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Chitosan Nanoparticles to Increase Natamycin's Candida albicans Inhibitory Effect

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Abstract

A persistent fungal infection that is common all over the world is fungus keratitis. Even the patient's life and health may be impacted. Natamycin is currently the first-line treatment for fungal keratitis, despite the fact that it has poor water solubility and low drug absorption in clinical settings. To test the viability of using chitosan and NAT together for eye therapy, simple natamycin-chitosan nanoparticles were used. The antifungal property of chitosan NPs was demonstrated by the results to have improved the antifungal effect of NAT. Due to their strong bacteriostasis, NAT-NPs are therefore anticipated to become promising options for the treatment of fungal keratitis.

Keywords: Fungal keratitis; Bacteriostatic; Drug absorption; Natamycin

Introduction

Fungal keratitis has become more common recently as a result of the growth in vegetative corneal damage, inappropriate contact lens wear, and extensive use of antibiotics and hormones. Most patients with fungal keratitis have a history of trauma and local medicine; it typically arises in the autumn and predominantly affects men and middle-aged and elderly farmers. Fungal keratitis severely impairs vision, and it is more difficult to treat than other corneal infections. Experts feel that natamycin, a tetraene polyene, is the most significant drug in the management of fungal keratitis even if the gold standard for the treatment of fungal keratitis has not yet been established [1].

The corneal cell is rather unique and has a sandwich-layered structure made of lipid, water, and lipid. Because NAT has weak water solubility, it is only effective as a monotherapy for superficial keratitis because it cannot penetrate deep corneal layers or the anterior chamber. Additionally, the drug is quickly cleared from the ocular surface by fast tear turnover, blinking, and lacrimal drainage; these events are the primary causes of the low drug bioavailability. The medication is also eliminated from the ocular surface within a few minutesChitosan, polyacid, alginic acid, pectin, hyaluronic acid, and lecithin have been employed as adhesive materials to improve the residence time in front of the eyes; these substances have shown promising outcomes [2].

A versatile substance with antibacterial properties is chitosan. Numerous studies have looked into how chitosan works. We give a current overview of chitosan's use as a natural fungicide in this article. Chitosan impacts the post-harvest fungal infections that are commercially significant in terms of germination and hyphal morphology. This polymer also prevents the growth of numerous other mycoparasitic and plant harmful fungus.

In order to increase the inhibitory impact of NAT on C. albicans, CTS and TPP were utilised as wrappers to include NAT into NAT-NPs. With an initial burst release of in the first hour, in vitro release showed sustained release of for 12 hours. NAT-NPs shown greater antifungal effectiveness than NAT against C. albicans in terms of IC50 and zone of inhibition. Additionally, we discovered that the outstanding antifungal impact of NAT-NPs was greatly enhanced by the antifungal property of CTS-NPs. As a result of their strong bacteriostasis, sodium tripolyphosphate/CTS-NPs are anticipated to become suitable options for the treatment of fungal keratitis [3].

CTS are a polycationic biopolymer that possesses unique biological, mechanical, and physical-chemical properties. Because of the polymer's non-toxic characteristics, it can be used in biomedical applications, and research into additional possible uses is encouraged by the material's antibacterial, antifungal, and wound-healing qualities. Because the mechanism of CTS's enhanced antifungal action on NAT is unknown, additional research without liposomes is necessary. Chitosan has great potential as an antifungal agent to treat diseases caused by human pathogenic fungus. In sensitive fungi, chitosan causes energy-dependent plasma membrane permeabilization [4].

Materials and Method

Ionic gelation was used to create NAT-loaded nanoparticles.This is an illustration of how NAT-NPs are made. To create a 1 mg/mL NAT solution, we first dissolved NAT in DMSO using ultrasound in a warm water bath. A concentration of aqueous acetic acid was used to solubilize CTS. TPP was solubilized at a concentration in deionized water. The NAT-NPs suspensions were created by mixing varying quantities of NAT solution with water-diluted CTS solutions before injecting the mixture. Using a membrane with a MWCO of 3500 Da, the NAT-NPs suspensions were dialyzed against deionized water at room temperature [5].

