



## Review Article

# A Review on: Herbal Nasal Gel

**Ritesh Shejul\*, Ram Kharode, Ritesh Kharat, Rushabh Chaval, S. D. Sagrule, K. R. Biyani**

*Anuradha College of Pharmacy, Anuradha Nagar, Sakegaon Road, Chikhli, Dist. Buldhana, Maharashtra – 443201, India. Affiliated to Sant Gadge Baba Amravati University, Amravati*

The nasal route is used for local drug delivery and, for suitable medicines, systemic delivery. Its advantages include non-invasive administration and avoidance of hepatic first-pass metabolism for the fraction absorbed systemically. A major limitation is mucociliary clearance, which can remove conventional nasal solutions and suspensions from the nasal cavity and shorten their contact time with the mucosa. Herbal nasal gels are being investigated as dosage forms that may improve local retention through suitable viscosity and mucoadhesion. Their performance depends on the botanical material, extract composition, polymer system, excipients, formulation pH, rheology, administration method, microbiological quality and packaging. This review summarises nasal anatomy and physiology; the concept, types, advantages and limitations of nasal gels; selection of herbal ingredients and polymers; extraction and formulation methods; and relevant evaluation parameters. It also discusses the need for botanical authentication, extract standardisation, marker analysis, stability testing and local safety assessment. Recent reviews support continued investigation of intranasal natural products and mucoadhesive or in-situ gelling systems, but they also highlight translational and safety challenges. Evidence from traditional use or laboratory studies of a plant does not establish that a specific herbal nasal gel is safe or effective. Herbal nasal gels should therefore be regarded as investigational formulations until their quality, nasal tolerability and therapeutic benefit have been demonstrated through appropriate studies.

**Keywords:** Herbal nasal gel; nasal drug delivery; mucoadhesion; herbal extract; gelling polymers; in-situ gel; nasal mucosa; formulation evaluation.

## INTRODUCTION

Herbal medicines are used in traditional healthcare systems and remain an important source of compounds investigated for pharmaceutical applications. Plant-derived materials contain diverse constituents, including phenolics, flavonoids, terpenoids, alkaloids and volatile compounds. Their composition may vary with species, plant part, growing conditions, harvest, storage and extraction procedure. Consequently, the development of a herbal dosage form requires botanical authentication, appropriate extraction, quality control and reproducible formulation rather than relying on the plant name or traditional use alone. The nasal route is an accessible, non-invasive route for administering medicines intended for local action, such as treatment of selected nasal conditions, and for systemic delivery

of suitable drugs. The nasal mucosa is vascularised and absorbed drugs may avoid hepatic first-pass metabolism. Nevertheless, nasal delivery is affected by mucociliary clearance, mucus, epithelial permeability, formulation volume, deposition pattern and the physicochemical properties of the active substance [1–4]. A conventional nasal liquid may drain from the nostrils or move towards the nasopharynx. Mucoadhesive gels and in-situ gelling systems have therefore been studied to increase contact between a formulation and the nasal mucosa. A successful product must balance retention with ease of administration, spreading, release and compatibility with normal nasal function. Increasing viscosity or adhesion alone does not guarantee improved drug delivery or clinical benefit [5–7].

## 2. Anatomy and Physiology of The Nasal Cavity

The nasal cavity is divided into right and left sides by the nasal septum. Its principal regions are the vestibule, respiratory region and olfactory region. The vestibule contains hairs that help filter larger particles. The respiratory region, which accounts for most of the nasal cavity, is lined mainly by ciliated epithelium with mucus-producing cells. Mucus traps particles, while coordinated ciliary movement transports the mucus towards the nasopharynx. This protective process is known as mucociliary clearance. The olfactory region is associated with smell and has distinct anatomical and cellular features. Formulation deposition depends on the device, application technique, nasal anatomy and properties of the preparation. Nasal mucus, pH, disease state and ciliary activity can also affect the performance of an intranasal product. A gel should not obstruct the nasal passage, cause unacceptable irritation or impair normal mucociliary function [1,2,5].

