

Preparation And Evaluation of Herbal Medicated Chocolate Containing Momordica Charantia for Antipyretic, Anti-Inflammatory and Antitussive Activity

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Abstract—The present research focuses on the formulation and evaluation of a novel herbal mediated chocolate containing Momordica charantia extract for its potential antipyretic, anti-inflammatory, and antitussive activities. Momordica charantia, commonly known as bitter gourd, is a medicinal herb rich in phytoconstituents such as flavonoids, saponins, alkaloids, and glycosides, which are responsible for its therapeutic properties. However, the intense bitter taste of the plant limits its patient acceptability and compliance. To overcome this challenge, the extract was incorporated into a chocolate-based dosage form to enhance palatability and improve patient convenience.

The extract was prepared by solvent extraction and subjected to phytochemical screening for the identification of active constituents. Herbal mediated chocolates were formulated using cocoa butter, cocoa powder, sweeteners, and other pharmaceutical excipients through moulding and cooling techniques. The prepared formulations were evaluated for various parameters including organoleptic properties, weight variation, hardness, friability, melting point, moisture content, pH, drug content uniformity, and in-vitro dissolution studies. Stability studies were also performed under different environmental and storage conditions.

The evaluation results showed that the mediated chocolates possessed satisfactory pharmaceutical characteristics, uniform s physicochemical distribution of the herbal extract, acceptable drug release behaviour, and good stability. The presence of bioactive compounds supports the possible antipyretic, anti-inflammatory, antioxidant, and antitussive effects of the formulation. In addition, the chocolate base effectively masked the bitterness of the extract and enhanced patient compliance, especially among pediatric and geriatric patients.

Thus, the study suggests that herbal mediated chocolate is a promising, palatable, stable, and patient-friendly

novel drug delivery system for the effective administration of Momordica charantia in the management of fever, inflammation, and cough.

Index Terms—Antipyretic, Anti-inflammatory, Antitussive, Bitter gourd, Herbal mediated chocolate, Momordica charantia, Novel drug delivery system, Patient compliance, Phytoconstituents.

I. INTRODUCTION

Herbal medicines have been used for centuries in the prevention and treatment of various diseases because of their effectiveness, natural origin, and reduced side effects. In modern healthcare, there is an increasing demand for herbal formulations as safer alternatives to synthetic medications, particularly for treating common conditions such as fever, inflammation, and cough. Among various medicinal plants, Momordica charantia Linn., commonly known as bitter gourd or karela, possesses significant therapeutic significance and has been traditionally used in Ayurveda, Unani, and Traditional Chinese Medicine.

Momordica charantia belongs to the Cucurbitaceae family and contains a variety of bioactive compounds including flavonoids, saponins, alkaloids, glycosides, steroids, and triterpenoids. These phytoconstituents are responsible for several pharmacological actions such as antidiabetic, antioxidant, antimicrobial, anti-inflammatory, antipyretic, and immunomodulatory activities. Traditionally, different parts of the plant, including fruits, leaves, and seeds, have been used for the treatment of diabetes, digestive disorders, liver diseases, fever, infections, and respiratory problems. Recent scientific studies have also supported its role in

reducing inflammation, lowering body temperature, and suppressing cough.

Despite its medicinal benefits, the major disadvantage associated with *Momordica charantia* is its highly bitter taste, which decreases patient acceptability and compliance, especially among children and elderly patients. Therefore, the development of a more palatable dosage form is necessary to improve its therapeutic use. Herbal medicated chocolate has emerged as an innovative and patient-friendly drug delivery system that can effectively mask unpleasant taste while enhancing convenience and acceptability. Chocolate based formulation offers advantages such as improved palatability, ease of administration, and enhanced patient compliance, easy administration, good stability, and suitability for incorporating herbal extracts.

