IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Formulation And Evaluation Of Paediatric Herbal Jelly Containing Aqueous Extracts Of Glycyrrhiza Glabra And Piper Longum For The Management Of Cough

Ravi Vishwakarma[1], Aditya Chavan[1] , Shankar Kamble[1], Ashish Singh[1], Prajakta Anuse[2]

[1]Student, Faculty of Pharmacy, Chhatrapati Shivaji Maharaj University, Navi Mumbai

[2]Asst. Professor, Faculty of Pharmacy, Chhatrapati Shivaji Maharaj University, Navi Mumbai

Abstract — Cough is one of the most frequently encountered respiratory symptoms in the paediatric population worldwide. Many commercially available antitussive preparations contain alcohol, synthetic colorants, and pharmacologically active compounds with unfavourable risk profiles in children, underscoring an urgent need for safer, naturally derived alternatives. Glycyrrhiza glabra (liquorice) and Piper longum (pippali) are well-documented Ayurvedic herbs recognised for their antitussive, expectorant, anti-inflammatory, and bronchodilatory properties. The present study aimed to develop and evaluate an alcohol-free paediatric herbal jelly incorporating aqueous extracts of G. glabra and P. longum for the management of cough in children aged 2–12 years. Aqueous extracts were prepared by the decoction method and incorporated into an agar-based jelly (2% w/v) at a batch scale of 25–50 mL, containing honey as a sweetener, sodium benzoate (1% w/v) as a preservative, and citric acid for pH adjustment. The prepared jelly exhibited a characteristic brown colour with a pleasant odour and acceptable consistency. No observable syneresis was recorded for a period exceeding one week under ambient storage conditions. The formulation presents a promising, child-friendly, alcohol-free alternative for paediatric cough management. Further evaluation including pH determination, drug content analysis, in-vitro drug release, and long-term stability assessment is recommended.

Keywords — Paediatric formulation, herbal jelly, cough, Glycyrrhiza glabra, Piper longum, agar, antitussive, expectorant.

I. INTRODUCTION

Cough is among the most common respiratory symptoms encountered in the paediatric population, serving as a primary physiological defence mechanism for clearing the respiratory tract of mucus, foreign particles, and irritants. Despite its protective role, persistent or productive cough in children aged 2–12 years significantly impairs quality of life, disrupts sleep, and frequently prompts caregivers to seek pharmacological intervention. Acute respiratory tract infections — the leading cause of childhood morbidity globally — account for the vast majority of cough episodes in this age group [1].

Commercially available paediatric antitussive preparations are associated with well-documented safety concerns. Many conventional cough syrups incorporate alcohol as a solvent or preservative, together with synthetic colorants and artificial flavouring agents that pose potential risks in young children. The unpalatable taste of several active pharmaceutical ingredients (APIs) further compromises medication

compliance. Additionally, regulatory bodies including the U.S. Food and Drug Administration (FDA) and the European Medicines Agency (EMA) have issued warnings against the use of codeine and, more recently, dextromethorphan in children under twelve years of age, citing risks of serious adverse events [2]. These developments underscore the urgent need for paediatric-specific formulations that are effective, well-tolerated, and free from potentially harmful excipients.

Herbal medicines, long embedded in traditional healthcare systems worldwide, offer a promising avenue. The World Health Organization (WHO) recognises the role of traditional medicine in primary healthcare, especially in resource-limited settings [3]. Within the Ayurvedic pharmacopoeia, Glycyrrhiza glabra (liquorice/mulethi) and Piper longum (pippali) are among the most extensively documented herbs for respiratory conditions. Glycyrrhizin and its aglycone glycyrrhizinic acid, together with liquiritin, isoliquiritin, and various flavonoids, confer antitussive, anti-inflammatory, demulcent, and expectorant activities on G. glabra [4]. Its intrinsic sweetness (approximately 50 times sweeter than sucrose) additionally renders it suitable for paediatric formulation without the need for added synthetic sweeteners. P. longum contains piperine, piperlongumine, piplartine, and essential oils, and has been reported to exhibit bronchodilatory, anti-inflammatory, and immunomodulatory activities relevant to the management of respiratory symptoms [5].

