

Dikamali Gum: An Unexplored Natural Polymer for Innovative Drug Delivery System

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ABSTRACT

Dikamali gum, obtained from *Gardenia gummifera* belonging to the family Rubiaceae, is a naturally occurring resinous exudate with potential applications in pharmaceutical formulations. Natural gums and resins have attracted considerable attention as pharmaceutical excipients because of their availability, biocompatibility, biodegradability, and ability to modify drug-release characteristics. Dikamali may exhibit useful physicochemical properties such as swelling, binding, viscosity and matrix-forming behavior. These characteristics make it a potential material for the development of tablets, microspheres, microcapsules, beads and other modified drug-delivery systems. Chemical or physical modification of Dikamali can further alter its swelling, mechanical and drug-release properties. However, variability in natural-source composition and the need for adequate characterization and standardization remain important considerations. This review discusses the source, properties, characterization, advantages, limitations and potential pharmaceutical applications.

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INTRODUCTION

Natural polymers have been extensively investigated as pharmaceutical excipients because they offer several advantages over some synthetic materials⁽¹⁾. They can function as binders, disintegrants, suspending agents, viscosity enhancers, film-forming agents and drug-release modifiers⁽⁴⁾. Dikamali, a resinous exudate obtained from *Gardenia gummifera*, is one such natural material that has attracted interest for pharmaceutical applications. The pharmaceutical performance of a natural polymer depends on its chemical composition, molecular structure, particle size, moisture content, processing conditions and concentration in the formulation⁽⁵⁾.

1.1 BIOLOGICAL SOURCE

Dikamali is obtained from *Gardenia gummifera*

Linn. f., which belongs to the family Rubiaceae⁽⁷⁾. The material is collected as a resinous exudate and can subsequently be dried and powdered for experimental use⁽¹⁾⁽⁴⁾. The physical and chemical characteristics may vary depending on geographical origin, harvesting conditions, processing and storage. ematic characterization is essential before its application as a pharmaceutical excipient⁽⁵⁾.

1.2. PHYSICO-CHEMICAL PROPERTIES

Dikamali can be evaluated for several physicochemical properties before formulation development⁽²⁾. These include appearance, colour, odour, moisture content, ash value, solubility, particle size, bulk density, tapped density, angle of repose, Carr's index and Hausner ratio⁽⁶⁾. Spectroscopic and thermal techniques such as FTIR, DSC, TGA, XRD and SEM can provide additional information regarding its functional

groups, thermal stability, physical structure and surface morphology⁽³⁾⁽¹⁰⁾.

1.3 ADVANTAGES

- Natural polymer – It is a naturally occurring polymeric material.
- Good binding property – Can help bind drug particles during tablet preparation.
- Sustained-release potential – Its swelling and matrix-forming characteristics can be explored controlled drug release⁽¹⁷⁾. Film-forming ability – Can potentially contribute to polymeric films/coatings.
- Mucoadhesive potential – May improve adhesion of formulations to mucosal surfaces.
- Swelling property – Hydration/swelling can help control drug diffusion⁽¹⁹⁾.
- Biodegradable/natural origin – Natural gums are generally attractive alternatives to some synthetic polymers. Low-cost excipient – Can be investigated as an economical pharmaceutical polymer.
- Modification is possible – Chemical or physical modification can improve its functionality⁽²⁴⁾.
- Useful for novel drug-delivery systems – It can be investigated in microspheres, microcapsules, beads, tablets, and controlled-release formulations. Can undergo cross-linking – Cross-linking can alter swelling, mechanical strength, and drug-release behavior⁽²²⁾.
- Potential as a release-retarding agent – Increasing gum concentration may be used to slow drug release in suitable formulations.

1.4 DISADVANTAGES

- Batch-to-batch variation – Being a natural plant-derived material, its chemical composition and properties can vary with geographical source, climate, harvesting season, and processing conditions⁽²⁵⁾.
- Lack of standardization – Compared with well-established pharmaceutical excipients, standardized specifications and comprehensive quality-control parameters may be limited. Variable solubility – Dikamali is a resinous exudate, and its different constituents may have different solubilities. Therefore, complete dissolution in aqueous media cannot be assumed.
- Possible poor aqueous dispersibility – Some preparations may swell or disperse rather than form a clear solution, which can complicate formulation development.
- Potential microbial contamination – Natural materials can be susceptible to microbial contamination if they are not properly dried, processed, and stored.
- Moisture sensitivity – Moisture content can influence powder flow, stability, swelling, and drug-release characteristics⁽²⁶⁾. Taste and odour – Natural resinous materials may have characteristic odour (or) taste, which can be undesirable in oral

formulations.

