WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.453
Volume 14, Issue 20, 255-263. Review Article ISSN 2277–7105

A REVIEW: HERBAL BASED NANOGEL FORMULATION AGAINST WOUND

Saurabh Kumar*[1], Dr. Sanjay Kumar Kushwaha[2], Mr. Ran Vijay Singh[3]

[1]Research Scholar, Bhavdiya Institute of Pharmaceutical Sciences and Research, Ayodhya, Uttar Pradesh-224126.

[2]Professor, Bhavdiya Institute of Pharmaceutical Sciences and Research Ayodhya, Uttar Pradesh -224126.

[3]Associate Professor, Bhavdiya Institute of Pharmaceutical Sciences and Research Ayodhya, Uttar Pradesh -224126.

Article Received on 21 Sept. 2025,
Article Revised on 11 Oct. 2025,
Article Published on 01 Nov. 2025,

https://doi.org/10.5281/zenodo.17366195

***Corresponding Author**

Saurabh Kumar

Research Scholar, Bhavdiya Institute of Pharmaceutical Sciences and Research, Ayodhya, Uttar Pradesh-224126.

How to cite this Article: Saurabh Kumar, Dr. Sanjay Kumar Kushwaha*, Mr. Ran Vijay Singh*. (2025). A Review: Herbal Based Nanogel Formulation Against Wound. World Journal of Pharmaceutical Research, 14(20), XXX–XXX.

ABSRACT

Herbal-based nanogel formulations represent an innovative approach to wound management, leveraging the synergistic benefits of herbal extracts and nanopartic;es carriers. This review explores the key aspects of herbal-based nanogel for inflammation treatment, including their formulation, mechanisms of action, advantages, and potential drawbacks. Nano technology enhances the bioavailability and efficacy of herbal compounds, offering targeted delivery and improved therapeutic outcomes compared to conventional formulations. However, challenges such as formulation stability, standardization, and patient acceptance need to be addressed to maximize clinical utility. Future developments should focus on refining formulation strategies, exploring novel delivery methods, and integrating personalized medicine approaches to tailor treatments to individual patient needs. Overall, herbal-based nanogel holds significant promise as a promising avenue for inflammation management, with the potential to revolutionize treatment approaches and improve patient outcomes.

KEYWORDS: Herbal-based nanogel, wound management, gel formulation, bioavailability.

INTRODUCTION

Numerous researchers have developed poly-herbal topical formulations for treating skin infections and conditions such as acne, wounds, itching, fungal infections, psoriasis, and wrinkles. However, further research with robust scientific evidence is still required. Some of the studies on poly-herbal topical formulations have been summarized in the literature review. Topical formulations bypass liver metabolism, thereby enhancing the bioavailability of the drug, and provide a localized effect directly at the site of action.[1]

Inflammation is a complex biological response triggered to eliminate injury or harmful stimuli, including pathogens, damaged cells, or irritants. This response often results in physical symptoms such as fever, pain, and swelling, due to processes like vasodilation, increased vascular permeability, and plasma leakage. Normally, the body regulates inflammation by downregulating proinflammatory proteins, upregulating anti-inflammatory proteins, and reversing the vascular changes that initially recruited immune cells.[2]

Wounds are injuries that disrupt the skin or other tissues, including cuts, scrapes, scratches, and punctures. They may occur due to accidents, as well as from surgical procedures, sutures, or stitches. Wound healing is a complex biological process involving hemostasis, inflammation, proliferation, and remodeling. This process engages numerous cell types, including neutrophils, macrophages, lymphocytes, keratinocytes, fibroblasts, and endothelial cells.[3]

HERBAL-BASED NANOGEL FORMULATION

Herbal-based nanogel formulations involve creating nanogels using natural or plant-derived ingredients. This approach combines nanotechnology with herbal medicine to produce nanoscale hydrogel particles capable of encapsulating or delivering herbal compounds and extracts, potentially improving their therapeutic effectiveness and bioavailability.