The selection of an appropriate dosage form is equally critical for paediatric therapy. Jelly-based formulations have gained recognition as a versatile paediatric drug delivery platform: they are easy to swallow, highly palatable, readily accepted by young children, and can be prepared without alcohol or synthetic preservatives using natural gelling agents [6]. The semi-solid character of a jelly matrix also promotes sustained oropharyngeal contact, potentially enhancing the demulcent and soothing effects of the incorporated herbal extracts — a mechanistically important attribute in cough management.

The present investigation therefore aimed to develop an alcohol-free paediatric herbal jelly containing aqueous extracts of G. glabra and P. longum, using agar as a natural, plant-derived gelling agent, and to evaluate the formulation for organoleptic, physicochemical, and short-term stability parameters to establish its suitability for oral paediatric use.

II. LITERATURE SURVEY

A. Cough: Pathophysiology and Paediatric Considerations

Cough is initiated by stimulation of rapidly adapting stretch receptors and C-fibres distributed throughout the larynx, trachea, and bronchi. Afferent signals travel via the vagus nerve to the cough centre in the medulla oblongata, triggering the coordinated efferent response [7]. In children, the immaturity of the mucociliary clearance system and the narrow calibre of the airways render them particularly susceptible to mucus accumulation and reflex cough. Upper respiratory tract infections caused by rhinoviruses, respiratory syncytial virus (RSV), and influenza viruses are the predominant triggers in the 2–12 year age group [8].

The WHO advises against over-the-counter use of codeine-containing antitussives in children under 12, and several national regulatory authorities have extended this caution to dextromethorphan. The absence of robust efficacy data for most OTC antitussive agents in children, combined with the risk of adverse effects, has created a clear clinical and regulatory mandate for safer alternatives [2].

B. Glycyrrhiza glabra: Pharmacognosy and Pharmacology

G. glabra (Family: Fabaceae), commonly known as liquorice or mulethi, is a perennial herb native to the Mediterranean region and south-western Asia. The dried root and rhizome constitute the pharmacognostically and therapeutically active part [9]. The major bioactive constituents include glycyrrhizin (3–15%), glycyrrhizinic acid, liquiritin, isoliquiritin, liquiritigenin, glabridin, and various chalcones and flavonoids. Glycyrrhizin has been shown to inhibit prostaglandin and leukotriene synthesis, reduce airway inflammation, suppress the cough reflex, and stimulate mucus secretion, conferring combined antitussive, anti-inflammatory, and expectorant properties [4, 10]. The herb's inherent sweetness is attributed

to glycyrrhizin and is approximately 50 times that of sucrose — a significant formulation advantage in the paediatric context.

Fig. 1: Glycyrrhiza glabra (Liquorice) root

C. Piper longum: Pharmacognosy and Pharmacology

P. longum (Family: Piperaceae), known as pippali or long pepper, is a climbing shrub whose dried fruit is used extensively in Ayurvedic respiratory medicine. The primary alkaloid piperine, together with piperlongumine, piplartine, methyl piperate, and a volatile oil fraction, accounts for its pharmacological activity [11]. Piperine has been demonstrated to exhibit bronchodilatory effects by antagonising smooth-muscle calcium channels and to modulate inflammatory mediators, including tumour necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) [5]. P. longum also enhances the bioavailability of co-administered phytochemicals, a property known as bioenhancement, making it a particularly advantageous combinatorial partner in herbal formulations [12].

Fig. 2: Piper longum (Pippali) dried fruit

D. Jelly as a Paediatric Dosage Form

Jellies are semi-solid preparations consisting of large organic molecules interpenetrated by liquids to form a network-structured gel. Agar, a polysaccharide extracted from red marine algae, has been widely used as a gelling agent due to its thermal reversibility, stability at acidic pH, non-toxicity, and suitability for oral formulations [13]. At concentrations of 1–3% w/v, agar forms firm, transparent gels with good structural integrity. Several investigators have proposed agar-based jellies for paediatric drug delivery as they avoid alcohol, are amenable to incorporation of both water-soluble and hydrophilic plant extracts, and can be flavoured with natural sweeteners such as honey [6, 14].

