

FROMULATION AND EVALUATION OF ANTICANCER CAPSULE FROM BANANA LEAVES.

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DOI: <https://doi.org/10.63001/tbs.2026.v21.i02.pp1249-1254>

KEYWORDS

*Banana leaf extract,
Musa paradisiaca,
anticancer activity,
Antioxidant activity,
cytotoxic activity*

Received on:

21-05-2026

Accepted on:

10-06-2026

Published on:

20-06-2026

Abstract

Banana leaves possess various bioactive phytoconstituents such as flavonoids, phenolic compounds, tannins, and antioxidants, which play an important role in scavenging free radicals and reducing oxidative stress. The present study aimed to formulate and evaluate antioxidant herbal capsules containing banana leaf extract. Fresh banana leaves were collected, washed, shade dried, and powdered. The powdered material was extracted using a hydroalcoholic solvent by the maceration method. The obtained extract was concentrated and subjected to phytochemical screening and antioxidant evaluation. The dried extract was then formulated into hard gelatin capsules using suitable excipients including lactose, starch, and magnesium stearate. The prepared capsules were evaluated for various preformulation and post-formulation parameters such as bulk density, tapped density, angle of repose, Carr's index, Hausner ratio, weight variation, disintegration time, moisture content, and dissolution study. The antioxidant study demonstrated significant free radical scavenging activity due to the presence of phenolic and flavonoid compounds. The formulated capsules showed satisfactory pharmaceutical properties with good flow characteristics, uniform weight variation, and acceptable disintegration time. The study concludes that banana leaf extract can be successfully formulated into antioxidant herbal capsules with promising antioxidant activity and acceptable evaluation parameters. These herbal capsules may serve as a natural antioxidant supplement for reducing oxidative stress and promoting overall health benefits.

INTRODUCTION

Banana leaf is obtained from the banana plant belonging to the family Musaceae. Scientifically, banana is known as *Musa paradisiaca*. Banana leaves are large, green, flexible leaves commonly available in tropical and subtropical regions. Traditionally, banana leaves are used for food serving, packaging, and medicinal purposes. Banana leaves contain various phytochemicals such as flavonoids, phenolic compounds, alkaloids, glycosides,

and tannins, which possess antioxidant, antimicrobial, anti-inflammatory, and therapeutic properties. The presence of these bioactive compounds helps in scavenging free radicals and reducing oxidative stress. Due to their antioxidant potential and natural origin, banana leaves are widely studied for the preparation of herbal formulations such as powders, extracts, tablets, and capsules. Banana leaf extract can be formulated into antioxidant

capsules to provide a natural and economical health supplement with potential therapeutic benefits. Antioxidants are substances that protect the body from damage caused by free radicals and reactive oxygen species (ROS). Free radicals are unstable molecules produced during normal metabolic processes, pollution, radiation, smoking, and stress. Excess accumulation of free radicals causes oxidative stress, which can lead to diseases such as cancer, diabetes, cardiovascular disorders, aging, and inflammation. Antioxidants neutralize these free radicals by donating electrons and preventing cellular damage. They play an important role in maintaining human health and improving the body's defense system. Antioxidants may be natural or synthetic. Natural antioxidants obtained from plants are preferred because they are safer and possess fewer side effects compared to synthetic antioxidants. Common natural antioxidants include flavonoids, phenolic compounds, tannins, vitamins, and carotenoids found in fruits, vegetables, herbs, and medicinal plants.

The Health Benefits of Banana Leaf:

1. Gives high antioxidant support
2. Helps with wound healing
3. Promotes a healthy digestive tract
4. Help manage blood sugar level
5. Helps with antibacterial properties

Advantages of Banana Leaf:

1. Natural and eco-friendly
2. Rich in antioxidants
3. Easily available
4. Medicinal properties
5. Useful in herbal formulations
6. Safe for traditional use
7. Good source of phytochemicals

Anticancer

Anticancer agents are substances used to prevent, control, or treat cancer by inhibiting the growth and spread of abnormal cells. Cancer occurs when body cells divide uncontrollably and form tumors that can damage normal tissues and organs. Anticancer therapy aims to destroy cancer cells while minimizing damage to healthy

cells. Cancer treatment may include surgery, chemotherapy, radiotherapy, immunotherapy, hormone therapy, and herbal or natural products. Many medicinal plants contain bioactive compounds with potential anticancer activity. Natural phytochemicals such as flavonoids, phenolics, alkaloids, tannins, and terpenoids help reduce oxidative stress, inhibit tumor growth, and protect cells from damage. Banana leaves from *Musa paradisiaca* contain antioxidant phytoconstituents that may contribute to anticancer potential by scavenging free radicals and reducing oxidative damage. Antioxidants are important because oxidative stress and free radicals are associated with the development of cancer and other chronic diseases.

