

Antimicrobial Activity Of Momordica Charantia And Vaccinium Sect.Cyanococcus Formulation Mediated Hafnium Oxide Nanoparticles Against Oral Pathogens

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ABSTRACT

Objective The present research article describes the Herbal mediated synthesis of Hafnium Oxide nanoparticles for various therapeutic applications. It also elaborates the estimation of anti-microbial activity of herbal mediated synthesised hafnium oxide nanoparticles.

Method A Herbal formulation made up of two plant extracts namely Vaccinium sect. Cyanococcus and Momordica Charantia was used in the synthesis of HfONPs. The produced HfONPs were tested for biomedical applications such as for estimation of Anti-microbial activity using Mueller hinton agar plates.

Result The Maximum zone of inhibition was found in C. Albicans species when compared to other oral pathogens. The zone of inhibition was 10 mm at 100µg/ml for C. Albicans whereas the zone of inhibition was 9 mm for other oral pathogens which was comparable to the standard i.e. plant extract.

Conclusion The Herbal formulation mediated synthesis of HfONPs showed some positive outcomes both in anti-oxidant and anti-inflammatory activities. The nanoformulation showed antifungal property in accordance with other inflammatory conditions.

KEYWORDS: Hafnium Oxide, nano formulations, anti-inflammatory, anti-oxidant, toxicity.

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INTRODUCTION

In recent years, there has been a growing interest in leveraging natural products and nanotechnology for the creation of innovative antimicrobial agents[1]. Among these natural products, medicinal plants have garnered significant attention due to their long-standing use in traditional medicine and their potential therapeutic properties[2]. Two such plants, *Vaccinium Sect. Cyanococcus*, commonly known as Blueberries, and *Momordica Charantia*, also known as Bittergourd, have been recognized for their medicinal value. *Vaccinium Sect. Cyanococcus*, a revered herb in Ayurveda, possesses anthocyanins, other polyphenols and various phytochemicals under preliminary research for their potential biological effects. Other Health benefits include presence of phytonutrients namely Vitamins A and Vitamin C which also render them an antioxidant property of protection of cells against disease free radicals[3]. *Momordica Charantia* the majority of existing studies on *M. charantia* bioactive compounds were performed only on cell lines and in animal models. Therefore, because the real impact of bitter melon on human health has not been thoroughly demonstrated, systematic clinical studies are needed to establish its efficacy and safety in patients[4]. Hafnium oxide nanoparticles (HfONPs) have gained prominence owing to their unique characteristics and diverse applications, including medicine. HfONPs have been thoroughly investigated for their antimicrobial prowess against an array of pathogens encompassing bacteria, fungi, and viruses. HfONPs exhibit anti-inflammatory and antioxidant attributes, positioning them as promising contenders for antimicrobial agent development[5]. Oral pathogens, comprising bacteria and fungi, exert a pivotal role in the onset of oral afflictions such as dental caries, periodontitis, and oral candidiasis. The emergence of drug-resistant strains among these pathogens has posed a formidable challenge in oral healthcare. Thus, there exists an urgent need to explore alternative antimicrobial agents capable of effectively combating these oral pathogens[6]. The amalgamation of herbal formulations with nanoparticles presents a potential avenue to amplify the antimicrobial potential of natural substances. The synergy between

bioactive compounds inherent to medicinal plants and the distinctive properties of nanoparticles may yield more potent antimicrobial agents.

In the case of *Vaccinium Sect.Cyanococcus* and *Momordica Charantia*, the integration of Hafnium oxide nanoparticles into their herbal formulations holds the promise of enhancing their antimicrobial efficacy against oral pathogens[7].

This study's objective is to assess the antimicrobial activity of *Vaccinium Sect.Cyanococcus* and *Momordica Charantia* herbal formulation-mediated Hafnium oxide nanoparticles against oral pathogens. The investigation involves determining the zone of inhibition via the mueller hinton agar and assessing sensitivity variations through the of the herbal formulation-mediated Hafnium oxide nanoparticles (HfONPs).The findings anticipated from this study are poised to make substantial contributions to the development of alternative antimicrobial agents for the treatment and prevention of oral diseases.The amalgamation of natural products and nanotechnology presents a promising avenue to address the challenges posed by drug resistant oral pathogens. By harnessing the therapeutic potential of *Vaccinium Sect.Cyanococcus* and *Momordica Charantia* and coupling it with the antimicrobial attributes of Hafnium oxide nanoparticles, this research has the potential to yield valuable insights into the creation of efficacious interventions for oral healthcare.