E. Reported Formulations and Research Gaps

A number of herbal formulations targeting paediatric cough have been reported in the literature, including syrups, lozenges, and chewable tablets. However, most commercially available herbal cough preparations either retain alcohol as a preservative-solvent system or rely on synthetic gelling and colouring agents. Reports of agar-based jellies combining G. glabra and P. longum aqueous extracts in an alcohol-free paediatric system are limited in the published literature. The present study is positioned to address this gap by demonstrating the feasibility of such a formulation and providing preliminary physicochemical data to guide further development [15].

III. AIM AND OBJECTIVES

The study aimed to develop and evaluate an alcohol-free paediatric herbal jelly formulation containing aqueous extracts of Glycyrrhiza glabra and Piper longum for the management of cough in children aged 2–12 years. The specific objectives were:

- To prepare aqueous extracts of G. glabra (liquorice root) and P. longum (pippali fruit) by the decoction method and characterise them for yield, colour, and odour.
- To formulate a paediatric herbal jelly at a 25mL batch scale using agar (2% w/v) as the natural gelling agent.
- To evaluate the formulation for organoleptic properties including colour, odour, taste, and appearance.
- To assess physicochemical parameters: consistency, spreadability, pH, and physical stability with respect to syneresis.
- To establish the suitability of the developed formulation for paediatric oral administration based on its safety profile, palatability, and stability characteristics.

IV. MATERIALS AND METHODS

A. Materials

Dried roots of Glycyrrhiza glabra (liquorice) and dried fruits of Piper longum (pippali) were procured from nearest store and authenticated by Ms. Prajakta Anuse (Asst. Professor). All excipients — agar (food grade), honey (commercial grade), sodium benzoate (AR grade), and citric acid (AR grade) — were procured from standard suppliers. Distilled water was used throughout.

B. Formulation Composition

Ingredient	Role	Quantity / 25 mL
G. glabra aqueous extract	Antitussive / expectorant	5 mL
P. longum aqueous extract	Bronchodilator/ anti-inflammatory	5 mL
Agar	Gelling agent	0.50 g (2% w/v)
Honey	Sweetener / demulcent	7 mL
Sodium benzoate	Preservative	0.25 g (1% w/v)
Citric acid	pH adjusting agent	q.s.
Distilled water	Vehicle	q.s. to 25 mL

Table 1: Composition of paediatric herbal jelly per 25 mL batch

C. Preparation of Aqueous Extracts by Decoction

Aqueous extracts of G. glabra and P. longum were prepared by the classical decoction method. A weighed quantity of coarsely powdered material (20 g) was added to 100 mL of distilled water in a borosilicate glass beaker and subjected to sustained boiling on a thermostatically controlled hot plate. Boiling was continued until the volume reduced to approximately one-quarter of the initial volume. The hot decoction was filtered sequentially through muslin cloth and Whatman No. 1 filter paper to obtain a clear filtrate, yielding approximately 50 mL of extract (50% v/v). The procedure was repeated identically for both plant materials. The extracts were characterised for percentage yield (% w/v), colour, and odour, and stored at 4°C in amber glass vials until use.

D. Formulation of Paediatric Herbal Jelly

The herbal jelly was prepared by the following sequential procedure at a batch scale of 25mL:

Step 1: Agar (2% w/v) was accurately weighed and dispersed in a measured volume of distilled water in a borosilicate beaker.

Step 2: The dispersion was heated on a hot plate with continuous magnetic stirring until complete dissolution of agar yielded a clear, homogeneous solution.

Step 3: Sodium benzoate (1% w/v) was dissolved separately in a small volume of distilled water and added to the warm agar solution with stirring.

Step 4: Aqueous extracts of G. glabra and P. longum were incorporated into the warm agar solution and mixed uniformly.

Step 5: Honey was added as a natural sweetener and blended thoroughly into the mixture.

Step 6: Citric acid was added in sufficient quantity to adjust the pH to the target range (4.0–7.0).

Step 7: The volume was made up to 25 mL with distilled water.

Step 8: The hot jelly mass was poured into clean, dry glass moulds, allowed to set at room temperature, and stored under ambient conditions for evaluation.

