Antioxidant, Anti-Inflammatory, and Antimicrobial Potential of Herbal Gel Formulated With Panax Ginseng

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**Abstract:** Muco-resolutive lesions are quite frequent and frequently include infections and non-infection. Aetiologies including idiopathic, inflammatory, reactive and neoplastic changes. Making an accurate diagnosis requires clinical history and awareness of the disease’s characteristics, such as lesion type. To formulate and assess the antioxidant, anti-inflammatory and antimicrobial effects of herbal gel derived using Panax ginseng.Materials and Methods: Real gels containing Panax ginseng extract was made and characterized using FTIR, TGA, UV-Vis, and antimicrobial studies. GC–FTIR data revealed functional groups that potential bioactive compounds ontain. As depicted earlier in the TGA analysis, the thermal stability of the herbal gel (H-Gel) was slightly decreased compared to that of plain gel (Gel). UV-Vis spectra also justified the presence of some bioactive compounds resent in the plant.Results: Antimicrobial tests found out that Panax ginseng had moderate antimicrobial activity although higher concentrations may be needed. Though, the extra characteristic peaks of H-Gel revealed new bands at 1383 cm⁻¹ and 1085 cm⁻¹ of the functional groups that could be Bioactive flavonoids, phenolic acids of Tannin origin from herbal extracts. It is stated that these listed compounds exhibit antioxidant activity so the functional performance of the gel can be further enhanced accompanied by the additional benefits such as protection from UV radiation and resistance to microbial contamination. TGA results showed that while there is a slightly lower thermal degradation temperature for the herbal gel (H-Gel), the gel’s efficacies in the management of oral lesions are not compromised. The UV-Vis absorption spectra proved that compounds in the gel sample are bioactive which accounted for the healing properties of the gel.In view of our information, it can be stated that H-Gel has the prospects for the treatment of oral lesions since it exhibits anti-inflammatory, antimicrobial, and moisture preserving effects. Further research should be done on the formulation to give it an improved therapeutic value.

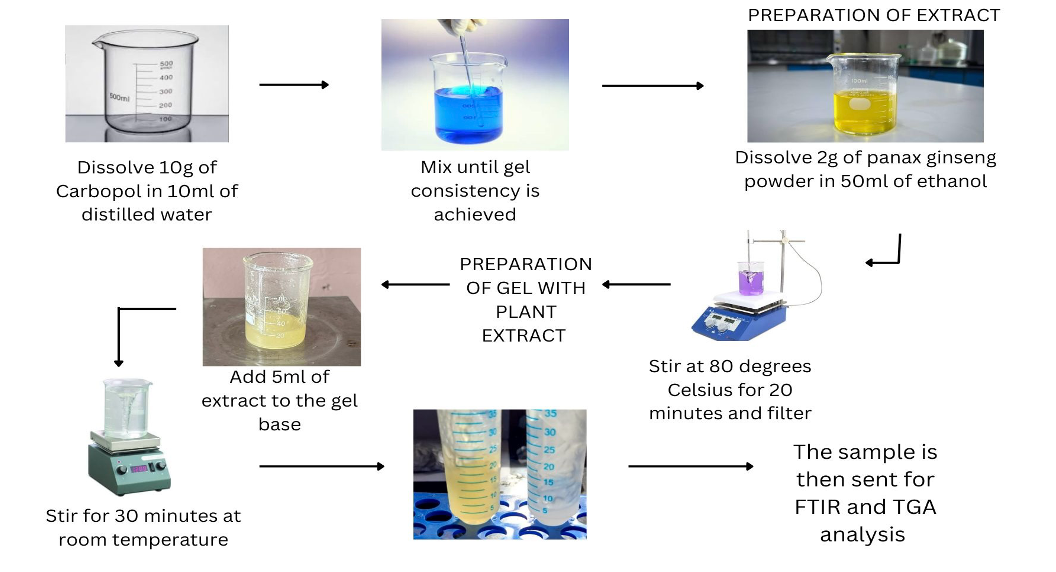
**Keywords:** Panax ginseng, oral keratinocytes, antioxidant, anti-inflammatory, antimicrobial, oral lesions, FTIR, TGA, UV-Vis, herbal gel