- Limited pharmaceutical data – Compared with established excipients such as HPMC, PVP, carbomers, or sodium alginate, comprehensive information on Dikamali's safety, toxicity, stability, and regulatory acceptance may be limited⁽²⁷⁾.
- Drug–excipient compatibility problems – Its chemical constituents may interact with certain drugs or other excipients, so compatibility studies are necessary.
- Variable drug-release behavior – Changes in particle size, concentration, hydration, and processing can significantly affect drug-release profiles.
- Processing difficulties – Resinous materials can sometimes be sticky or difficult to mill and handle, particularly when moisture or temperature is not controlled⁽²⁹⁾.
- Need for purification – Raw Dikamali may contain impurities or non-polymeric constituents, so purification may be required before pharmaceutical application.
- Limited scalability data – Laboratory-scale results may not directly translate to large-scale manufacturing without optimization. Need for extensive characterization – FTIR, DSC, TGA, XRD, SEM, moisture, flow and other studies may be required to establish reproducible pharmaceutical quality⁽³⁰⁾.





Figure no- 1:Dikamali gum resin-Plant source,Gum resin and Dried resin.

1.5 CHEMICAL STRUCTURE OF DIKAMALI
Gum formation in plants is generally associated with a physiological response known as gummosis. Several factors can stimulate this process, including mechanical injury, insect attack, microbial infection, drought, temperature stress and other environmental or physiological stresses. These stimuli can cause degradation or transformation of plant cell-wall components and promote the production or release of polysaccharide-rich materials and/or resinous exudates⁽⁴⁾.

The structural characteristics of natural gums are mainly related to their carbohydrate or polymeric components. Depending on the particular gum, monosaccharide units such as glucose, galactose, arabinose, mannose, xylose and glucuronic acid may be present. These units are connected through glycosidic linkages (C–O–C) to form polymeric chains. Numerous hydroxyl (–OH) groups provide hydrophilicity and enable hydrogen bonding with water. Acidic polysaccharides may additionally contain carboxyl (–COOH) groups⁽¹³⁾.

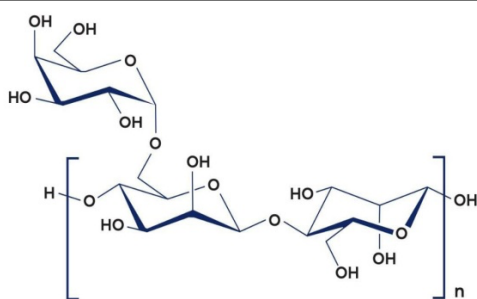


Figure no- 2:Chemical structure of Dikamali

Table no -1: Chemical constituents of Dikamali in Different solvents

Bioactive compounds	Aqueous	Methanol	Ethanol
Tannins	Absence	Presence	Presence
Saponins	Presence	Presence	Presence
Flavonoids	Presence	Absence	Absence
Terpenoids	Absence	Absence	Presence

Phenolic compounds	Presence	Presence	Presence
Reducing sugars	Absence	Absence	Absence
Steroids	Absence	Absence	Presence
Alkaloids	Absence	Presence	Presence
Carbonyl compounds	Absence	Absence	Absence

2. IDENTIFICATION TESTS

- **Tannin Test:** A quantity of approximately 1 ml of the gum extract was taken. Three to five drops of 10% lead acetate solution were added to it. The appearance of a gelatinous precipitate confirmed the presence of tannin⁽¹⁾.
- **Saponin Test:** A quantity of approximately 1 ml of the gum extract was taken, and 1 ml of distilled water was added. The mixture was shaken thoroughly. The continued formation of froth confirmed the presence of saponin⁽³⁾.
- **Test for flavonoids:** One millilitre of the gum extract was taken and 2 millilitres of 2% sodium hydroxide solution was added. Dilute hydrochloric acid was then added to the mixture. The colour initially turned into a bright yellow with the sodium hydroxide and later became colourless. This change in colour confirmed the presence of flavonoids⁽²⁾.
- **Test for terpenoids:** One millilitre of the filtrate was taken and 6 drops of chloroform were added. The mixture was placed in a water bath for a few minutes. Then, 6 drops of concentrated sulphuric acid were added. The formation of a reddish-brown interface confirmed the presence of terpenoids⁽⁹⁾.
- **Test for phenolic compounds:** One millilitre of the gum extract was taken and a few drops of 5% ferric chloride solution were added. The appearance of a dark bluish-black colour confirmed the presence of phenolic compounds⁽¹⁸⁾.
- **Test for reducing sugars:** One millilitre of the gum extract was taken and 2-3 drops each of Fehling's solution A and B were added. The mixture was then kept in a water bath for some time. The presence of a red-orange precipitate confirmed the presence of reducing sugars⁽¹⁷⁾.
- **Test for steroids:** About 1 ml of the gum extract was taken. 1 ml of chloroform and 1ml of concentrated sulphuric acid was added into it. The appearance of 2 phases with the upper red and lower yellow with green fluorescence confirmed the presence of steroids⁽²²⁾.