The present study focuses on the formulation and evaluation of herbal medicated chocolate containing *Momordica charantia* extract for its potential antipyretic, anti-inflammatory, and antitussive activities. The study aims to combine the medicinal benefits of the plant with improved palatability to enhance patient compliance. Furthermore, the developed formulation was evaluated for various physicochemical parameters, stability, and potential therapeutic effectiveness to determine its suitability as a novel herbal dosage form.

Botanical Description

- Kingdom: Plantae
- Family: Cucurbitaceae
- Genus: *Momordica*
- Species: *M. Charantia*
- Morphology: *Momordica Charantia* is a climbing vine with slender stems and tendrils. The leaves are deeply lobed, and the flowers are yellow, unisexual, and grow singly in leaf axils. The fruit is elongated, warty, and green when unripe, turning orange upon ripening. Seeds are flat and white to light brown in color.

Phytochemical Constituents: *Momordica charantia* contains a wide array of bioactive compounds, which contribute to its medicinal properties. Important constituents include:

1. Alkaloids: Momordicine, Charantin
2. Saponins: Charantin
3. Flavonoids: Quercetin, Kaempferol

4. Triterpenes: Cucurbitane-type triterpenoids
5. Polysaccharides: With immunomodulatory and antioxidant activity.

Vitamins and minerals: Vitamin C, Vitamin A, Iron and potassium.

Traditional Uses

Historically, *Momordica charantia* has been used for:

- Antidiabetic activity – Reducing blood glucose levels.
- Digestive disorders – Constipation, dyspepsia.
- Liver disorders – Hepatoprotective effects.
- Antimicrobial activity – Against bacteria and viruses.
- Antioxidant activity – Scavenging free radicals.

Pharmacological Activities

Modern research has validated several pharmacological activities of *Momordica charantia*, including:

- ❖ Antidiabetic: Enhances insulin secretion and glucose uptake
- ❖ Antioxidant: Protects against oxidative stress
- ❖ Anti-inflammatory and immunomodulatory: Reduces inflammation markers
- ❖ Antipyretic and antitussive potential: Emerging studies suggest beneficial effects in fever and cough management.

II. RATIONALE FOR THE STUDY

Fever, inflammation, and cough are common symptoms associated with infections and respiratory disorders. Conventional drugs for these conditions, such as NSAIDs and antitussives, may cause adverse effects with prolonged use. Hence, there is growing interest in herbal alternatives that are safer, effective, and easily accessible. *Momordica charantia* contains several bioactive phytoconstituents, including flavonoids, saponins, triterpenes, and polysaccharides, which have been reported to modulate inflammatory pathways, reduce pyrexia, and suppress cough reflex. The development of a herbal chocolate formulation ensures a standardized dose, enhances patient compliance, and preserves the stability of active constituents.

III. BENEFITS OF MOMORDICA CHARANTIA

The development of Momordica charantia-based medicated chocolates for antipyretic, anti-inflammatory, and antitussive purposes provides numerous therapeutic, scientific, and healthcare-related advantages. In addition to these activities, the plant possesses several other medicinal benefits as described below:

Anti-diabetic Activity

Momordica charantia contains important bioactive compounds such as charantin, vicine, and polypeptide-p, which are known for their blood glucose-lowering properties. These constituents exhibit insulin-like activity, improve glucose utilization, reduce intestinal glucose absorption, and support glycogen regulation. Therefore, the formulation may also serve as a beneficial nutraceutical preparation for diabetic individuals.

Antioxidant Activity

Bitter gourd is rich in flavonoids, phenolic compounds, and vitamin C, which help neutralize harmful free radicals and reduce oxidative stress. In addition, dark chocolate contains cocoa polyphenols with strong antioxidant potential. The combination of herbal extract and chocolate base may therefore provide enhanced antioxidant effects and help protect against disorders associated with oxidative damage, such as diabetes, cardiovascular diseases, and premature aging.

Antipyretic and Antitussive Effects

Traditionally, Momordica charantia has been used in Ayurveda and folk medicine for reducing fever and relieving cough and throat irritation. Its phytoconstituents possess anti-inflammatory properties that may help soothe the respiratory tract and suppress cough reflexes naturally.