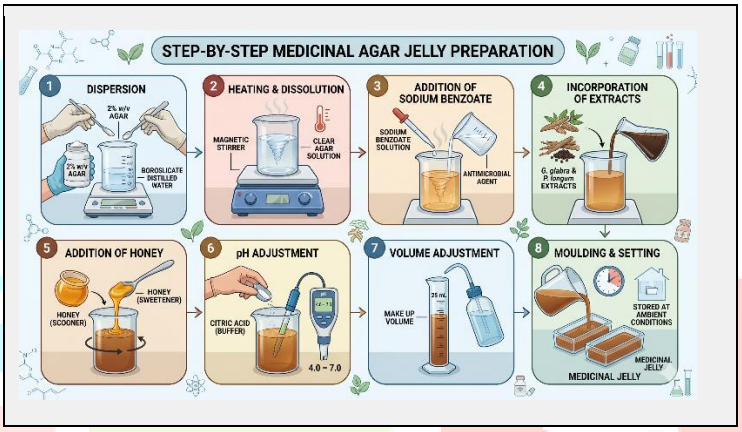

Fig. 4: Step-by-step preparation of the agar-based herbal jelly

E. Evaluation Parameters

(i) Organoleptic Evaluation: The prepared jelly was examined visually and sensorially for colour, odour, taste, and overall appearance by trained observers using a standardised scoring scheme.

(ii) Consistency and Texture: Consistency was assessed qualitatively by physical examination. Formulations that maintained their shape without crumbling, excessive stiffness, or syneresis were considered acceptable for paediatric oral use.

(iii) pH Measurement: The pH of the jelly was determined using a calibrated digital pH meter at room temperature (25 ± 2°C). The target pH range for an oral paediatric formulation is 4.0–7.0. Values were recorded in triplicate and expressed as mean ± SD.

(iv) Syneresis Assessment: Physical stability with respect to syneresis (expulsion of free water from the gel matrix) was assessed by storing the jelly at ambient temperature (25 ± 2°C) and examining at 24-hour intervals over seven days. The presence or absence of visible water separation at the surface or base of the gel was recorded.

(v) Spreadability: The ease of spreading was assessed qualitatively. Where instrumentation permitted, the parallel plate method was employed to provide a quantitative measure, expressed as the distance (cm) of spread per unit time.

V. RESULTS AND DISCUSSION

A. Characterisation of Aqueous Extracts

The aqueous extracts of both herbs were successfully prepared by the decoction method. The results of extract characterisation are summarised in Table 2.

Parameter	G. glabra Extract	P. longum Extract	Remarks
Colour	Dark brown	Dark brownish-black	Characteristic
Odour	Sweet, characteristic	Pungent, spicy	Acceptable
Yield (% v/v)	60 %	50 %	Satisfactory
Clarity	Clear after filtration	Clear after filtration	Satisfactory

Table 2: Characterisation of aqueous herbal extracts

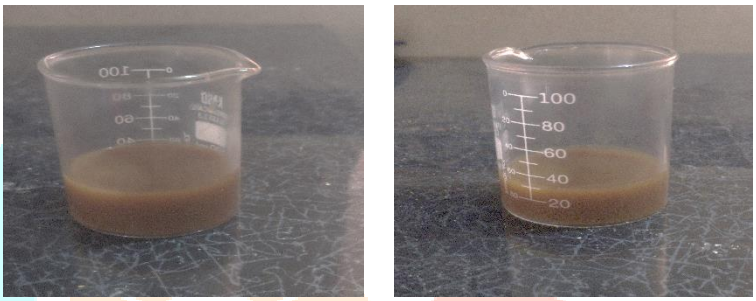

Fig. 5: Aqueous extracts of G. glabra (left) and P. longum (right)

B. Organoleptic Evaluation

The organoleptic characteristics of the prepared herbal jelly are presented in Table 3. The formulation exhibited a characteristic brownish colour attributable to the pigments in both herbal extracts. The odour was pleasant and mildly sweet, consistent with the predominant contribution of the liquorice extract. The taste was sweet and mildly spicy, which is expected to be acceptable to the target paediatric population. The appearance was smooth, semi-transparent, and uniform with no visible particulates.