- **Test for alkaloids:** A test for alkaloids was conducted by taking about 1 ml of the extract and adding 3 to 4 drops of Dragendroff's reagent. The appearance of a reddish-brown precipitate indicated the presence of alkaloids⁽¹⁹⁾.
- **Test for carbonyl compounds:** A test for carbonyl compounds was conducted by taking approximately 1 ml of the gum extract and adding 3 to 4 drops of 2,4-dinitrophenylhydrazine (DNPH) reagent. The formation of yellow crystals confirmed the presence of carbonyl compounds⁽²⁵⁾.

3. ROLE OF PHARMACEUTICAL INDUSTRY

3.1 Tablet formulations

Dikamali gum can be investigated as a natural binder in tablets. It may improve:

- Tablet hardness
- Granule binding
- Mechanical strength
- Powder cohesiveness

Examples : diclofenac sodium , paracetamol 500 mg⁽¹¹⁾.

3.2 Sustained-release formulations

Because hydrated natural polymers can form a matrix around drug particles, Dikamali gum may be used as a release-retarding polymer for sustained-release tablets.

It can help control drug release by: Water penetration → polymer hydration/swelling → formation of a viscous matrix → slower drug diffusion⁽¹²⁾.

Examples : zidovudine , Repaglinide , Fenoprofen.

3.3 Microspheres and microcapsules

Dikamali gum can be explored as a matrix or coating polymer in microsphere/microcapsule formulations. These systems can provide controlled drug release and potentially protect the drug from environmental conditions⁽⁷⁾.

Examples : Fenoprofen , Flurbiprofen , Lornoxicam.

3.4 Matrix tablets

Dikamali gum can be incorporated into hydrophilic matrix tablets to modify drug-release rates. The concentration of gum can be optimized to obtain the desired release profile⁽¹³⁾.

Examples : Zidovudine , Fenoprofen⁽⁸⁾.

3.5 Suspending and viscosity-modifying agent

Natural gums can increase the viscosity of liquid formulations. Dikamali gum may therefore be investigated as a:

- Suspending agent
- Thickening agent
- Viscosity modifier⁽¹⁵⁾

3.6 Film and coating applications

After suitable processing or modification, it may be explored as a film-forming or coating material for pharmaceutical dosage forms⁽¹⁴⁾.

3.7 Controlled drug-delivery systems

Chemical or physical modification of Dikamali gum can potentially improve its:

- Swelling
- Mechanical strength
- Drug-loading capacity
- Drug-release control
- Mucoadhesive properties

Example: paracetamol, fenoprofen⁽¹⁶⁾.

4. IR STUDIES

FTIR (Fourier Transform Infrared Spectroscopy) is a spectroscopic technique used to identify the functional groups and chemical bonds present in a sample and to study possible drug–excipient interactions⁽²³⁾.

- Identification of Dikamali gum – to determine its characteristic functional groups.
- Drug–excipient compatibility – to check compatibility between Paracetamol and Dikamali gum.
- Detection of chemical interactions – changes in characteristic peaks may indicate interaction or degradation.
- Comparison of spectra – compare pure Paracetamol, pure Dikamali gum, and the physical mixture/formulation.

Typical procedure

Prepare the sample by ATR or KBr pellet method. For KBr method, mix approximately 1–2 mg sample with 100–200 mg dry KBr and compress into a transparent pellet. Record the spectrum generally over 4000–400 cm⁻¹. Compare the characteristic peaks of the pure drug and excipient with those of their physical mixture/formulation⁽²¹⁾.