Hepatoprotective Activity

Research studies suggest that Momordica charantia may help protect liver function by reducing lipid peroxidation and maintaining normal levels of liver enzymes such as ALT, AST, and ALP. It may also provide protection against liver damage caused by toxins, alcohol, and certain drugs, making it useful as a supportive herbal supplement for liver health.

Benefits of Herbal Medicated Chocolate

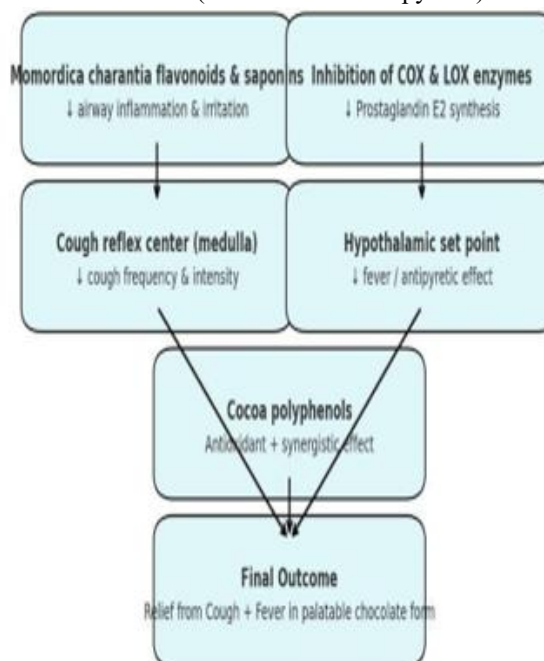
Pharmaceutical and Therapeutic

- Provides natural antitussive action by soothing throat irritation and reducing cough.
- Exhibits antipyretic activity due to the presence of flavonoids and saponins in the herbal extract.
- Offers anti-inflammatory and antioxidant effects from both Momordica charantia and cocoa flavonoids.
- Produces synergistic therapeutic benefits, as cocoa contributes antioxidant and mood-enhancing properties that complement the herbal constituents.
- Acts as a safer herbal alternative to synthetic cough syrups and tablets, which may cause side effects such as drowsiness or gastric irritation.

Patient-Oriented

- Effectively masks the bitter taste of Momordica charantia through the chocolate base.
- Improves patient compliance and acceptability, particularly among pediatric and geriatric patients and individuals who dislike conventional tablets or syrups.
- Provides a convenient, palatable, and easy-to-administer dosage form suitable for routine use.

Mechanism of Action (MOA) Mechanism Of Action of Momordica Charantia Chocolate (Antitussive + Antipyretic)



Here's how Herbal Medicated Chocolate with *Momordica charantia* works as an antitussive and antipyretic which explain how flavonoids and saponin help reduce cough, COX inhibition lowers fever, and cocoa adds synergistic antioxidant support leading to relief from cough + fever in a palatable chocolate form.

1. Antitussive Mechanism (Cough suppression)

- Flavonoids (Astragalin, Isoquercetin) → exhibit anti-inflammatory effect on the respiratory mucosa → reduce irritation of cough receptors.
- Saponins & Triterpenoids (Momordicosides) → have a mild expectorant effect, helping to loosen mucus and soothe airway irritation.
- Central action: Some studies suggest flavonoids modulate the cough center in the medulla, reducing frequency and intensity of cough.
- Overall effect → Decreases cough reflex, reduces throat irritation, and improves breathing comfort.

2 Antipyretic Mechanism (Fever reduction)

- Fever is mediated by prostaglandins (PGE₂) released due to pyrogen-induced activation of COX-2. *Momordica charantia* flavonoids and glycosides → inhibit cyclooxygenase (COX) and lipoxygenase (LOX) pathways, leading to ↓ PGE₂ synthesis in the hypothalamus.
- Reduction in PGE₂ levels → resets hypothalamic thermostat to normal → lowers body temperature.
- An additional antioxidant effect also helps modulate oxidative stress linked to fever.