## 3. Concept and Types of Nasal Gel

A gel is a semisolid system in which a liquid phase is held within a three-dimensional network formed by a gelling agent. A nasal gel is designed for application to the nasal cavity and must be formulated with ingredients appropriate for intranasal use. Two broad approaches are commonly discussed:

### 3.1 Ready-to-use nasal gel

This formulation is a semisolid before administration and is applied using a suitable applicator or delivery system. Its viscosity and adhesion may help maintain contact with the mucosa, but high viscosity can make dosing and spreading difficult.

### 3.2 In-situ gelling nasal system

An in-situ gelling system is administered as a liquid or lower-viscosity preparation and undergoes sol-to-gel transition after exposure to a physiological trigger. Depending on the formulation, gelation may be triggered by temperature, pH or ions. Such systems may combine ease of administration with increased retention, but gelation, dose delivery, rheology and tolerability must be established experimentally [6,7].

## 4. Advantages, Limitations and Desirable Characteristics

### 4.1 Potential advantages

- Potentially prolonged contact with the nasal mucosa through suitable viscosity and mucoadhesion.
- Possible reduction in rapid drainage or leakage when the formulation is appropriately designed.
- Non-invasive administration and potential suitability for local delivery of compatible active ingredients.
- Formulation flexibility through the selection of polymers, vehicles and release-controlling ingredients.
- Potential use as a carrier for standardised herbal extracts after compatibility and safety have been demonstrated.

### 4.2 Limitations and risks

- Excessive viscosity or adhesion may hinder administration, spreading or normal mucociliary clearance.
- The nasal cavity accepts only limited volumes; dosing and delivery-device performance are important.
- Herbal extracts may vary in composition and can introduce colour, odour, insoluble matter or instability.
- Plant constituents, solvents, preservatives or other excipients may irritate nasal tissue.
- Aqueous formulations may support microbial growth and require appropriate microbiological controls.
- Longer residence time does not by itself prove greater absorption, improved symptom control or clinical efficacy.

### 4.3 Desirable characteristics of a nasal gel

An ideal candidate should have reproducible composition, suitable pH and osmolality, appropriate viscosity and spreadability, adequate but not excessive mucoadhesion, uniform extract distribution, acceptable release characteristics, microbiological quality, stability, a compatible container-closure system and evidence of nasal

tolerability. Acceptance limits should be justified for the specific formulation; a single universal target value cannot be applied to every nasal gel.

## 5. Herbal Ingredients and Standardisation

A herbal nasal gel may contain a single authenticated plant extract or a combination of extracts selected for a clearly stated research rationale. Selection should consider published evidence, botanical identity, availability, extractability, chemical stability, potential allergens or irritants, compatibility with the polymer and suitability for contact with nasal mucosa. Traditional use and in-vitro pharmacological activity may justify further investigation, but neither establishes intranasal safety or efficacy.

## 5.1 Botanical authentication and quality

The botanical name, author citation where appropriate, family, plant part and source should be recorded. Plant material should be authenticated by a qualified person or recognised institution, and a voucher specimen should be retained where feasible. Collection, drying, storage and processing conditions should be documented. Relevant controls may include identity testing, foreign matter, moisture content, microbial limits, contaminants and extraction yield, according to the material and applicable standards.

## 5.2 Extraction methods

| Method                         | Principle and potential use                                                                      | Important limitation                                                                             |
|--------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Maceration                     | Plant material is soaked in a selected solvent for a defined period, with mixing as appropriate. | May require substantial time and may give variable or incomplete extraction.                     |
| Percolation                    | Solvent passes through moistened and packed plant material.                                      | Efficiency depends on particle size, packing, solvent and flow rate.                             |
| Soxhlet extraction             | Repeated hot-solvent cycles extract constituents from the material.                              | Prolonged heating may degrade heat-sensitive constituents.                                       |
| Infusion/decoction             | Water is used to steep or boil the plant material.                                               | May not extract less-polar constituents; aqueous extracts may be less stable.                    |
| Ultrasound-assisted extraction | Ultrasonic energy can improve solvent penetration and mass transfer.                             | Equipment and conditions require optimisation; heat and sonication can affect some constituents. |

The solvent and method should be chosen according to the intended chemical profile, safety requirements and subsequent formulation. Residual solvent should be controlled when relevant. Extraction yield alone is not sufficient: the extract should also be characterised using a suitable analytical fingerprint or marker assay when feasible [8,9].