# Introduction

Different mouth lesions present themselves to clinicians on a daily basis. Numerous aetiologies, including infectious, idiopathic, inflammatory, reactive, and neoplastic alterations, can result in oral lesions. To provide an accurate diagnosis, a clinician needs to get a complete clinical history and possess sufficient understanding of the signs and symptoms, including the location, size, color, and morphology of the oral mucosal lesion[(Zahid et al., 2022)](https://paperpile.com/c/35roZx/p0sHa).The upper aero-digestive tract enters the mouth through the oral cavity and ends at the anterior surface of the faucial arch. It begins at the level of the lips.A few small salivary glands and stratified squamous epithelium, either keratinizing or non-keratinizing, line the inside. Because the mouth cavity is constantly exposed to ingested and inhaled carcinogens, it is one of the most prevalent places where malignant neoplasms originate.Tobacco, alcohol, and betel nut are the most prevalent carcinogenic agents linked to lesions in the mouth. Primary oral cavity tumors may originate from small salivary glands, submucosal soft tissues, or the surface epithelium and the most common cancer of oral cavity is squamous cell carcinoma and the rest are the tumors related to minor salivary glands Males are more likely than females to develop mouth cancer. The tongue and the floor of the mouth are the most frequent places in the western region of the world where primary squamous cell carcinoma of the oral cavity originates. However, the retromolar trigone and buccal mucosa are the most commonly reported primary sites for oral malignancies in developing nations such as india where chewing tobacco is popular[(Shah et al., 2019)](https://paperpile.com/c/35roZx/zcRkk).Oral cancer is the third most common cancer in India, which makes it a serious health concern[(Elango et al., 2006)](https://paperpile.com/c/35roZx/yku1R).Numerous studies have shown that smoking and alcohol abuse are significant risk factors for oral and pharyngeal cancers[(Madani et al., 2010)](https://paperpile.com/c/35roZx/Xw1XI)[(Ajay et al., 2023; Chokkattu et al., 2023; Padarthi et al., 2023)](https://paperpile.com/c/35roZx/BnKqt+61oKZ+DQyYr)[(Dharman et al., 2023; Sindhu et al., 2023; Sreenivasagan et al., 2023)(Dharman et al., 2023; Sindhu et al., 2023; Sreenivasagan et al., 2023)](https://paperpile.com/c/35roZx/IO6X+rrXp+Id1J)[(Kasabwala et al., 2021; Rajeshkumar & Lakshmi, 2021; Varghese et al., 2023)](https://paperpile.com/c/35roZx/9CpCJ+XN9Ex+JpQm2).Oral cavity lesions are extremely prevalent. These may be cancerous or benign. The oral cavity's most frequent benign lesions include lymphoid hyperplasia, retention cysts, inflammation, haemangiomas, fibromas, and others. Additionally, squamous cell carcinoma is the most prevalent type of malignant lesion. Oral cancer is the third most frequent cancer in India and ranks eighth globally. The age-standardized incidence rate of oral cancer is 12.6 per 100,000 people[(Petersen, 2005)](https://paperpile.com/c/35roZx/z8A0j)[(Keerthana & Ramesh, 2021; Murugesan, 2021; Tiwari & Jain, 2021)](https://paperpile.com/c/35roZx/psOR+7EDY+iiwk)[(Keerthana & Ramesh, 2021; Murugesan, 2021; Subramanian et al., 2021; Tiwari & Jain, 2021)(Keerthana & Ramesh, 2021; Murugesan, 2021; Subramanian et al., 2021; Tiwari & Jain, 2021)](https://paperpile.com/c/35roZx/psOR+7EDY+iiwk+aUNx)[(Pranati et al., 2021; Sakthi 2021)](https://paperpile.com/c/35roZx/Jcmfb+bBxsV).Mouth ulcers present themselves in various forms from being single quiet easy lesions to deep-seated infections, which can be a major focus of clinical attention given their incidence rate alongside their effects on patient’s quality of life. Modern treatment strategies are mainly oriented at alleviation of symptoms and frequently do not affect the inflammation and microbial load which contribute to these lesions pathogenesis. Thus, the requirement of an all-encompassing treatment that is covering anti-inflammatory, antioxidant, and microbial action becomes apparent. Panax