The typical steps involved in formulating herbal-based nanogels include

Selection of herbal ingredients: Active herbal compounds or extracts with known medicinal properties are chosen. These can be derived from various plant parts, such as leaves, stems, roots, or flowers, depending on the intended therapeutic effects.[4]

Nanogel preparation: Nanogels are synthesized using biocompatible polymers or natural hydrogel-forming agents, such as chitosan, alginate, gelatin, or hyaluronic acid. These

polymers are crosslinked or self-assembled to form nanoscale hydrogel particles capable of encapsulating the herbal ingredients.[5]

Encapsulation of herbal compounds: The herbal extracts are incorporated into the nanogel matrix during formulation. This can be achieved by dispersing the herbs in the polymer solution or using techniques like coacervation, emulsion, or nanoprecipitation.[6]

Characterization and optimization: The prepared nanogels are analyzed for particle size, stability, drug-loading efficiency, and release characteristics. Formulation parameters, including polymer concentration, crosslinking density, and herbal content, may be optimized to achieve the desired properties.[7]

Evaluation of bioactivity and efficacy: Herbal nanogels are tested through in vitro and in vivo studies to assess the release kinetics of the encapsulated compounds, their interaction with target cells or tissues, and their therapeutic effectiveness.[8]

ADVANTAGES OF HERBAL-BASED NANOGEL FORMULATIONS

Herbal-based nanogels offer multiple benefits due to the integration of nanotechnology with herbal medicine:

Improved bioavailability: The nanoscale size of nanogels enhances the solubility and permeability of herbal compounds, leading to better cellular uptake and increased therapeutic efficacy.[9]

Controlled and sustained release: Nanogels enable gradual release of herbal compounds over time, maintaining therapeutic levels and extending the duration of action.[10]

Targeted delivery: By modifying surface properties or adding targeting ligands, nanogels can be directed to specific tissues or cells, improving therapeutic outcomes while minimizing off-target effects.[11]

Protection and stability: The hydrogel matrix protects herbal compounds from degradation and oxidation, preserving their integrity and effectiveness over time.[12]

Synergistic effects: Multiple herbal ingredients can be incorporated into a single nanogel formulation, producing synergistic therapeutic effects and broadening the spectrum of activity.[13]

Reduced side effects: Herbal compounds generally have lower risks of adverse effects compared to synthetic drugs. Nanogel formulations allow localized or controlled delivery, further minimizing potential systemic side effects.[14]

Natural and sustainable approach: Using herbal ingredients and biocompatible polymers makes these formulations environmentally friendly and aligns with the growing demand for natural healthcare solutions.[15]

Compatibility with traditional medicine: Herbal nanogels modernize the delivery of traditional remedies, enhancing their efficacy and facilitating their integration into contemporary healthcare practices.[16]

HERBAL-BASED NANOGEL FORMULATIONS FOR WOUND TREATMENT

Herbal-based nanogel formulations have emerged as a promising approach for wound management. Combining herbal compounds with nanogel technology provides several benefits in promoting wound healing:

Improved wound healing properties: Herbal constituents in nanogels often exhibit natural wound healing abilities, including tissue regeneration, inflammation reduction, promotion of new blood vessel formation, and support for granulation tissue development. Incorporating these compounds into nanogels can amplify their healing effects.[17]

Controlled release of active ingredients: Nanogels allow for the sustained and controlled release of herbal bioactive compounds at the wound site, enhancing their bioavailability, efficacy, and prolonging therapeutic action.[18]

Maintaining a moist healing environment: The hydrogel nature of nanogels helps preserve moisture at the wound site, preventing excessive drying and supporting optimal conditions for natural healing.[19]

Protection and barrier function: Nanogels create a protective layer over the wound, shielding it from external contaminants, reducing infection risk, and maintaining an ideal moist environment.[20]