## 5.3 Phytochemical characterisation

Preliminary phytochemical tests may indicate broad classes such as phenolics, flavonoids, tannins, saponins or alkaloids. These tests are screening tools and generally do not identify or quantify individual compounds. Where feasible, a validated or fit-for-purpose analytical method such as HPLC, HPTLC, GC or spectrophotometry should be selected according to the expected constituents. Total phenolic

content may be useful as a supplementary measure but should not be described as the content of a specific active ingredient.

## 6. Excipients And Polymers Used In Nasal Gels

Excipients are selected to provide the required gel structure, viscosity, compatibility, stability and delivery characteristics. An ingredient used in a topical or oral product cannot automatically be assumed suitable for intranasal administration. Grade, concentration, impurities, route-specific tolerability and regulatory status must be considered.

| Excipient/polymer                    | Potential function                                                                   | Key development consideration                                                          |
|--------------------------------------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Carbomer (e.g., Carbopol grades)     | Viscosity enhancement and gel formation after suitable neutralisation.               | pH, neutraliser, electrolytes and extract composition can strongly affect viscosity.   |
| Hydroxypropyl methylcellulose (HPMC) | Viscosity enhancement and modification of flow and release.                          | Grade and concentration influence hydration, rheology and release.                     |
| Sodium carboxymethylcellulose        | Thickening and potential mucoadhesion.                                               | Viscosity, compatibility and local tolerability require evaluation.                    |
| Chitosan                             | Mucoadhesive polysaccharide; may also affect permeability in some systems.           | Solubility and charge depend on pH; local safety and intended use need evidence.       |
| Poloxamer                            | Thermoresponsive gelation in suitable formulations.                                  | Gelation temperature, dilution, rheology and dose delivery need optimisation.          |
| Gellan gum/alginate/pectin           | Natural polysaccharides that may form gels under suitable ionic or other conditions. | Gelation depends on polymer grade, ions, formulation composition and intended trigger. |
| Vehicle                              | Dissolves or disperses the extract and excipients.                                   | Must be compatible, appropriate for intranasal use and microbiologically controlled.   |
| pH-adjusting agent/buffer            | Adjusts final pH and may support stability.                                          | Must not cause unacceptable irritation or destabilise the polymer/extract.             |
| Preservative, if required            | Controls microbial growth in an appropriate multidose product.                       | Compatibility, effectiveness and nasal tolerability must be established.               |

Polymer selection should be based on comparative data for viscosity, rheology, spreadability, mucoadhesion, release, stability and nasal compatibility. Carbopol and HPMC may be studied as candidate polymers, but their suitability and the optimum concentration must be established for each extract and formulation [6,7,10].

## 7. Formulation Development and Preparation

### 7.1 General development workflow

1. Authenticate the plant material and document its source and plant part.
2. Select and optimise the extraction method and solvent.
3. Determine extraction yield and characterise the extract using suitable screening and analytical methods.
4. Choose polymers and excipients based on intranasal suitability and compatibility.
5. Prepare preliminary batches under controlled mixing, hydration and processing conditions.

6. Assess appearance, homogeneity, pH, viscosity/rheology and spreadability.
7. Evaluate marker content, mucoadhesion and in-vitro release where analytically appropriate.
8. Assess microbiological quality, packaging compatibility, stability and relevant nasal safety endpoints.
9. Compare batches against predefined criteria and select a candidate only when supported by the data.