ginseng, an ancient Oriental materia medica, has given indications in these areas and may therefore be a new application of managing oral lesions.For thousands of years, East Asian nations have utilized ginseng, sometimes known as the "king of all herbs," as a traditional medicine to heal various ailments. It has become one of the most widely used herbs globally in the last three decades[(“Ginsenoside Rc from Panax Ginseng Exerts Anti-Inflammatory Activity by Targeting TANK-Binding Kinase 1/interferon Regulatory Factor-3 and p38/ATF-2,” 2017)](https://paperpile.com/c/35roZx/WA3l). Nearly every species in the Panax genus has been employed as a source of medicine, making it one of the most significant genera in the Orient for medicinal purposes[(“Phylogeny and Biogeography ofPanaxL. (the Ginseng Genus, Araliaceae): Inferences from ITS Sequences of Nuclear Ribosomal DNA,” 1996)](https://paperpile.com/c/35roZx/nG9YO).From the central Himalayas to China, Korea, Japan, and North America, Panax species can be found in the northern hemisphere[(Shin et al., 2000)](https://paperpile.com/c/35roZx/mROPa).Asia, particularly China, Japan, and Korea, have been using ginseng root empirically for thousands of years. Additionally, Russia, the former Soviet Union, and the United States of America utilize it[(“Recent Advances on Ginseng Research in China,” 1992)](https://paperpile.com/c/35roZx/l1vM4)[(Maheshwaran et al., 2024; Merchant et al., 2025; Shenoy, Rohinikumar, et al., 2023)](https://paperpile.com/c/35roZx/E22SE+0PJ4X+wWiHY)[(Amrutha Shenoy, Vinay Sivaswamy, Subhabrata Maiti, Deepak Nallaswamy, n.d.; Shenoy et al., 2025; Vohra et al., 2024)](https://paperpile.com/c/35roZx/gadir+y4o5N+8XC1p)[(Shenoy, Rohinikumar, et al., 2023; Singh, Maiti, et al., 2024; Singh, Shenoy, et al., 2024)](https://paperpile.com/c/35roZx/0qPzz+sIb3S+wWiHY)[(Shenoy, Ahmed, et al., 2022; Shenoy, Maiti, et al., 2023; Shenoy, Rajaraman, et al., 2022)](https://paperpile.com/c/35roZx/OlImU+GR6qn+fGgFb).Extracts from ginseng contain anti-inflammatory, anti-oxidant, and anti-cancer properties[(Rokot et al., 2016)](https://paperpile.com/c/35roZx/rv8Jl).ginseng has shown curative effects on many diseases. The constituents of ginseng include carbohydrates, alkaloids, amino acids, polypeptides, vitamins, trace elements, and enzymes. Amongst these, the major active ingredients of ginseng are ginsenosides. Ginsenosides are a class of steroid compounds, also known as triterpenoid saponins, which are normally extracted from roots[(Ru et al., 2015)](https://paperpile.com/c/35roZx/75szw).The benefits of ginseng and its extracts in the prevention and treatment of oral health disorders and symptoms have been assessed in a number of recent research.This is in addition to anti-oxidant and anti-inflammatory effects that are found in the plant, Panax ginseng, as well as showing significant antimicrobial activity. The active ingredients present in ginseng medicine has been proved to act against the growth of a variety of microorganisms, such as bacteria and fungi prevailing in the oral cavity. It’s useful to inoculate the drug because its antimicrobial action helps in treating oral lesions most of which predispose to secondary infections. Therefore the choice of using Panax ginseng in an oral gel matrix could be of immense relief since it will treat both microbial and inflammation responsible for oral lesions.While research into the possible uses of Panax ginseng for oral health is still limited and the concept of the oral gel is innovative. Therefore the present study seeks to study the curtain oral gel formulation of Panax ginseng in relation to the antioxidant, anti –inflammatory and antimicrobial activity in the treatment of oral lesions[(Keerthana & Ramesh, 2021; Murugesan, 2021; Tiwari & Jain, 2021)](https://paperpile.com/c/35roZx/psOR+7EDY+iiwk)[(Keerthana & Ramesh, 2021; Murugesan, 2021; Subramanian et al., 2021; Tiwari & Jain, 2021)](https://paperpile.com/c/35roZx/psOR+7EDY+iiwk+aUNx)[(Pranati et al., 2021; Sakthi & 2021)](https://paperpile.com/c/35roZx/Jcmfb+bBxsV)

