the optimized formulation due to its superior balance of physicochemical properties, stability, taste, and overall acceptability.

In conclusion, Musa paradisiaca pseudo stem extract can be successfully formulated into a stable, safe, and acceptable herbal syrup. The developed formulation has potential applications as a nutraceutical and herbal health supplement. Further studies involving antioxidant evaluation, pharmacological investigations, toxicity assessment, and clinical studies are recommended to establish its therapeutic efficacy and commercial potential.

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