### 7.2 Dispersion and hydration method

For a polymer that is suitable for this method, the polymer is gradually dispersed into the selected vehicle under controlled mixing to minimise lump formation. It is allowed to hydrate according to the manufacturers or established method requirements. The extract and other compatible ingredients are then incorporated using a process that limits degradation and ensures uniformity. The pH is adjusted only when appropriate for the polymer and extract. The final preparation is checked for homogeneity, entrapped air, pH and rheological properties. Carbomer viscosity commonly depends on neutralisation and the

formulation environment; the neutraliser and its quantity should therefore be optimised rather than assumed. HPMC hydration behaviour depends on grade and processing conditions. The preparation procedure should document order of addition, mixing speed and duration, temperature, hydration time, final mass or volume and any deaeration step.

### 7.3 Factors influencing formulation quality

Important variables include polymer type and concentration, extract loading, pH, ionic strength, mixing conditions, temperature, hydration time, vehicle composition, preservative system and packaging. Increasing polymer concentration may

increase viscosity and alter adhesion and release, but the relationship is formulation-dependent. The final product must remain deliverable at the intended dose and must not impair normal nasal function.

## 8. Evaluation Of Herbal Nasal Gel

Evaluation methods and acceptance criteria should be chosen according to the type of gel, the intended delivery system and applicable standards. The methods below are common development considerations; not every test is relevant to every formulation, and no result should be assumed before testing.

| Parameter                      | Suggested approach                                                                           | Purpose/interpretation                                                                           |
|--------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Appearance and homogeneity     | Visual examination and appropriate sampling.                                                 | Identify lumps, visible particles, phase separation and non-uniformity.                          |
| pH                             | Calibrated pH meter using a suitable method.                                                 | Characterise pH and assess compatibility; justify the target range for the formulation.          |
| Viscosity/rheology             | Suitable viscometer or rheometer under defined temperature and shear conditions.             | Characterise flow and consistency relevant to dispensing, spreading and retention.               |
| Spreadability                  | A justified spreading test under defined conditions.                                         | Assess how readily the gel spreads under the selected test conditions.                           |
| Extrudability/dispensing       | Measure force or delivered quantity where tube or device packaging makes this relevant.      | Assess ease and reproducibility of administration.                                               |
| Marker/extract content         | Fit-for-purpose analytical assay, with method performance assessed.                          | Support content consistency and batch reproducibility.                                           |
| Mucoadhesive strength          | Justified detachment-force method using a relevant mucosal model.                            | Compare adhesion under controlled conditions; does not directly prove human residence time.      |
| In-vitro release               | Suitable diffusion/release apparatus and analytical method.                                  | Compare release of a marker or constituent where feasible.                                       |
| Microbiological quality        | Appropriate microbial-limit and, where required, preservative-effectiveness testing.         | Assess microbiological quality and protection during use/storage.                                |
| Nasal tolerability             | Appropriate preclinical assessment of local irritation and relevant mucosal/ciliary effects. | Investigate potential local adverse effects; one screening test is not proof of complete safety. |
| Stability                      | Defined protocol assessing relevant physical, chemical and microbiological attributes.       | Determine whether quality is maintained under proposed storage conditions.                       |
| Container/device compatibility | Assess compatibility, closure integrity and delivered dose where applicable.                 | Ensure packaging does not adversely affect product quality or administration.                    |

### 8.1 Interpretation of results

A formulation with the highest viscosity or mucoadhesive strength is not necessarily the best formulation. Results should be interpreted together

with ease of administration, spreadability, release, stability, nasal tolerability and dose reproducibility. Laboratory release or adhesion tests are comparative tools and do not independently establish clinical

efficacy. Predefined criteria and suitable replicate measurements improve the reliability of comparisons.

## 9. REVIEW OF LITERATURE

The literature relevant to herbal nasal gels includes (i) general nasal drug-delivery research, (ii) reviews of mucoadhesive and in-situ gelling systems, and (iii) studies of intranasal herbal products or natural products. These evidence categories inform formulation development but should not be treated as equivalent.

