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Development and *In-vitro* Evaluation of Polyherbal Candy from phytoconstituents for Cough Management and Stability Evaluation

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Abstract:

The present study was undertaken to formulate and evaluate polyherbal candies for the management of cough and throat infections by integrating traditional herbal knowledge with modern pharmaceutical techniques. The candies were prepared by incorporating weighed quantities of powdered herbs, turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), and black pepper (*Piper nigrum*) into a simple syrup base, followed by the addition of honey and propylparaben as a natural sweetener and preservative, respectively. The formulations were assessed for organoleptic properties, stability, and therapeutic potential. Turmeric, ginger, and black pepper are well-documented for their antimicrobial, anti-inflammatory, and antioxidant properties, which synergistically soothe throat irritation, reduce the microbial load, and enhance immune response. Honey further provides demulcent and antimicrobial activity, thereby improving both efficacy and palatability. The prepared candies exhibited satisfactory physical characteristics with acceptable texture, colour, taste, and aroma. Stability testing indicated that the formulations retained their integrity and organoleptic quality over the study period, confirming their suitability for storage. Overall, the developed polyherbal candies offer a convenient, palatable, and effective herbal-based formulation that may serve as a supportive remedy for coughs, throat infections, and general immune support.

Keywords: Polyherbal Candy, *In-vitro*, Physicochemical Properties, Phytoconstituents, Stability Evaluation.

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1. INTRODUCTION

In recent years, there has been a growing interest in the utilization of traditional herbal remedies for promoting health and well-being [1]. Herbal medicines are one type of dietary supplement [2]. They are natural, safe, and have no side effects, and offer a wide range of cost-effective,

preventive, and curative therapies. The World Health Organization (WHO) has reported that about 7000 chemical substances used in medicine originate from plants. According to recent WHO reports, more than 30-40% of medications in Europe and 24% in the US are plant-based [3]. Herbs and spices play an important role in the Indian kitchen and have been used since time immemorial for flavouring foods and beverages and for medicinal purposes. Both cough and cold are common in cold regions, in the winter season. Change in season leads to bacteria, viruses that cause cold, leading to overproduction of mucous, which initiates cough [4]. Herbal Candy is a sweet food product made up of impregnating fruits or vegetables with syrup. Commonly, these candies are used to treat sore throat, cough, and other respiratory problems. These candies reduce cough symptoms by reducing inflammation and opening the airways [5]. Candy has witnessed a dynamic evolution marked by experimentation with various ingredients and techniques to enhance its attributes. From the early days of incorporating fruits or vegetables with syrups to the modern utilization of medicinal plants and herbs, the journey of candy formulation has been characterized by a relentless pursuit of excellence [6].

Polyherbal candies were formulated by adding a weighed number of powdered herbs to a simple syrup, then adding honey and a preservative [7]. The use of herbal plants in candy formulation has shown positive results, improving both flavour and medicinal value [8]. Cough and throat infections are common respiratory ailments often associated with microbial invasion, inflammation, and weakened immunity. The increasing demand for safe, effective, and patient-friendly remedies has led to growing interest in herbal-based formulations that integrate traditional knowledge with modern pharmaceutical practices. Turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), and black pepper (*Piper nigrum*) are well-documented spices with powerful antimicrobial, anti-inflammatory, and antioxidant properties. Collectively, these herbs not only help alleviate throat irritation and cough symptoms but also support the immune system and promote overall respiratory health. The present study aims to formulate and evaluate herbal-based candies using turmeric, ginger, and black pepper, focusing on their organoleptic characteristics, stability, and therapeutic potential for managing cough and throat infections. The development of polyherbal candies represents a step toward integrating traditional remedies into modern, user-friendly dosage forms. Future research may include clinical validation, large-scale production, and exploration of additional herbal combinations to expand their use as natural, safe, and effective alternatives for respiratory health and immune support.

1. MATERIALS AND METHODS

1.1. Plant profile

1.1.1. Turmeric

Turmeric (*Curcuma longa* L.), a perennial herb belonging to the family Zingiberaceae, was selected for formulation due to its wide range of therapeutic properties (Figure 1). The rhizome, which is the medicinally important underground stem, was used in this study. Phytochemical investigations have shown that turmeric contains curcuminoids (3–5%), primarily curcumin, desmethoxycurcumin, and bisdemethoxycurcumin, along with volatile oils (2–7%) such as α-turmerone, β-turmerone, and zingiberene. In addition, starch, proteins, and resins are also present, contributing to its nutritional and therapeutic value. Pharmacologically, turmeric exhibits diverse biological activities, including anti-inflammatory effects mediated by the inhibition of

prostaglandins and leukotrienes, antioxidant action against free radical damage, and antimicrobial efficacy against various pathogens. It has also been reported to possess anticancer, hepatoprotective, and wound-healing properties, making it an important traditional remedy and a scientifically validated candidate for incorporation into herbal-based formulations such as polyherbal candies for cough and throat infections [9].