Using a Zetasizer Nano ZS Zen 3600, photon correlation spectroscopy was used to evaluate the size distribution and zeta potential of NPs. PDI and size distribution analysis were carried out. A disposable zeta cuvette was used to measure the zeta potential via electrophoretic light scattering. The findings of each measurement, which were carried out in triplicate, are shown.

The NAT-NPs' topography and structure were investigated using TEM analysis at a 100 kV acceleration voltage. A clean copper grid was

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carefully cast with one drop of the sample dispersion. Extra solution was air dried and immediately stained-free examined under TEM.

A specific volume of the NAT-NPs mixture was centrifuged quickly. After that, the sediment was dried and weighed in order to calculate the DL and EE of NAT in NAT-NPs, and the supernatant was collected and examined to assess its free NAT concentration. A standard curve for NAT was obtained after measuring the NAT content using a UV-visible light spectrophotometer at 303 nm. On the basis of the following equations, DL and EE were calculated [6].

Bacteriostatic diameter was measured using a technique. The entire surface of the agar plate was coated with the bacterial liquid three times while rotating the plate each time. A sterile cotton swab was dipped in the bacterial liquid, rotated, and pressed within the tube wall to remove the surplus bacterial liquid. The plate's edge was then finished with a circle. The dish cover's surface was somewhat dried by being left at room temperature.

The drug-containing paper was flattened on the plate's surface with sterile forceps, and the plate was then placed in an incubator while being glued. The bacteriostatic circle was calculated using the bacteriostatic band. NAT-NPs, free NAT, and PBS made up the first group, whereas NAT-NPs, free NAT, and blank-NPS made up the second [7].

Discussion

The IC50 was established in order to evaluate the antifungal effectiveness of NAT-NPs. NAT-NPs' IC50 against C. albicans shown greater antifungal activity than free NAT. We performed an inhibitory zone experiment to more precisely measure the antifungal effect of NAT-NPs. The greatest distances between the test disc and the edge of the fungus' development were used to identify the zones of inhibition. The NAT-NPs' zones of inhibition are displayed. Whether the antifungal impact of NAT-NPs was significantly more potent than that of NAT, commensurate with the IC50 result. As anticipated, the zone of inhibition shrank over time.

In actuality, platelets are crucial to the host defence mechanism. Atypical platelet amount and quality might worsen an infection and raise the mortality rate associated with it. In the processing, thrombin—a potent activator of platelets-was introduced. Even though the APG's antibacterial mechanisms are unclear, platelets might be involved. In addition to releasing different growth factors that are crucial for accelerating ulcer healing, activated platelets may also secrete proteins that are microbicidal to platelets.

The increase in NAT's water solubility and the antifungal properties of blank-NPs themselves were the factors that improved the antifungal effect of NAT-NPs. We examined the antifungal efficacy of NAT-NPs, blank-NPs, and NAT using the inhibition zone experiment in order to further confirm the impact of blank-NPs on C. albicans. Notably, NAT-NPs had a far stronger antifungal impact than NAT and CTS. NAT and CTS might complement one another. These findings might offer helpful information for NAT-NPs' simple use [8-10].

Conclusion

This work demonstrated that NAT-NPs had potent antifungal effects against C. albicans by virtue of their favourable physicochemical characteristics. The antifungal characteristics of CTS itself were the basis for NAT-NP's superior antifungal performance over NAT. CTS is a great NAT carrier since it increases NAT in an antifungal way. As a result of its powerful ability to inhibit fungus, NAT-NPs is predicted to be useful in treating clinical fungal keratitis. Further research should be done to enable NAT-NPs to be used earlier in clinical patients with fungal keratitis, even though the NPs generated in this work showed the slow-release action of NAT-NPs and robust antifungal activities.

Conflict of Interest

None

Acknowledgment

None

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