### 9.1 Nasal drug delivery and mucoadhesive systems

Kublik and Vidgren (1998) reviewed nasal delivery systems and the influence of formulation and device characteristics on deposition and absorption [1]. Illum (2003) discussed opportunities and limitations of nasal drug delivery, including physiological barriers and formulation challenges [2]. Pires and colleagues (2009) reviewed the rationale and applications of intranasal drug delivery [3]. Ugwoke and colleagues (2005) reviewed nasal mucoadhesive systems and the potential role of polymers in increasing contact with the mucosa [4]. Singh, Kumar and Pathak (2013) discussed mucoadhesive in-situ nasal gels, polymer choices and translational challenges [5]. Collectively, these sources support the rationale for studying formulation properties that may influence residence time, while not proving that every gel improves clinical outcomes.

### 9.2 Reviews of herbal and natural-product intranasal delivery

Tran and colleagues (2024) published a systematic review of intranasal herbal medicines, identifying both preclinical and clinical studies across different plants, preparations and indications [11]. The review supports the conclusion that intranasal herbal delivery is an area of investigation, but its findings cannot be generalised to every plant, extract, dose or dosage form. Differences in botanical material, formulation and study design require product-specific interpretation. Hsu and colleagues (2025) reviewed advances in nasal delivery systems for natural products and described opportunities alongside barriers such as solubility and stability [12]. Sonawane, Shelke and Bonde (2025) reviewed

natural-polysaccharide-based in-situ nasal gels, including polymers such as chitosan, gellan gum, alginate and pectin [13]. Qian, Cook and Dreiss (2025) reviewed formulation, characterisation and applications of in-situ nasal gels and noted the diversity of polymers and the need for appropriate performance evaluation [14]. Porfiryeva and colleagues (2026) further reviewed mucoadhesive and mucus-interacting systems and highlighted continuing translational and safety challenges [14].

### 9.3 Critical appraisal and relevance

The literature provides a rationale for researching herbal nasal gels as formulation platforms. However, evidence for a plant's traditional use or pharmacological activity is not evidence that an intranasal preparation is safe or effective. Likewise, published findings for one polymer, active ingredient or in-situ gel cannot be directly transferred to a different formulation. A review should clearly distinguish general platform evidence, plant-specific evidence, direct evidence for the proposed product and results that remain to be generated.

## 10. FUTURE SCOPE

- A key research need is to connect the general promise of nasal gels with reproducible, product-specific evidence. For a proposed herbal nasal gel, the following work may be needed:
- Botanical authentication and standardisation of the selected plant material and extract.
- Selection of a suitable marker or analytical fingerprint to support extract and batch consistency.
- Systematic comparison of candidate polymers and concentrations using predefined formulation criteria.
- Optimisation of pH, viscosity, spreadability, mucoadhesion and delivery-device compatibility.
- Evaluation of release behaviour using an appropriate marker or constituent when feasible.

- Microbiological quality assessment and stability studies in the proposed packaging.
- Appropriate preclinical assessment of nasal irritation, mucosal integrity and ciliary function.
- Further efficacy studies only when justified by quality and safety findings, with study design appropriate to the intended indication.
- These are proposed research activities, not established outcomes. A formulation should not be described as effective for allergic rhinitis, nasal congestion, infection or another condition unless appropriate evidence supports that specific claim.

## CONCLUSION

Herbal nasal gels are an area of pharmaceutical formulation research that combines the potential of plant-derived ingredients with the delivery characteristics of semisolid or in-situ gelling systems. The nasal route is non-invasive and is used for local delivery and, for suitable substances, systemic delivery. However, mucociliary clearance, limited administration volume, variability in herbal extracts and the sensitivity of nasal tissues present important formulation challenges. Suitable polymers may alter viscosity, spreadability, mucoadhesion and release, but these properties must be optimised together rather than maximised individually. The development of a herbal nasal gel should begin with authenticated botanical material and a reproducible, characterised extract. Candidate polymers and excipients must be appropriate for intranasal use, and the finished formulation should be evaluated for appearance, homogeneity, pH, rheology, content consistency, release where relevant, microbiological quality, stability, packaging compatibility and nasal tolerability. Published reviews support further research into herbal intranasal delivery and mucoadhesive gels, but do not establish the safety or efficacy of any particular formulation. Therefore, a herbal nasal gel should be regarded as investigational until adequate product-specific quality, safety and efficacy evidence is available.