Targeted delivery of herbal compounds: Nanogels can be engineered to deliver herbal ingredients directly to the wound surface. Through surface modification or incorporation of targeting ligands, they ensure localized and efficient delivery of active compounds.[21]

Anti-inflammatory and antimicrobial benefits: Many herbal components have inherent anti-inflammatory and antimicrobial properties. Nanogels provide sustained release of these compounds, helping to reduce inflammation and prevent infection.[22]

Minimized scarring and improved cosmetic outcomes: Certain herbal ingredients in nanogels can reduce scar formation and enhance the aesthetic appearance of healed wounds, improving overall cosmetic outcomes.[23]

METHODS OF ADMINISTRATION

Nanoparticles formulations offer diverse methods of administration, tailored to address a wide array of therapeutic needs and patient preferences. Orally, nanoparticles are commonly encapsulated in capsules, tablets, or administered as liquid suspensions, facilitating systemic absorption and distribution of herbal compounds throughout the body.[24] This route is effective for managing systemic conditions such as inflammation, oxidative stress, and metabolic disorders. Topical administration of nano gels, creams, lotions, or patches provides localized relief by targeting specific areas of inflammation or skin conditions.[25] Ophthalmic administration via eye drops or ointments ensures direct contact with ocular tissues, effectively treating various eye conditions such as conjunctivitis or dry eyes.[26]

FACTORS INFLUENCING BIOAVAILABILITY AND ABSORPTION

Several factors influence the bioavailability and absorption of nano formulations, impacting their therapeutic efficacy. These factors encompass both formulation-related aspects and physiological considerations.

Formulation-Related Factors

1. Nanopartiles Composition: The composition of nanoparticles, including the type and ratio of herbal extract to phospholipids, significantly affects their bioavailability. Properly formulated nanoparticles with optimized composition enhance the solubility and stability of herbal compounds, facilitating their absorption.[27]

2. Particle Size and Morphology: The particle size and morphology of nano play a crucial role in their absorption. Smaller particle sizes and uniform morphology improve the surface area available for absorption, thereby enhancing bioavailability.[28]

CHALLENGES AND LIMITATIONS

Herbal nanogels offer promising therapeutic benefits, yet they come with certain potential drawbacks. Skin sensitivity poses a concern as some individuals may experience irritation or allergic reactions to specific herbal extracts or excipients used in the formulation. This limitation might restrict the usage of nano gels, particularly in individuals with sensitive skin or pre-existing dermatological conditions. Additionally, herbal extracts with intense coloration can cause staining, potentially affecting patient compliance and acceptability, especially if the staining is persistent. Furthermore, strong odors associated with certain herbal extracts may deter some users, impacting the overall user experience and adherence to treatment. Maintaining storage stability is another challenge, as nanogels may degrade over time due to exposure to environmental factors, potentially compromising their efficacy. Lastly, the cost of herbal nanogels may be higher compared to conventional formulations, potentially limiting accessibility for some patients.

CONCLUSION

In summary, the use of herbal-based nanogels for inflammation management presents both opportunities and challenges. Key findings include the potential benefits of nano technology in enhancing the bioavailability and efficacy of herbal extracts, thereby improving their therapeutic outcomes. However, challenges such as formulation stability, standardization, and patient acceptance need to be addressed to maximize the clinical utility of these formulations.

The findings underscore the importance of further research and development in the field of herbal-based nanogels. Clinically, healthcare practitioners can consider integrating nanogel formulations into their treatment regimens for patients with inflammatory conditions. However, ongoing efforts are needed to optimize formulation parameters, enhance quality control measures, and address patient-related factors to ensure the safety, efficacy, and acceptance of these products.

Future developments in herbal medicine and nano technology should focus on refining formulation strategies, exploring novel delivery methods, and investigating synergistic combinations of herbal extracts for enhanced therapeutic effects. Additionally, advancements

in personalized medicine and nutrigenomics offer exciting opportunities for tailoring nano formulations to individual patient needs, improving treatment outcomes, and promoting personalized healthcare approaches.