Figure 1. *Curcuma longa* L.

2.1.2 Black pepper

Black pepper (*Piper nigrum* L.), a flowering vine of the family Piperaceae, was incorporated in the formulation owing to its medicinally significant bioactive compounds (Figure 2). The fruit (peppercorns) was used as the principal plant part. Phytochemical studies reveal the presence of alkaloids, primarily piperine (5–9%), which is responsible for its pungency and many pharmacological effects. In addition, it contains volatile oils (1–2%) comprising β-caryophyllene, limonene, and sabinene, along with resins and starch that contribute to its functional properties. Pharmacologically, black pepper demonstrates a broad spectrum of biological activities, including antimicrobial, antioxidant, anticancer, and anti-inflammatory effects, as well as gastroprotective action, making it an important adjuvant in traditional medicine. Its inclusion in the polyherbal candy formulation enhances the bioavailability of curcumin from turmeric and synergistically contributes to cough relief, throat soothing, and immune support [10].

Figure 2. *Piper nigrum* L.

2.1.3 Ginger

Ginger (*Zingiber officinale* Roscoe), a widely used medicinal and culinary plant from the family Zingiberaceae, was selected for the formulation due to its broad therapeutic potential (Figure 3). The rhizome (underground stem) constitutes the medicinally valuable part and is rich in bioactive constituents. Phytochemical analysis indicates the presence of volatile oils (1–3%), primarily zingiberene, β-bisabolene, and α-curcumene, which contribute to its characteristic aroma. The pungent principles such as gingerol, shogaol, and zingerone are chiefly responsible for its taste as well as its pharmacological properties. In addition, resin and starch are present, enhancing its nutritional profile. Pharmacologically, ginger exhibits potent anti-inflammatory, antioxidant, and antimicrobial activities, and is well recognized for its role as a digestive stimulant by enhancing gastric motility. It also functions as an effective antiemetic, alleviating nausea and vomiting. The inclusion of ginger in the polyherbal candy formulation supports cough relief, soothes throat irritation, and contributes to faster recovery through its immunity-boosting and protective actions [11].

Figure 3. *Zingiber officinale*

1.2. Preparation of herbal candy

The powdered herbal ingredients were first milled to a fine, uniform particle size to enhance homogeneity, facilitate dispersion, and ensure consistency in the final product, thereby contributing to improved stability and therapeutic efficacy. The quality specifications of all ingredients used in the formulation of herbal candy are presented in Table 1. A sucrose solution was prepared by dissolving 50 g of sucrose in 50 ml of distilled water under constant stirring, with the temperature maintained between 70–80 °C to achieve complete dissolution. Care was taken to ensure even heating to prevent caramelization or degradation of sucrose, thereby yielding a clear and homogeneous solution suitable for use as the formulation base. Subsequently, 3 g of turmeric powder was incorporated into the hot sucrose solution under continuous stirring to achieve uniform dispersion. Following this, 1 g of black pepper powder was gradually added in small increments while maintaining the temperature between 60–70 °C, ensuring proper mixing, stability, and prevention of clumping. Thereafter, 6 g of dried ginger powder was introduced slowly, with constant stirring, to preserve the active constituents and achieve a smooth, consistent blend. To enhance the therapeutic and sensory properties, 20 ml of honey was added in gradual

portions with continuous agitation. Additionally, 0.040 g of propylparaben was incorporated as a preservative to ensure microbial stability and prolong shelf life. The mixture was stirred until a thick, uniform mass was obtained. Once the desired consistency was achieved, the heating was discontinued, and the mixture was allowed to cool gradually to preserve texture and stability. The warm, pliable mass was then transferred into pre-lubricated candy molds and left to set at room temperature under controlled conditions. Upon solidification, the candies were carefully demolded, inspected for uniformity of shape and consistency, and subsequently packed in airtight containers. The stepwise procedure for the preparation of herbal candy is illustrated in Figure 4. The prepared formulations were stored in a cool environment until subjected to evaluation for organoleptic properties, hardness, texture, moisture content, and microbial stability, ensuring quality and compliance with standard formulation parameters.

Table 1. List of herbal ingredients for polyherbal candy preparation.