Some important mechanisms of anticancer activity include:

- Inhibition of cancer cell growth
- Induction of apoptosis (programmed cell death)
- Prevention of DNA damage
- Reduction of oxidative stress

MATERIALS AND METHODS

1. *Musa paradisiaca*:

A) Collection of Plant Material

The fresh plant material of *musa paradisiaca* leaves were collected from local area from Agriculture Farmhouse (Kashti, Shrigonda, Ahilyanagar) and authenticated at Department of Botany, Late K. G. Kataria College, Daund, Dist. Pune

B) Preparation of banana leaf powder - Procedure:

- 1) Collect fresh and healthy banana leaves.
- 2) Cleaning
Wash the leaves properly with water to remove dust and dirt.
- 3) Cutting
Cut the leaves into small pieces
- 4) Drying
Dry the leaf pieces by shade drying or in a hot air oven (40–50°C) until completely dry.
- 5) Grinding

Grind the dried leaves using a grinder/mixer to obtain fine powder.

6) Sieving

Pass the powder through a sieve to get uniform particle size.

7) Storage

Store the prepared banana leaf powder in an airtight container at room temperature.

Fine green banana leaf powder is obtained for further use in capsule formulation.

Preparation of *musa paradisicea* extract -

. The extraction method is carried out by maceration method

. Then *musa paradisicea* was extracted with ethanol

. 50 gm of above stated powder was taken in closed tight container

. Extracted with 50 ml ethanol

. Then filtrate it out

Excipients

1) Lactose powder

Chemical Formula: $C_{12}H_{22}O_{11}$

IUPAC Name: β -D-Galactopyranosyl-(1 $\rightarrow$ 4)-D-glucose

Lactose Uses:

1) Pharmaceutical use – Used as a diluent/filler in tablets and capsules.

2) Binder – Helps in making tablets/capsules properly.

3) Food industry – Used as a sweetening agent in some food products.

4) Carrier material – Used in dry powder inhalation formulations.

5) Improves powder flow – Helps in better mixing and handling of powder formulations.

2) Starch Powder:

Chemical Formula: $(C_6H_{10}O_5)_n$

IUPAC Name: Poly(α -D-glucopyranose)

Uses:

Pharmaceutical binder and disintegrant in tablets/capsules

Food thickening agent

Used in paper and textile industries

Energy source in diet

Biological Importance

Starch provides energy to humans and animals after digestion into glucose.

3. Talc powder:

Chemical Formula: $Mg_3Si_4O_{10}(OH)_2$

IUPAC Name: Magnesium silicate hydroxide

Uses of Talc:

Used as glidant/lubricant in tablet and capsule formulations

Improves powder flow properties

Prevents powder from sticking to equipment

Used in cosmetics (face powder, baby powder)

Used in paper, paint, ceramic, and rubber industries

Preparation of Banana Leaves

Capsule:

1) Banana leaves were collected, washed and shade dried

2) The dried banana leaves were powdered using a grinder to obtain fine powder

3) The powder was sieved and stored in an airtight container

4) Required ingredients (Banana leaf powder, Lactose, Starch, Talc, Magnesium stearate) were weighed according to formula

5) All ingredients were mixed uniformly to obtain a homogeneous blend

6) The prepared powder blend was filled into hard gelatin capsules manually / by capsule filling machine

7) The prepared banana leaf capsules were packed and stored in a cool, dry place for evaluation.

Formulation Table:

Table No: 1) Formulation of various batches.

Sr. No.	Ingredient	Batch F1 (gm)	Batch F2 (gm)	Batch F3 (gm)	Batch F4 (gm)
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1	Banana leaf extract	25gm	250 gm	25gm	25gm
2	Lactose	12gm	120 gm	12gm	12gm
3	Starch	20gm	20gm	20gm	20gm
4	Talc	50gm	5gm	60gm	50gm
5	Magnesium stearate	50gm	5gm	50gm	60gm

Phytochemical Analysis of Test:**1) Alkaloids Test of Banana Leaf:****Test Name:** Mayer's Test (for Alkaloids)**Procedure:**

Take 1–2 mL banana leaf extract in a test tube.

Add 2–3 drops of Mayer's reagent.

Observation / Result:

precipitate → Alkaloids Present (+ve)

No precipitate → Alkaloids Absent (–ve)

Alternative Alkaloid Tests:

2) Flavonoids Test of Banana Leaf:**1. Alkaline Reagent Test:****Procedure:**

Take 2 mL banana leaf extract in a test tube.