MATERIALS AND METHODS

Estimation of Anti-microbial Activity

Using the agar well diffusion method, the antimicrobial activity of the Herbal formulation synthesised Hafnium oxide nanoparticles was assessed. To prepare the Mueller hinton agar plates, the plates were first autoclaved at 121 degree celsius for 15-20 minutes.The plates were then sterilized and prepared.Different types of Oral pathogen namely (*S.aureus*,*S.mutans*,*Lactobacillus sp.*,*E.faecalis*,*C.albicans*) were inoculated using sterile cotton swabs and 9mm well diameter using sterile polystyrene strip.

Then, these green synthesized hafnium oxide nanoparticles at varying quantities (25 µg/ml, 50 µg/ml, and 100 µg/ml) were added to the wells.The zone of inhibition (ZOI) was measured using the ruler surrounding the wells.The antimicrobial activity of these green synthesized hafnium oxide nanoparticles were assessed and recorded in mm.

RESULT

Evaluation of antimicrobial activity using mueller hinton agar plates revealed the maximum zone of inhibition against *C.albicans* as 10mm at 100µg/ml followed by 9mm at 50µg/ml, 9mm at 25µg/ml.The zone of inhibition against *S.aureus* was found to be 9mm at 100µg/ml followed by 9mm at 50µg/ml and 9mm at 25µg/ml whereas the zone of inhibition against *S.mutans* was found to be 9 mm at 100µg/ml followed by 9mm at 50µg/ml and 9mm at 25 µg/ml.Similarly,the zone of inhibition against *E.faecalis* was found to be 9mm at 100µg/ml, 9mm at 50µg/ml, 9mm at 25µg/ml whereas the zone of inhibition against *Lactobacillus sp.* was found to be least among all the micro-organisms having 9mm at 100µg/ml, 9mm at 50µg/ml, 9mm at 25µg/ml.

DISCUSSION

The study aimed to assess the antimicrobial activity of zinc oxide nanoparticles (HfONPs) synthesized through an herbal formulation involving *Vaccinium Sect.Cyanococcus* and *Momordica Charantia* against a panel of oral pathogens[8]. In addition, the antimicrobial activity was evaluated using the agar-well diffusion method, providing a comprehensive understanding of the Hafnium oxide nanoparticles (HfONPs) efficacy[9].The results from the agar-well diffusion assay further corroborated the antimicrobial potential of green synthesized zinc oxide nanoparticles. The assay demonstrated the ability of zinc oxide nanoparticles to create zones of inhibition around the wells, indicative of their antimicrobial effects.Notably, the zones of inhibition observed for various oral pathogens were consistent with the concentration-dependent activity observed.The comparative analysis revealed variations in the sensitivity of these oral pathogens to the zinc oxide nanoparticles[10].*C. albicans*, a fungal pathogen, exhibited the highest sensitivity to Hafnium oxide nanoparticles, with significant growth inhibition observed even at lower concentrations.This finding suggests the potential of Hafnium oxide nanoparticles in managing fungal oral infections, such as oral candidiasis. *S. mutans* and *S. aureus*, which are common bacterial pathogens associated with dental caries and oral infections, displayed moderate sensitivity to Hafnium oxide nanoparticles.While oxide nanoparticles effectively inhibited their growth in a time-dependent manner, higher HfONP concentrations were required for pronounced effects[11].This implies that Hafnium oxide nanoparticles may have promise in controlling bacterial oral infections but may need optimization for maximal efficacy. In contrast, *E. faecalis* and *Lactobacillus* species exhibited lower sensitivity to zinc oxide nanoparticles, necessitating higher concentrations for significant inhibition. *E. faecalis* is known for its association with endodontic infections, while *Lactobacillus* species include probiotics and commensal bacteria important for oral health. The lower sensitivity of these organisms suggests that zinc oxide nanoparticles may selectively target pathogenic bacteria while sparing beneficial ones, a crucial consideration in maintaining oral microbiome balance. The combined results of the time-kill curve assay and the agar-well diffusion assay support the therapeutic potential of green synthesized zinc oxide nanoparticles in oral health applications. These nanoparticles exhibit differential antimicrobial activity against a range of oral pathogens, offering versatile solutions for various oral infections[12]. Furthermore, the study highlighted the inhibitory effect of zinc oxide nanoparticles on *Streptococcus mutans*, a key contributor to dental caries. This corresponds with the moderate sensitivity of *S. mutans* to Hafnium oxide nanoparticles observed in the current research.The findings reinforce the potential application of zinc oxide nanoparticles in addressing oral health issues related to bacterial pathogens.The green synthesis of Hafnium oxide nanoparticles (HfONPs) using plant extracts, such as the herbal formulation involving *Vaccinium Sect. Cyanococcus* and *Momordica Charantia*, has gained attention in recent years.The leaf extract of *Vaccinium Sect.Cyanococcus*, reported excellent antimicrobial activity of green-synthesized Hafnium oxide nanoparticles against various pathogens. This supports the methodology employed in the present

study and underscores the potential of these herbal extracts for eco-friendly nanoparticle synthesis.