3 Role of Chocolate Base (Cocoa Polyphenols)

- Cocoa flavonoids (epicatechin, catechin) provide antioxidant & anti-inflammatory support, enhancing the effect of *M. charantia*.
- Cocoa butter provides a protective lipid matrix that improves stability and slow release of herbal actives.
- Chocolate also improves patient compliance by masking bitterness.

Experimental Procedure

Step 1: Collection and Preparation of Plant Material

- 1) Collect fresh *Momordica charantia* leaves/fruits from a verified herbal garden.
- 2) Authenticate the plant with a botanist or herbarium.
- 3) Wash thoroughly to remove dust and foreign particles.

4) Dry the plant material in shade at room temperature for 7–10 days.

5) Grind the dried plant material into coarse powder using a mechanical grinder.

6) Sieve through a 60-mesh sieve to obtain uniform powder.

7) Store powdered plant material in an airtight container.

Step 2: Preparation of Extract

A- Solvent Selection:

Use ethanol, methanol, or hydro alcoholic solution to extract polar and non-polar bioactive compounds.

B-Extraction Procedure (Maceration)

1-Weigh 50 g of dried Karela powder.

2-Add 250 mL ethanol in an airtight container (1:5 ratio).

3-Shake occasionally during 24 hours at room temperature.

4-Filter through muslin cloth / filter paper → collect filtrate.

5-Concentrate filtrate using heating mantle at 30 °C until thick extract remains (~4–6 hours).

6-Use this extract for chocolate formulation.

Step 3: Phytochemical Screening

PHYTOCONSTITUENT	TEST
Alkaloid	Mayer's & Dragendroff's Test
Flavonoid	Shinoda Test
Saponins	Froth Test
Phenols and Tannins	Ferric Chloride Test
Steroid And Triterpenoids	Libermann-Burchard Test

Step 4: Formulation of Herbal Chocolate

1. Melting the Chocolate Base

Use a double boiler to gently melt dark chocolate and cocoa butter (don't exceed 45°C).

Stir continuously for even melting.

2. Incorporating Extract

Weigh and sieve the *M. charantia* extract to avoid lumps.

Slowly add extract into melted chocolate while stirring continuously to ensure uniform dispersion.

3. Add Sweetener & Flavor

Add stevia or powdered sugar and vanilla/mint essence. Mix well until uniform.

4. Add Emulsifier (Optional)

Add lecithin to improve texture and stability.

5. Moulding

Pour the final chocolate mixture into pre-sterilized silicone moulds. Tap gently to remove air bubbles.

6. Cooling

Refrigerate the moulds at 4–8°C for 30–60 minutes or until solidified.

Step 5: Evaluation of Chocolate Formulation

The main evaluation parameters for herbal medicated chocolates are as follow:

1. Organoleptic Properties
2. Weight Variation Test
3. Hardness & Texture Analysis
4. Melting Point determination
5. Moisture Content
6. Drug Content Uniformity
7. Dissolution Test
8. Stability Studies

Evaluation Parameters

1. Organoleptic Properties-

Objective: To be checked by visual inspection and sensory evaluation.

- Colour
- Odor
- Taste
- Texture

2. Weight Variation-

Objective: To ensure uniformity of chocolate weight.

Procedure:

1. Weigh 10-20 pieces of chocolate individually using a digital balance.
2. Calculate the average weight.
3. Compare individual chocolate weight with the average.
4. The deviation should be within $\pm 5\%$ for herbal chocolates.
3. Hardness/Texture Analysis-
Objective: To determine the mechanical strength (resistance to deformation or breakage) of herbal medicated chocolates, ensuring that the formulation is neither too soft (leading to shape loss during handling) nor too hard (leading to poor mouthfeel and delayed disintegration).