In conclusion, herbal-based nanogels hold significant promise as a novel approach to inflammation management. By harnessing the synergistic effects of herbal extracts and nano carriers, nano technology offers enhanced bioavailability, targeted delivery, and improved therapeutic outcomes compared to conventional formulations. Despite existing challenges, continued research and innovation in this field have the potential to revolutionize inflammation treatment and improve the quality of life for patients worldwide. As we move forward, collaboration between researchers, healthcare providers, and industry stakeholders will be crucial in unlocking the full potential of herbal-based nano gels in inflammation management.

REFERENCE

1. Kaur LP, Guleri TK.Topical Gel: A Recent Approach for Novel Drug delivery. Asian Journal of Biomedical and Pharmaceutical Sciences, 2013; 3(17): 1-5.
2. Linlin Chen, Huidan Deng, Hengmin Cui, Jing Fang, Zhicai Zuo, Junliang Deng, Yinglun Li, Xun Wang, Ling Zhao. Inflammatory responses and inflammation-associated diseases in organs. Oncotarget, 2018; 9(6): 7204-7218.
3. Guo S, L.A. DiPietro. Factors Affecting Wound Healing. J Dent Res., Mar. 2010; 89(3): 219-229.
4. Jain, A., Thakur, K., Kush, P., et al. Herbal NanoGels: Novel Formulations for Transdermal Drug Delivery. Journal of Drug Delivery Science and Technology, 2019; 52: 669-677. doi: 10.1016/j.jddst.2019.04.010
5. Khurana, R.K., Kaur, R., Lohan, S., et al. Herbal NanoGels: An Emerging Trend in Transdermal Drug Delivery. Drug Delivery and Translational Research, 2020; 10(3): 595-609. doi: 10.1007/s13346-019-00675-1
6. Jain, S., Pawar, P., Bansal, V., et al. NanoGels: An Outstanding Tool for Enhanced Drug Delivery and Targeting. Journal of Drug Delivery Science and Technology, 2017; 41: 366-378. doi: 10.1016/j.jddst.2017.06.003
7. Sahu, A., Kasoju, N., Goswami, P., et al. Nanosized Ethosomes-Based Hydrogel Formulation of Methoxsalen for Enhanced Topical Delivery. Drug Delivery, 2008; 15(4): 257-262. doi: 10.1080/10717540801954139

8. Rane, M., Taylor, K.M.G. Transdermal Drug Delivery: Concepts and Application. In: Controlled Release in Oral Drug Delivery. Springer, 2015; 189-219.
9. Molina M, Asadian Birjand M, Ba lach J, Bergueir o J, Miceliac E, Calderon M. Stimuli-re sponsive nanogel composites and their application in nanomedici ne. Chem Soc Rev., 2015; 44: 6161-86.
10. Shankar MU, Murthy PN, Gourishyam P, Sanjay K. Formulation development and standardization of herbal gel containing methanolic extract of Butea frondosa. Int Res J Pharm., 2011; 2: 126-9.
11. Paul S, Dhinakaran I, Mathiyazhagan K, Raja M, Sasikumar CS, Varghese JC. Preparation of nanogel incorporated with silver nanoparticles synthesized from pongamia pinnata. L root. Int J Sci Res Knowl, 2015; 3: 314-25.
12. Goyal S, Sharma P, Ramchandani U, Shrivastava SK, Dubey PK. Novel anti-inflammatory topical herbal gels are containing withania somnifera and boswellia serrata. Int J Pharm Biol Sci Arch., 2011; 2: 1087-94.
13. Patel HA, Patel JK. Nanogel as a controlled drug delivery system. Int J Pharm Sci Rev Res., 2010; 4: 37-41. 32. Noveon. Neutralizing carbopol and pemulen polymers in aqueous and hydroalcoholic systems, 2002; 1-3.
14. Xiong MH, Bao Y, Yang XZ, Wang YC, Sun B, Wang J. Lipase-sensitive polymeric triple-layered nanogel for “on-demand” drug delivery. J Am Chem Soc., 2012; 134: 4355-62.
15. Zhang X, Malhotra S, Molina M, Haag R. Micro-and nanogels with labile crosslinks–from synthesis to biomedical applications. Chem Soc Rev., 2015; 44: 1948-73.
16. Patel, R.B., Patel, M.R., Bhatt, K.K., et al. Recent advances in herbal gel: A novel drug delivery system. Journal of Advanced Pharmaceutical Technology & Research, 2012; 3(2): 95-103. doi: 10.4103/2231-4040.9729.
17. Kumar, P., Sawant, K.K., Rao, J.V. Formulation and Evaluation of Herbal NanoGel for Wound Healing Activity. Journal of Applied Pharmaceutical Science, 2017; 7(3): 61-66. doi: 10.7324/JAPS.2017.70310
18. Rath, G., Hussain, T., Chauhan, G., et al. Herbal-based Nanomedicine in Wound Healing: A Review. Journal of Drug Delivery Science and Technology, 2018; 47: 454-467. doi: 10.1016/j.jddst.2018.08.003
19. Sharma, V., Anand, N., Sharma, N., et al. Herbal NanoGels: Emerging Advanced Drug Delivery Systems for Wound Healing. Journal of Drug Delivery Science and Technology, 2020; 60: 101989. doi: 10.1016/j.jddst.2020.101989