## REFERENCES

1. Kublik H, Vidgren MT. Nasal delivery systems and their effect on deposition and absorption. *Advanced Drug Delivery Reviews*. 1998;29(1–2):157–177.
2. Illum L. Nasal drug delivery—possibilities, problems and solutions. *Journal of Controlled Release*. 2003;87(1–3):187–198.
3. Pires A, Fortuna A, Alves G, Falcão A. Intranasal drug delivery: how, why and what for? *Journal of Pharmacy and Pharmaceutical Sciences*. 2009;12(3):288–311.
4. Ugwoke MI, Agu RU, Verbeke N, Kinget R. Nasal mucoadhesive drug delivery: background, applications, trends and future perspectives. *Advanced Drug Delivery Reviews*. 2005;57(11):1640–1665.
5. Singh RM, Kumar A, Pathak K. Mucoadhesive in situ nasal gelling drug delivery systems for modulated drug delivery. *Expert Opinion on Drug Delivery*. 2013;10(1):115–130. doi:10.1517/17425247.2013.746659.
6. Washington N, Steele RJ, Jackson SJ, Bush D, Mason J, Gill DA, et al. Determination of baseline human nasal pH and the effect of intranasally administered buffers. *International Journal of Pharmaceutics*. 2000;198(2):139–146.
7. Qian L, Cook MT, Dreiss CA. In Situ Gels for Nasal Delivery: Formulation, Characterization and Applications. *Macromolecular Materials and Engineering*. 2025;310(6):2400356. doi:10.1002/mame.202400356.
8. Azwanida NN. A review on the extraction methods use in medicinal plants, principle, strength and limitation. *Medicinal & Aromatic Plants*. 2015; 4:196. doi:10.4172/2167-0412.1000196.
9. World Health Organization. Quality control methods for herbal materials. Geneva: WHO; 2011.
10. Rowe RC, Sheskey PJ, Quinn ME, editors. *Handbook of Pharmaceutical Excipients*. 6th ed. London: Pharmaceutical Press; 2009.
11. Tran KN, Kwon JH, Kim MK, Nguyen NPK, Yang IJ. Intranasal delivery of herbal medicine for disease treatment: A systematic review. *Phytomedicine*. 2024; 127:155484. doi:10.1016/j.phymed.2024.155484.

12. Hsu Y, Yang J, Cao M, Xu T, Jia J, Hong H, et al. Advancements in nasal drug delivery system of natural products. *Frontiers in Pharmacology*. 2025; 16:1667517. doi:10.3389/fphar.2025.1667517.
13. Sonawane S, Shelke H, Bonde S. A comprehensive review on natural polysaccharides based in situ gels for nasal drug delivery. *International Journal of Biological Macromolecules*. 2025;320(Pt 3):145987. doi:10.1016/j.ijbiomac.2025.145987.
14. Porfiryeva NN, Moustafine RI, Khutoryanskiy VV. Advances in mucoadhesive and mucus-penetrating materials, nano-formulations, and in situ gelling systems for nasal drug delivery. *Expert Opinion on Drug Delivery*. 2026;23(5):797–822. doi:10.1080/17425247.2026.2628612.

**Cite:** Ritesh Shejul\*, Ram Kharode, Ritesh Kharat, Rushabh Chaval, S. D. Sagrule, K. R. Biyani, A Review on: Herbal Nasal Gel, *Int. J. Med. Pharm. Sci.*, 2026, 2 (10), 338-345. <https://doi.org/10.5281/zenodo.23721960>