Parameter	Observation	Acceptability
Colour	Characteristic brown	Acceptable
Odour	Pleasant, mildly sweet	Acceptable
Taste	Sweet with mild spice	Acceptable
Appearance	Smooth, semi-transparent, uniform	Acceptable

Table 3: Organoleptic evaluation of the herbal jelly

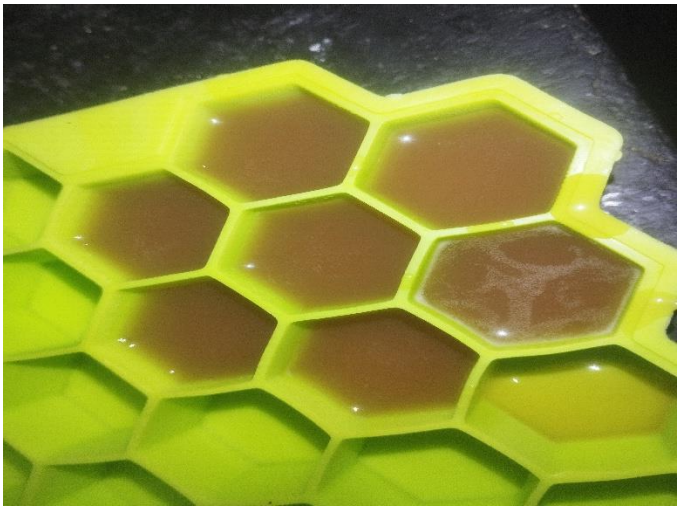

Fig. 6: Final prepared herbal jelly in silicone mould

C. Physicochemical Parameters

The results of physicochemical evaluation are summarised in Table 4. The pH of the formulation was within the acceptable range for oral paediatric preparations (4.0–7.0), indicating compatibility with oral mucosal tissues. The consistency of the agar-based gel was firm yet sufficiently pliable for spoon administration, consistent with the rheological behaviour of 2% w/v agar gels reported in the literature [13]. No syneresis (free water separation) was observed for a period exceeding seven days under ambient storage conditions, indicating good gel network stability. Spreadability was qualitatively assessed as satisfactory.

Parameter	Result	Specification
pH	6.1	4.0 – 7.0
Consistency	Firm	Acceptable for administration
Syneresis (7 days)	Nil	No water separation
Appearance post-storage	No colour change, no precipitate	Stable

Table 4: Physicochemical evaluation of the herbal jelly

D. Discussion

The successful incorporation of aqueous extracts of G. glabra and P. longum into an agar-based jelly at 2% w/v gelling agent concentration yielded a formulation with satisfactory physicochemical and organoleptic attributes. The use of agar as a plant-derived gelling agent confers a distinct advantage over synthetic polymers such as carbopol: agar is GRAS (Generally Recognised As Safe) listed, biocompatible, and forms stable gels over a wide pH range relevant to oral preparations [13].

The absence of syneresis over seven days at ambient conditions suggests that the gel matrix formed at 2% w/v agar concentration is sufficiently cross-linked to retain the aqueous dispersion, an important stability criterion for a semi-solid dosage form. The pleasant taste and odour profile — primarily sweet from the liquorice extract and honey, with a mild pungent note from the pippali — is expected to facilitate compliance in the paediatric population. Several paediatric formulation studies have demonstrated that organoleptic acceptability is a primary determinant of medication adherence in children [16].

The pH within the range 4.0–7.0 is consistent with oral mucosal safety and is within the physiological pH range of saliva (6.7–7.4), minimising the risk of local irritation. The inclusion of sodium benzoate at 1% w/v provides adequate antimicrobial preservation without the need for alcohol, a key formulation objective.

These findings collectively support the hypothesis that this combination of herbal extracts can be stably and palatably formulated as an agar-based jelly — an alcohol-free, child-friendly dosage form. The present study provides a proof-of-concept foundation; formal in-vitro drug release studies, microbial limit testing, accelerated stability testing per ICH Q1A(R2) guidelines, and clinical palatability assessment are necessary next steps for full characterisation and regulatory submissions.