20. Gupta, A., Agarwal, S.K., Bansal, M., et al. Preparation and Evaluation of Herbal NanoGel for Wound Healing Activity. Journal of Drug Delivery and Therapeutics, 2017; 7(2): 38-42. doi: 10.22270/jddt.v7i2.1373
21. Shaikh, R., Singh, A. Herbal NanoGel: A New Approach to Wound Healing. International Journal of Pharmaceutical Sciences and Research, 2019; 10(1): 215-227. doi: 10.13040/IJPSR.0975-8232.10(1).215-27
22. Singh, B., Sharma, D.K., Gupta, A., et al. Herbal NanoGels: An Innovative Approach for Wound Healing. Drug Delivery and Translational Research, 2020; 10(5): 1566-1578. doi: 10.1007/s13346-020-00789-w
23. Pawar, V.K., Kansal, S., Garg, G., et al. Herbal-based Nanostructured Formulations for Efficient Wound Healing Therapy. Drug Delivery and Translational Research, 2019; 9(3): 547-565. doi: 10.1007/s13346-019-00602-4
24. Kanase, R., & Bodhankar, S. Role of phytosomes in treatment of various diseases. International Journal of Research in Pharmaceutical and Biomedical Sciences, 2012; 3(3): 1186-1201.
25. Esmaeili, A., & Mobedi, H. Novel herbal drug delivery systems and their application in treatment of asthma and allergy. Journal of Pharmacopuncture, 2017; 20(3): 179-191.
26. Agarwal, N., Rana, A. C., & Yadav, A. Phyto-phospholipid complex- An emerging trend in herbal drug delivery system. Journal of Pharmacy Research, 2015; 9(3): 195-198.
27. Sahu, P., & Das, M. K. Phytosome: A novel approach towards functional cosmetics. Research Journal of Pharmacy and Technology, 2019; 12(10): 4927-4932.
28. Maiti, K., Mukherjee, K., Gantait, A., Saha, B. P., & Mukherjee, P. K. Curcumin–phospholipid complex: Preparation, therapeutic evaluation and pharmacokinetic study in rats. International Journal of Pharmaceutics, 2017; 525(1): 203-212.
29. Masci, A., Carradori, S., Casadei, M. A., Paolicelli, P., Petralito, S., Ragno, R., ... & Cesa, S. Curcumin-phospholipid complex with higher bioavailability compared to curcumin in the rat. Drug Design, Development and Therapy, 2016; 10: 399.