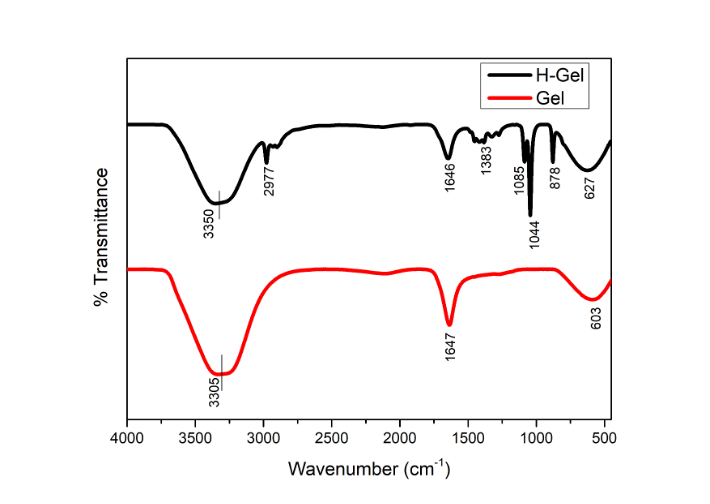
# Materials and methods

To prepare the experimental gels, the following materials and methods were procured from SAI HERB pvt ltd and it was manufactured by KR IMPEX enterprises Amritsar India. 7.5 grams of Carbopol 940 was accurately weighed and taken in a beaker. 10 milliliters of distilled water were measured using a graduated cylinder and . Panax ginseng extract, prepared using an ethanolic extraction method, was collected for the gel preparation. The process was conducted in two distinct steps. In the first step, 7.5 grams of Carbopol 940 were added to a beaker, followed by the addition of 10 milliliters of distilled water. The mixture was stirred continuously using a magnetic stirrer for 30 minutes to ensure complete dissolution and homogeneity, resulting in a gel. In the second step, another 7.5 grams of Carbopol 940 and 10 milliliters of distilled water were combined in a separate beaker. To this mixture, the ethanolic extract of Panax ginseng was added. The combined ingredients were then stirred continuously on a magnetic stirrer for 30 minutes to obtain a uniform gel incorporating the Panax ginseng extract. This method ensured the consistent preparation of both gels for further experimental use.



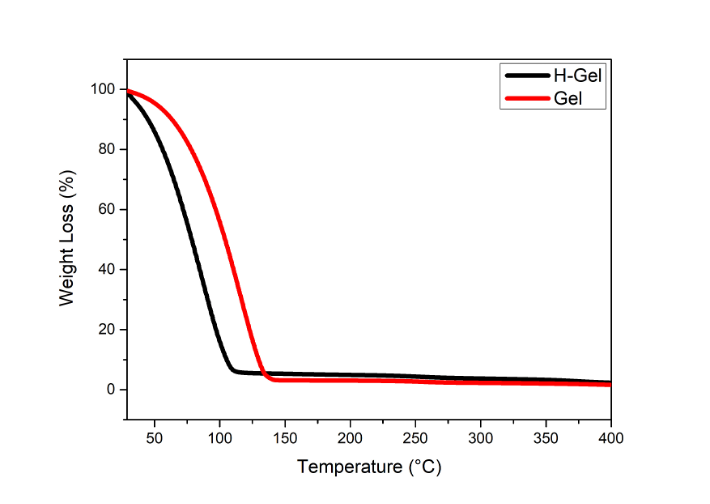
**Fig 1:** Schematic representation of materials and methods