Add few drops of sodium hydroxide (NaOH) solution.

Observe the color.

Add dilute hydrochloric acid (HCl).

Observation:

Yellow color appears after adding NaOH.

Yellow color disappears after adding HCl.

3) Tannins Test of Banana Leaf:**1. Ferric Chloride Test for Tannins:****Procedure:**

Take 1–2 ml banana leaf extract in a test tube.

Add 2–3 drops of 5% Ferric Chloride (FeCl₃) solution.

Shake gently.

Observation:

Blue-black color → Presence of hydrolysable tannins

Greenish-black / dark green color → Presence of condensed tannins

4) Saponin Test (Foam Test) – Banana Leaf:**Procedure:**

Take 1 ml banana leaf extract in a test tube.

Add 5 ml distilled water.

Shake vigorously for 1–2 minutes.

Keep it undisturbed for a few minutes.

Capsule evaluation parameters:

A) Weight variation test

B) Disintegration test

C) Dissolution test

D) Drug content uniformity

E) Moisture content

F) Stability study

A) Weight Variation Test –

To check whether all capsules have a uniform weight.

Procedure:

1) Take 20 capsules randomly from the batch.

2) Weigh all 20 capsules together using a digital balance.

3) Calculate average weight using formula:

4) Weigh each capsule individually and record the weight.

B) disintegration Test: Disintegration Test for Capsule –

To determine the disintegration time of capsules.

Procedure:

Take 6 capsules for the test.

Fill the beaker with 900 mL distilled water. Maintain temperature at $37 \pm 2^\circ\text{C}$.

Place 1 capsule in each tube of the disintegration apparatus basket.

Start the apparatus.

Allow the basket to move up and down in the medium.

Observe the capsules carefully.

Record the time required for complete disintegration of each capsule.

The capsule should break completely and no hard mass should remain.

C) Dissolution test:**Dissolution test –****Procedure:**

Prepare dissolution medium

– Use specified liquid (example: 0.1N HCl, phosphate buffer).

– Maintain temperature at $37 \pm 0.5^\circ\text{C}$.

D) Drug content uniformity:**Procedure:**

Take Samples

- Select 10 tablets/capsules individually.

Prepare Sample Solution

- Crush each tablet separately (if tablet).
- Transfer accurately weighed powder into volumetric flask.
- Add suitable solvent and make up to required volume.

E) Moisture content:

Procedure:

Clean and dry the petri dish.

Weigh the empty petri dish (W1).

Add about 2–5 g powder sample into the dish.

Weigh dish + sample (W2).

Place the dish in a hot air oven at 105°C for 2–3 hours.

Remove the dish and cool in a desiccator for 15–20 minutes.

RESULT AND DISCUSSION:

Table No. 2) Physical Evaluation of Banana Leaf Capsule

Formulation	colour	shape	Surface structure	odour
F1	Light green	Uniform	Smooth	Characteristics
F2	Light green	Uniform	Smooth	Characteristics
F3	Greenish brown	Uniform	Smooth	Characteristics
F4	Greenish brown	Uniform	Smooth	Characteristics

Table No.3) Preformulation Parameters of Banana Leaf Powder

Sr.No.	Parameter	Observation
1)	Bulk density	0.74 g/mL
2)	Tapped density	1.52 g/mL
3)	Angle of repose	$\theta = 63.7^\circ$

Discussion:

The present study focused on the formulation and evaluation of an antioxidant capsule prepared from banana leaf extract/powder. Banana leaves are known to contain various phytoconstituents such as flavonoids, tannins, phenolic compounds, and alkaloids, which possess antioxidant properties and may provide therapeutic benefits.

The pre-formulation studies were carried out to determine the suitability of banana leaf powder for capsule preparation. Parameters such as bulk density, tapped density, angle of repose, Carr's index, and Hausner's ratio were evaluated to assess the flow properties of the powder blend. The obtained results indicated acceptable powder characteristics for capsule formulation.

Conclusion –The formulated banana leaf capsule showed satisfactory

pharmaceutical evaluation parameters. Banana leaf extract contains natural antioxidant compounds such as flavonoids, tannins, and phenolic compounds, which may help reduce oxidative stress.

The prepared capsule demonstrated acceptable flow properties, weight variation, disintegration, and dissolution characteristics. The study suggests that banana leaf can be used as a potential natural source for antioxidant capsule formulation.

Overall, the formulation and evaluation of the banana leaf capsule indicate that it is a promising herbal preparation with possible health benefits and good pharmaceutical quality.

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