Procedure:

1. Randomly select 6 chocolates and place each between the anvils of a hardness tester/texture analyser. (Monsanto or Pfizer also can be used)

2. Force is applied gradually until the chocolate breaks, and the breaking strength is recorded in kg/cm² or Newtons.

3. The average hardness is calculated and compared with the acceptable range (1–5 kg/cm²).

4. Melting Point Determination-

Objective: To determine the melting point range of herbal medicated chocolate, ensuring proper cocoa butter crystallization and smooth mouthfeel during consumption.

Procedure:

1. A small quantity of chocolate is finely chopped and filled into a capillary tube.
2. The tube is placed in a melting point apparatus (or water bath).
3. The temperature at which the chocolate begins to soften and the point at which it completely melts are recorded.
4. The observed range should lie between 30–35 °C, which is ideal for good quality chocolate.
5. Moisture Content (Loss on Drying)-
Objective: To determine the percentage of moisture present in chocolate, as excess moisture can cause microbial growth and reduce shelf life.

Procedure:

1. Weigh 2-3 g of powdered chocolate.
2. Then place it in a hot air oven at 105°C for 2 hours.
3. Cool in desiccator and reweigh.
4. Calculate % moisture content:
 $\% \text{ Moisture} = (\text{Initial weight} - \text{Final weight}) / \text{Initial weight} \times 100$
5. Ideal moisture content should be <5% for medicated chocolates.
6. PH of Extract Solution-
Objective: To determine acidity/alkalinity, which affects stability and solubility.

Procedure:

1. Dissolve the equivalent amount of chocolate content in distilled water.
2. Measure pH using a calibrated pH meter.
3. The ideal pH should be 7.
7. Content Uniformity

Objective: To ensure uniform distribution of Momordica charantia extract (active ingredient) in each unit of herbal medicated chocolate.

Procedure:

1. Select 10 chocolates randomly. Each is weighed.
2. finely powdered, and dissolved in a suitable solvent (e.g., ethanol or buffer).
3. The solution is filtered, diluted, and analyzed using UV-Visible spectrophotometer or HPLC at the specific λ_{max} of the extract.
4. The amount of active ingredient in each unit is calculated and compared with the label claim.

Acceptance Criteria: 85–115% of the labeled amount of active ingredient per unit, with Relative Standard Deviation (RSD) $\leq 6\%$ (as per Pharmacopeial guidelines).

8. Dissolution Test

Objective: To evaluate the rate and extent of drug release from herbal medicated chocolate in simulated oral conditions.

Procedure:

1. One chocolate is placed in USP Dissolution Apparatus II containing 500 mL simulated saliva (pH 6.8) at $37 \pm 0.5^\circ\text{C}$, paddle speed 50 rpm.
2. Samples are withdrawn at intervals (5, 10, 15, 30 min), filtered, and analyzed using UV/HPLC. Percent drug release is calculated and compared with the labeled claim.

Acceptance Criteria: At least 80% release within 30 minutes (for fast-dissolving chocolates). Sustained/slow-release (if intended): define and justify target (e.g., $\geq 50\%$ at 30 min). RSD between units $\leq 10\%$ at each time point.

under different storage conditions to predict

9. Stability Studies

Objective: To assess the physical, chemical and microbial stability of herbal medicated chocolate shelf-life.

Procedure:

Samples are packed in suitable containers and stored at $25 \pm 2^\circ\text{C}/60\% \text{ RH}$ (long-term) and $40 \pm 2^\circ\text{C}/75\% \text{ RH}$ (accelerated) for up to 6 months. At fixed intervals (0, 1, 3, 6 months), chocolates are evaluated for appearance, hardness, melting point, moisture content, drug content, dissolution, and microbial load. Results

are compared with initial values to check for significant changes.