# Results



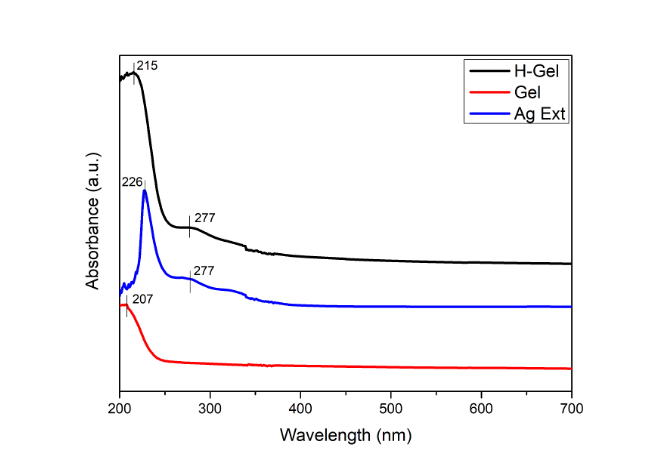
**Figure 2:**FTIR spectra of plain gel (Gel) and herbal gel (H-Gel) showing characteristic peaks for hydroxyl groups, carbonyl groups, and additional functional groups introduced by herbal extracts.

A comparison of the obtained FTIR spectra of the plain gel (Gel) and the herbal gel (H-Gel) identifies several functional groups. As can be seen from the figures, both spectra reflect a wide band at about 3350 cm⁻¹, which refers to O-H mathematical expectations, which means the presence of hydroxyls. The bands at 1646 cm⁻¹ in H-Gel and at 1647 cm⁻¹ in Gel can be assigned to C=O stretching vibrations, which may be originated from the carbonyl groups could be belongs to polymer back bone or additives. Notably, by using the same method of analysis there is H-Gel that has extra peaks at 1383 cm⁻¹ and 1085 cm⁻¹. These peaks are less characteristic or not observed in the plain gel and can be associated with several types of the components observed in the herbal extract like phenolic compounds or flavonoids absorbed in the respective regions.



**Figure 3:** TGA curves of plain gel (Gel) and herbal gel (H-Gel), demonstrating the thermal stability and weight loss behavior of both formulations.

As evidenced by the TGA analysis, it can be observed that the weight of both gels decreases significantly below 100°C which maybe because of the evaporation of water and other volatile additives. The plain gel (Gel) begins to depolymerize at a slightly higher temperature than the herbal gel (H-Gel) which makes the herbal gel less thermally stable. In the case of H-Gel, the initial weight loss starts right from the gel and is much more significant, implying that the herbal components lessen the gel’s thermal stability. This may be attributed to the loss of thermally labile bioactive constituents of the herbal extract.



**Figure 4:** UV-Vis absorption spectra of plain gel (Gel), herbal gel (H-Gel), and the herbal extract (Ag Ext), highlighting the absorption characteristics due to the incorporation of herbal components into the gel.

UV-Vis absorption spectra are different for the plain gel (Gel) and the one with the herbal extract (H-Gel and Ag Ext). There are two major absorption peaks of the H-Gel at 215 nm and 226 nm while the Gel does not have such peaks. These peaks could probably be attributed to aromatic or conjugated systems present in the herbal extract used, thus establishing that these bioactive compounds were well ‘immobilised’ in the gel matrix. Also, Gel and H-Gel have another sharp peak at 277 nm, which may be attributed to the presence of aromatic rings or similar structures in both the formulations. The same trends were also observed in the herbal extract (Ag Ext) of which had a peak at 277 nm proving that these ingredients are present both in the extract and the gel formulations.



**Figure 5:** Antimicrobial activity of Panax ginseng extracts against Streptococcus mutans,Candida albicans,Enterococcus faecalis. The plate shows the zone of inhibition for the standard antibiotic disc (AB), and the Panax ginseng samples (G and GP).

The antimicrobial activity of herbal gel was evaluated against three microorganisms: Among them, the streptococcus mutans, Candida albicans, and Enterococcus faecalis are most studied species. The zones of inhibition were obtained, so as to determine the efficiency of the nanoparticles.In Streptococcus mutans the standard antibiotic disc, AB test showed zone of Inhibition with distinguishable and significant measures. Concerning Candida albicans, both the standard antibiotic disc (AB) had a reasonable zone of inhibition compared to herbal gel.Nonetheless, the herbal gel showed less zones of inhibition when compared to the standard antibacterial discs.As in the case with Enterococcus faecalis, the standard antibiotic in this case was GEN which did show a zone of inhibition on the agar plates. The herbal gel samples G and GP produced areas of inhibition which were slightly larger than the area produced by the blank paper.