S.N.	Ingredients	Taken quantity
1.	Turmeric	3g
2.	Black paper	1g
3.	Ginger	6g
4.	Honey	20ml
5.	Sugar	50g
6.	Propylparaben	0.4g
7.	Purified water	20ml

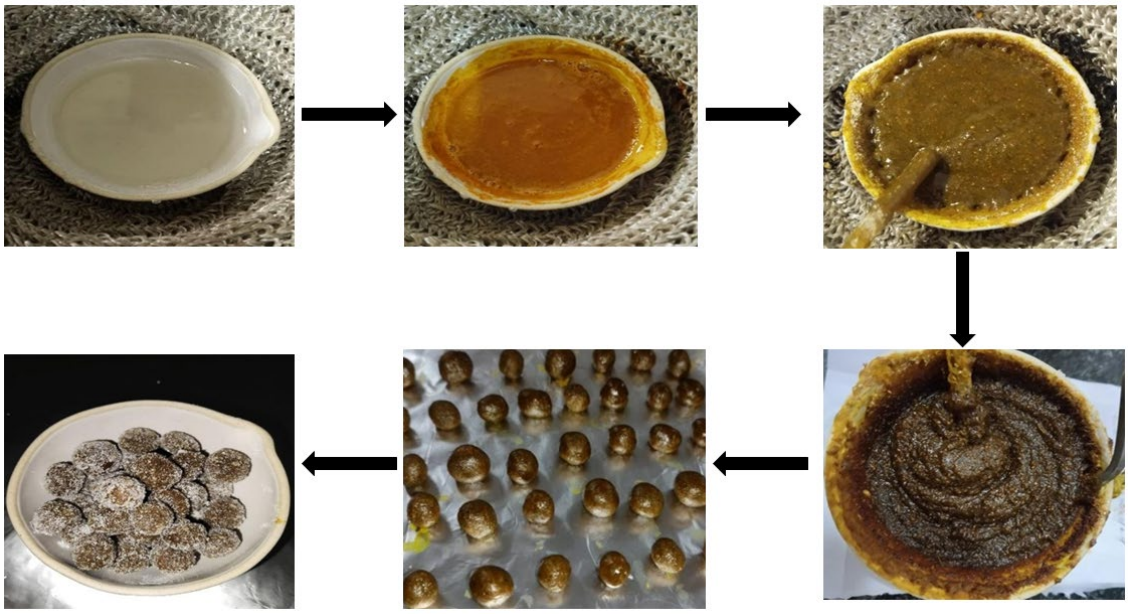

Figure 4. Schematic illustration of the preparation method of polyherbal candies.

1.3. Evaluation of Polyherbal Candy

2.3.1 Physico-chemical parameters

The prepared polyherbal candies were evaluated based on their physico-chemical, sensory, and stability parameters to ensure quality, acceptability, and formulation consistency

2.2.2 Color examination

Candies were carefully placed on a clean watch glass and visually inspected under natural white light against a white background.

2.2.3 Odor examination

Organoleptic evaluation of odour was conducted with five volunteers. Each subject assessed the aroma of the candy five times at intervals of 5 minutes

2.2.4 Taste examination:

Taste evaluation was performed with three volunteers; each provided with a complete candy unit. The perception of taste on the tongue was noted, and responses were collected to assess palatability and acceptability.

2.2.5 Measurement of pH

Accurately weighed candies were transferred to a 100 ml volumetric flask containing 100 ml of distilled water. The mixture was sonicated for 15 minutes, and the pH of the resultant solution was determined using a calibrated digital pH meter.

2.2.6 Sensory evaluation

Sensory profiling of the prepared candy was carried out by a panel of 20 semi-trained judges using the nine-point hedonic scale. Attributes including color, appearance, flavor, texture, taste, mouthfeel, and overall acceptability were assessed, where a score of 10 indicated maximum acceptability and 1 indicated poor acceptability. Mean values were calculated for each parameter to determine overall sensory quality.

2.2.7 Stability test

The physical stability of polyherbal candies was assessed under different storage conditions (2°C, 25°C, and 37°C) for a duration of 4 weeks. No significant changes in physical appearance, texture, or acceptability were observed, confirming the formulation's stability across variable environmental conditions [12-13].

2. Result and discussion

The prepared Polyherbal Candy was successfully formulated using turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), and black pepper (*Piper nigrum*), with honey and sugar as base sweeteners. The inclusion of black pepper was particularly important, as piperine is known to enhance the bioavailability of curcumin by inhibiting its rapid metabolism and improving solubility. This strategic incorporation addressed one of the major challenges associated with curcumin-based formulations. The evaluation of physicochemical properties confirmed the quality and stability of the developed formulation. The candy exhibited a brown color, characteristic of the combined herbal constituents. The odour was distinctive and pleasant, attributed to volatile oils present in ginger, turmeric, and black pepper. The formulation achieved the desired hard state, essential for maintaining integrity and shape during storage. Taste evaluation revealed a sweet flavor profile with mild pungent herbal notes, contributed by ginger and black pepper, while honey provided a natural sweetening effect. The pH of the formulation was measured at 6, which falls within the acceptable range for herbal edible preparations, ensuring compatibility with oral administration without irritation ([Table 2). Overall, the findings demonstrate that the Polyherbal

Candy maintained consistent physical attributes such as color, odor, taste, and hardness, with stable pH, validating its suitability as a nutraceutical confectionery product.