Interpretation

If the principal characteristic peaks of Paracetamol and Dikamali gum remain present without major disappearance or significant shifting, it generally suggests no major chemical interaction between the drug and excipient⁽²⁰⁾.

Important: FTIR alone does not prove complete compatibility; it should be supported by techniques such as DSC, XRD, or stability studies when required.

Table no -2: FTIR analysis of Dikamali Gum.

Peak region (cm ⁻¹)	Functional group	Vibrations
3600 - 3200	-OH	O-H Stretching

~2920	-CH ₂ /-CH ₃	Aliphatic C-H Stretching
~1730	C=O	Carbonyl stretching
~1600 - 1650	H-O-H / C=O	Bending of absorbed water
~1450	C-H	C-H Bending / Deformation
~1370	C-H / O-H	Deformation vibrations
1200 - 1000	C-O / C-O-C	Polysaccharide / Glycoside stretching
~1050 - 1100	C-O	C-O Stretching
~890	Glycosidic structure	C-H Deformation / anomeric region vibration

FTIR analysis of Dikamali gum: The FTIR spectrum of Dikamali gum exhibited a broad absorption band in the 3200–3600 cm⁻¹ region, which can be attributed to O–H stretching vibrations. The band around 2920 cm⁻¹ corresponds to aliphatic C–H stretching. Absorption in the 1600–1650 cm⁻¹ region may be associated with absorbed water and carbonyl-related vibrations. The fingerprint region between 1000 and 1200 cm⁻¹ shows prominent C–O and C–O–C stretching vibrations characteristic of carbohydrate/polymeric structures. These characteristic peaks support the presence of hydroxyl, aliphatic and oxygen-containing functional groups in Dikamali gum⁽²⁸⁾.

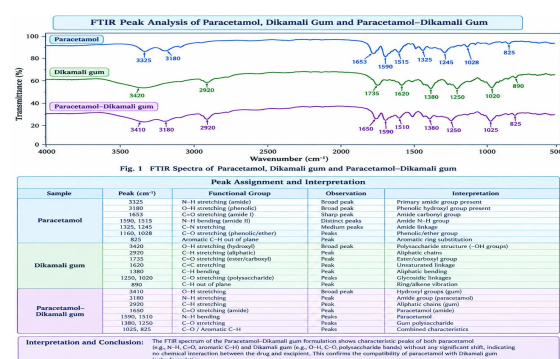


Figure no-3: FTIR Spectra of paracetamol, Dikamali gum and paracetamol-Dikamali gum.

5.RESULT

The qualitative phytochemical screening of *G. gummifera* resin revealed the presence of various bioactive compounds. The aqueous extract showed the presence of saponins, flavonoids, and phenolic compounds. The methanol extract showed the presence of tannins, saponins, alkaloids, and

phenolic compounds. The ethanol extract showed the presence of tannins, saponins, terpenoids, steroids, and phenolic compounds. The toxicity analysis using brine shrimp nauplii showed that the methanol and ethanol extracts of *G. gummifera* resin exhibited significant toxicity. The results of the phytochemical screening and toxicity analysis suggest that *G. gummifera* resin contains a range of bioactive compounds with potential pharmacological applications. The presence of saponins, flavonoids, and phenolic compounds in the resin may contribute to its reported medicinal uses, including anti-inflammatory and antimicrobial activities. The findings of this study support the traditional use of *G. gummifera* resin in medicine and highlight its potential as a source of new drugs and therapies. The presence of bioactive compounds such as saponins, flavonoids, and phenolic compounds in the resin may contribute to its reported medicinal uses.

6.CONCLUSION

Dikamali gum, obtained from *Gardenia gummifera*, is a promising natural resinous material with potential pharmaceutical applications. Its physicochemical characteristics, including potential swelling, binding, matrix-forming and drug-release-modifying properties, make it an interesting candidate for the development of tablets, microspheres, microcapsules, beads and other controlled drug-delivery systems. Its natural origin and potential for chemical or physical modification further increase its research value. However, limitations such as batch-to-batch variation, variable composition, limited standardization, solubility issues and insufficient comprehensive pharmaceutical data need to be addressed. Therefore, proper purification, characterization, standardization, compatibility testing, stability studies and safety evaluation are essential before its use in pharmaceutical formulations. Overall, Dikamali gum represents a promising natural excipient for future pharmaceutical and advanced drug-delivery research, provided its properties are scientifically established and standardized.

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