# Discussion

The alleviation of contact dermatitis when treated with the herbal extract incorporated gel shows that, FTIR results present extra peaks in H-Gel spectra which are not registered in the plain gel (Gel). The additional peaks of H-Gel demonstrated some new bands at 1383 cm⁻¹ and 1085 cm⁻¹ of the functional groups which might be due to the bioactive flavonoids, phenolic acids or tannins from the herbal extract. The listed compounds are said to possess antioxidant activity that may further improve functional performance of the gel with such extra advantages as UV protection, microbial resistance and Because both gels include hydroxyl groups (O-H), it is possible that they will have moisturizing properties, which are vital for preserving the moisture content of the oral mucosa and encouraging healing[(Lin et al., 2021)](https://paperpile.com/c/35roZx/5zMl).TGA results reveal that although thermal degradation temperature is slightly lower for the herbal gel (H-Gel), it does not affect the Gel’s efficacy in oral lesion treatment since the Gel will not be exposed to high temperatures(Saadh et al., 2024). Perhaps, early weight loss might be due to volatilization or decomposition of some bioactive compounds of H-Gel having relatively low thermal stability; nevertheless, such components might be responsible for therapeutic effects of the gel by having anti-inflammatory and anti-bacterial properties to prevent infection in mouth cavity[(*Website*, n.d.)](https://paperpile.com/c/35roZx/urQc)These new typical multiple peaks from the UV-Vis of H-Gel support the bioactive compounds of the herbal extract present in the formulation which is not seen in the plain gel(Almatrafi et al., 2024). They most probably contribute to the therapeutic effect of the gel, protect the organism against free radicals and may even promote the healing of the oral lesions. The presence of the base matrix in both gels can be observed at 277 nm; this is important because the base should not be altered in order for the gel to maintain its integrity and functions as a carrier of the active components, amply and readily[(Takayama et al., 2022)](https://paperpile.com/c/35roZx/rkZN).The results indicate that Panax ginseng extracts have some degree of antimicrobial activity against Streptococcus mutans, Candida albicans, and Enterococcus faecalis[(Machado et al., 2020)](https://paperpile.com/c/35roZx/xyzX). In contrast, the sizes of the inhibition zones obtained in this study for all the analyzed nanoparticle samples were considerably smaller than the sizes of the inhibition zones of the standard antibiotics.This shows that there was not enough Panax ginseng extract utilized in this trial to provide a significant antibacterial impact. The Panax ginseng samples' modest zones of inhibition suggest that in order to produce a more potent antimicrobial response, Panax ginseng may need to be used at higher concentrations or in other formulations.Taken together, the result from FTIR, TGA, and UV-Vis and Antimicrobial tests it suggested that the herbal gel (H-Gel) could possibly be used to treated oral lesions due to the anti-inflammatory, antimicrobial, and moisture retaining properties that are crucial for oral mucosa healing Further research should focus on optimizing the concentration and formulation of the nanoparticles to enhance their antimicrobial properties.

# Conclusion

This research proved that the herbal extract-incorporated gel or H-Gel has potential for oral lesion treatment due to its anti-inflammatory, antimicrobial, and mild moisturizing characteristics. Thus, from FTIR analysis, new bands at 1383 cm⁻¹ and 1085 cm⁻¹ has been detected, which refers to the presence of flavonoids and phenolic acids. Nevertheless, even lower TGA values corresponding to the thermal degradation temperature of the compound do not influence the gel’s efficacy under ordinary conditions. The UV-Vis spectra gave evidence concerning the presence of bioactive compounds that are responsible for high therapeutic potential of the gel. Though in the case of antimicrobial tests, it was observed that higher concentration of Panax ginseng extract may be required to show substantial antibacterial effect. More studies should be conducted on how to improve the formulation to increase the antimicrobial efficacy.

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