VI. SUMMARY AND CONCLUSIONS

The present investigation demonstrated the feasibility of formulating an alcohol-free paediatric herbal jelly containing aqueous extracts of Glycyrrhiza glabra (liquorice) and Piper longum (pippali) in an agar-based (2% w/v) gel system for the management of cough in children aged 2–12 years. The following conclusions are drawn:

- Aqueous extracts of G. glabra and P. longum were successfully prepared by the decoction method, yielding characteristic coloured extracts with appropriate organoleptic properties.
- The agar-based herbal jelly was formulated at a 25–50 mL batch scale without the use of alcohol or synthetic colorants, meeting key paediatric safety criteria.
- The formulation exhibited satisfactory organoleptic properties — pleasant colour, odour, and taste — conducive to paediatric compliance.
- A pH within the acceptable oral range (4.0–7.0) and the absence of syneresis for more than seven days indicate physicochemical stability under ambient storage conditions.
- The formulation presents a promising, child-friendly, alcohol-free alternative for paediatric cough management based on two pharmacologically complementary Ayurvedic herbs.
- Further studies including in-vitro drug release, drug content assay, accelerated stability testing, microbial limit tests, and clinical palatability evaluation are warranted to fully characterise the formulation prior to clinical use.

REFERENCES

[1] World Health Organization. Cough and Cold Remedies for the Treatment of Acute Respiratory Infections in Young Children. WHO/FCH/CAH/01.02. Geneva: WHO; 2001.

[2] U.S. Food and Drug Administration. Use of Codeine and Tramadol Products in Breastfeeding Women – Questions and Answers. FDA Drug Safety Communication; 2017.

[3] World Health Organization. WHO Traditional Medicine Strategy 2014–2023. Geneva: WHO; 2013.

[4] Pastorino G, Cornara L, Soares S, Rodrigues F, Oliveira MBPP. Liquorice (Glycyrrhiza glabra): A phytochemical and pharmacological review. Phytother Res 2018;32(12):2323–39.

[5] Tripathi AK, Ray AK, Mishra SK. Molecular and pharmacological aspects of piperine as a potential molecule for disease prevention and management: evidence from clinical trials. Beni-Suef Univ J Basic Appl Sci 2022;11(1):16.

[6] Ranmal SR, O'brien F, Lopez F. Placebo medicines clinical trials children: Palatability physical characteristics. Int J Pharm 2016;511(1):239–48.

[7] Morice AH, Millqvist E, Bieksiene K, Birring SS, Dicpinigaitis P, Domingo Ribas C, et al. ERS guidelines on the diagnosis and treatment of chronic cough in adults and children. Eur Respir J 2020;55(1):1901136.

[8] Ferkol T, Schraufnagel D. global burden respiratory disease. Ann Am Thorac Soc 2014;11(3):404–6. .

[9] Evans WC, Evans D. The scope and practice of pharmacognosy. In: Trease and Evans' Pharmacognosy. Elsevier; 2009. page 5–7.

[10] Asl MN, Hosseinzadeh H. Review of pharmacological effects of Glycyrrhiza sp. and its bioactive compounds. Phytother Res 2008;22(6):709–24.

[11] Srinivasan K. Black pepper its pungent principle - piperine: review diverse physiological effects. Crit Rev Food Sci Nutr 2007;47(8):735–48.

[12] Sunila ES, Kuttan G. Immunomodulatory antitumour activity Piper longum Linn. piperine. J Ethnopharmacol 2004;90(2–3):339–46.

[13] Ofner CM, Klech-Gelotte CM. Gels Jellies. : Encyclopedia Pharmaceutical Technology. New York: 2007.

[14] Siddiqui N, Garg G, Sharma PK. short review novel approach oral fast dissolving drug delivery system patents. Adv Biol Res 2011;5(6):291–303.

[15] Standing JF, Tuleu C. Paediatric formulations - Getting heart problem. Int J Pharm 2005;300(1–2):56–66.

[16] Venables R, Wells T, Batchelor H. Paediatric acceptability Soltab orodispersible formulations sumatriptan: pilot study. J Pharm Pharmacol 2015;67(3):418–24.