Table 3. Evaluation of physicochemical attributes of herbal candy.

S. N.	Physicochemical parameters	Observation
1.	Colour	Brown
2.	Odour	Characteristics
3.	State	Hard
4.	Taste	Sweet
5.	pH	6

The sensory attributes of the prepared Polyherbal Candy were evaluated by a panel of 20 semi-trained judges using the nine-point hedonic scale, where higher scores indicated greater acceptability. The evaluation included key parameters such as color, odour, appearance, taste, flavor, texture, mouthfeel, and overall acceptability. The results (Table 4) indicated that the candy scored well across all sensory attributes, reflecting its palatability and consumer acceptability. The color received a score of 7, indicating an appealing brown hue from the combined herbal powders. Odour and appearance were highly appreciated, scoring 8, reflecting the characteristic aromatic profile and visually attractive presentation of the candy. Taste and flavor were rated 7, highlighting a balanced sweetness from honey and sugar while retaining subtle herbal notes from turmeric, ginger, and black pepper. Texture and mouthfeel also scored 8, indicating a firm yet smooth consistency suitable for oral consumption. The overall acceptability was rated 8, demonstrating that the formulation was generally well-received by the panelists. The favorable sensory scores suggest that the polyherbal candy formulation successfully masks the bitterness of the herbal powders while providing a pleasant taste and aroma. The combination of natural sweeteners and solubility enhancers (piperine from black pepper) contributed not only to therapeutic efficacy but also to consumer-friendly organoleptic properties. These results affirm that the developed candy is both palatable and acceptable, supporting its potential as a functional confectionery for managing cough, throat irritation, and immune support.

Table 4. Sensory evaluation of prepared polyherbal candy.

S. N.	Attribute	Rating
1.	Colour	7
2.	Odour	8
3.	Appearance	8
4.	Taste	7
5.	Flavour	7
6.	Texture	8
7.	Mouth feel	8
8.	Overall acceptance	8

The stability of the prepared Polyherbal Candy was evaluated over a period of 4 weeks under various temperature conditions (21–38°C) to assess the retention of its physicochemical properties. Parameters such as color, odour, and pH were monitored weekly to determine the

formulation's physical and chemical stability (Table 5). The results indicated no observable changes in color or odour across all temperature conditions throughout the 4-week study period. The pH of the formulations remained stable at 6 at lower temperatures (21–29°C) and slightly higher at 6.5 at elevated temperatures (37–38°C), which is within an acceptable range for edible herbal formulations. No physical degradation, discoloration, or off-odour was noted, indicating the robustness of the formulation. These findings suggest that the polyherbal candy exhibits excellent physicochemical stability under both ambient and slightly elevated temperatures. The incorporation of honey and propylparaben as a preservative likely contributed to microbial stability and the prevention of chemical degradation. Furthermore, the stable pH indicates that the formulation maintains its structural and organoleptic integrity over time, which is critical for consumer acceptability and shelf-life. Overall, the stability study confirms that the prepared polyherbal candy is physically and chemically stable, making it a suitable candidate for long-term storage and potential commercialization as a functional confectionery product for cough, throat irritation, and immune support.

Table 5. Stability evaluation of polyherbal candy under different temperature conditions.

Time	Temperature (°C)	Physicochemical parameter			Stability
		Colour	Odour	pH	
Week 1	22	No change	No change	6	Stable
	29	No change	No change	6	Stable
	37	No change	No change	6.5	Stable
Week 2	21	No change	No change	6	Stable
	26	No change	No change	6	Stable
	38	No change	No change	6.5	Stable
Week 3	21	No change	No change	6	Stable
	25	No change	No change	6	Stable
	37	No change	No change	6.5	Stable
Week 4	25	No change	No change	6	Stable
	29	No change	No change	6	Stable
	38	No change	No change	6.5	Stable

Conclusion

The present study successfully developed and evaluated a polyherbal candy incorporating turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), black pepper (*Piper nigrum*), and honey, each selected for their well-documented therapeutic properties in traditional Indian medicine. The strategic inclusion of black pepper enhanced the bioavailability of curcumin, effectively overcoming a common limitation of turmeric-based formulations. The prepared candy demonstrated favorable physicochemical characteristics, including stable pH, appealing color, pleasant taste, and suitable hardness. Sensory evaluation revealed high acceptability among panelists, while stability studies confirmed that the product maintained its integrity and quality under various temperature conditions over four weeks. Overall, the polyherbal candy represents a

promising, consumer-friendly nutraceutical product that integrates traditional Ayurvedic knowledge with modern confectionery techniques. This formulation provides a convenient, palatable option for preventive healthcare, making herbal therapy more accessible, particularly to children and adults who are reluctant to consume conventional herbal preparations.

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