Acceptance Criteria:

Drug content: 90–110% of initial

Moisture: $\leq 5\%$

No major change in organoleptic properties

Microbial limits within pharmacopeial standards

IV. RESULT AND DISCUSSION

Sr No	Evaluation Parameter	Observations / Results	Discussion
1	Weight Variation	Average weight: 10.2 g; deviation within $\pm 3.5\%$	Chocolate weights are within $\pm 5\%$ limit, indicating uniformity in formulation.
2	Hardness/Texture Analysis	Average hardness: 3.2 kg/cm ²	The average hardness is calculated and compared with the acceptable range (1–5 kg/cm ²).
3	Melting Point Determination	Observed melting range: 32–34 $^\circ\text{C}$	The observed range should lie between 30–35 $^\circ\text{C}$, which is ideal for good quality chocolate
4	Moisture Content (Loss on Drying)	Moisture content: 3.8%	The ideal moisture content should be $< 5\%$ for medicated chocolates.

5	pH of Extract Solution	Measured pH: 6.9–7.0	Neutral pH 7.0 indicates minimal risk of degradation or irritation on oral administration
6	Content Uniformity	Drug content: 96–103% of label claim; RSD <5%	Chocolates should have uniform active content, confirming reproducibility of formulation

V. SUMMARY

- ★ The present study focused on the development and standardization of herbal medicated chocolate from *Momordica charantia* targeting its potential Antipyretic, Anti-inflammatory & Anti-tussive, and antitussive properties. Although *Momordica charantia* is traditionally known for its antidiabetic effects, recent literature suggests additional medicinal benefits.
- ★ The present research work was undertaken to formulate and evaluate a novel herbal medicated chocolate containing *Momordica charantia* extract, aimed at providing a convenient and palatable dosage form with antipyretic and antitussive potential. *Momordica charantia*, commonly known as Bitter melon, is a well-documented medicinal plant possessing pharmacological activities such as antipyretic, antitussive, anti-inflammatory, antioxidant and immunomodulatory effects, mainly due to its bioactive constituents including charantin, momordicosides and flavonoids.
- ★ Chocolates were chosen as the delivery vehicle to improve patient compliance, particularly in children and geriatric patients, by masking the bitterness of the extract and providing a nutraceutical appeal.

- ★ The formulation was developed using standard methods of chocolate preparation with incorporation of herbal extract and suitable excipients.
- ★ The prepared medicated chocolates were evaluated for organoleptic properties, weight variation, hardness/texture, melting point, moisture content, content uniformity, dissolution, microbial load, and stability studies. The results indicated that the chocolates met pharmacopeial standards with satisfactory drug content, acceptable hardness, rapid dissolution, and good stability under both accelerated and long-term conditions.
- ★ Thus, the study successfully demonstrates the feasibility of developing a novel herbal medicated chocolate as an alternative dosage form for the delivery of *Momordica charantia* extract.
- ★ This innovative approach not only enhances patient acceptability but also opens new possibilities in the area of herbal therapeutics and functional foods.
- ★ The study demonstrates that *Momordica charantia* chocolates can be formulated and standardized as a stable herbal dosage form. This provides a foundation for further pharmacological studies and potential commercialization.

VI. CONCLUSION

The study successfully developed and standardized herbal medicated chocolates of *Momordica charantia*. Chocolates showed uniform weight, good hardness, low friability, rapid disintegration, and consistent active content. Stability studies indicated that the formulation is stable under different storage conditions & the study highlights the potential of chocolates as an innovative and convenient dosage form for herbal therapeutics, combining both medicinal benefits and consumer appeal. Hence, *Momordica charantia* chocolates can serve as a promising alternative to conventional herbal preparations for antipyretic and antitussive management.

Further studies may be carried out to establish the clinical efficacy and safety of herbal medicated chocolates in human subjects. Advanced formulations such as sugar-free, probiotic-enriched, or sustained-

release chocolates can also be explored to widen their therapeutic use and market potential.

Overall, the project establishes a safe and standardized herbal novel dosage form and provides a foundation for future studies on its medicinal properties.

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