In another study, nanoparticles of ZnO, MgO, NiO, AlO, and composite oxides were synthesized utilizing an extract derived from *Ocimum basilicum* leaves. The antibacterial properties of these nanoparticles were subsequently examined[13]. Notably, zinc oxide nanoparticles demonstrated a pronounced inhibitory effect against *Pseudomonas aeruginosa*. This demonstrates the versatility of plant-based approaches for the production of zinc oxide nanoparticles. Overall, the herbal formulation-mediated synthesis of Hafnium oxide nanoparticles using *Vaccinium Sect. Cyanococcus* and *Momordica Charantia* represents a promising approach to addressing oral inflammatory conditions.

The comprehensive antimicrobial assessment through both time and agar well diffusion assays highlights the potential of green-synthesized zinc oxide nanoparticles as effective tools in oral healthcare, with varying sensitivity across oral pathogens, providing a foundation for tailored treatment strategies[14]. Further exploration in this field may unlock the full potential of Hafnium oxide nanoparticles as valuable assets in oral health management.

CONCLUSION

The present study indicates that HfONPs synthesized through green methods using *Vaccinium Sect. Cyanococcus* and *Momordica Charantia* herbal formulations exhibiting antimicrobial activity against oral pathogens. This suggests their potential use as an effective mouth cleanser to reduce bacterial load in the mouth and for rinsing teeth. However, comprehensive research on HfONPs is crucial due to their unique properties, as some nanoparticles have shown adverse effects on the oral cavity at higher concentrations. While natural *Vaccinium Sect. Cyanococcus* and *Momordica Charantia* based mouthwash hold potential therapeutic properties, further investigation is necessary to identify optimal clinical applications for treatment. HfONPs might contribute to gum health, prevent oral diseases, and show potential as antimicrobial agents in future dentistry.

Notes

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Conflict of Interest

The authors have no conflict of interest.

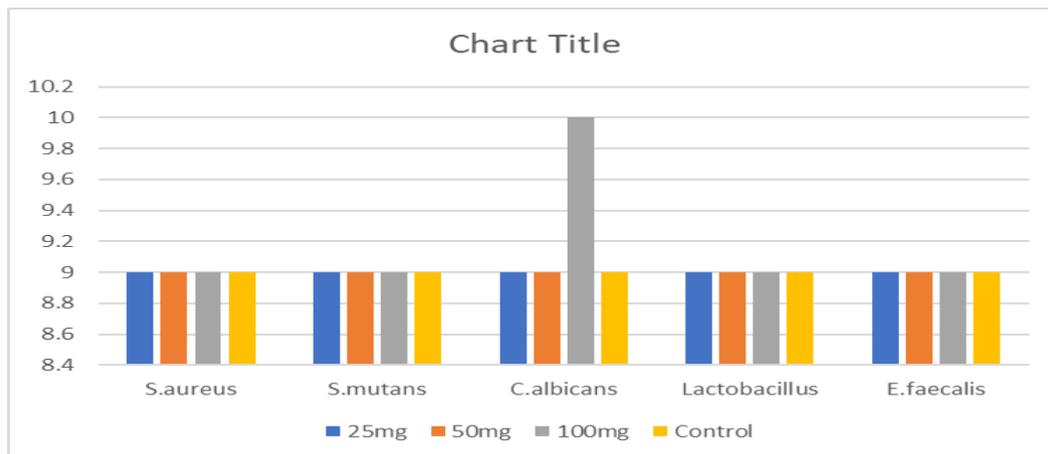
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Figures :



Fig. Anti-microbial Activity of *Vaccinium Sect.Cyanococcus* and *Momordica Charantia*



Graph depicts Antimicrobial Activity in *C.Albicans* compares to other oral pathogens

Table

Oral Pathogens	25µg/ml	50µg/ml	100µg/ml	Control
<i>Lactobacillus</i>	9	9	9	9
<i>S.mutans</i>	9	9	9	9
<i>S.aureus</i>	9	9	9	9
<i>E.faecalis</i>	9	9	9	9
<i>C.albicans</i>	9	9	10	9

Table shows Antimicrobial Activity of *Vaccinium Sect.Cyanococcus* and *Momordica Charantia*