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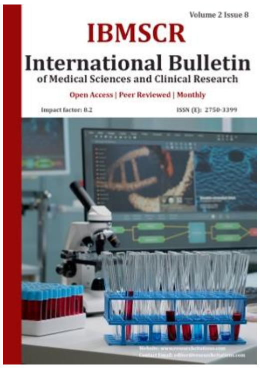

ANTIMICROBIAL ACTIVITY OF 6-AMINOPURINE DERIVATIVES ENCAPSULATED IN NANOSTRUCTURED HYDROGELS

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Abstract: Nanostructured hydrogels are widely investigated as advanced drug delivery systems due to their high biocompatibility, large water content, and controlled release properties. Incorporation of biologically active purine derivatives such as **6-aminopurine** into hydrogel matrices may enhance antimicrobial activity while maintaining a moist environment suitable for tissue regeneration. The present study investigates the antimicrobial activity of **6-aminopurine derivatives encapsulated in nanostructured hydrogels** against several pathogenic microorganisms. The results demonstrated that the hydrogel system provided sustained release of the active compound and significantly inhibited microbial growth compared with the control samples. These findings suggest that nanostructured hydrogel systems containing purine derivatives may serve as promising antimicrobial materials for biomedical and pharmaceutical applications.

Key words: nanostructured hydrogel, 6-aminopurine derivatives, antimicrobial activity, controlled release, biomedical materials.

Introduction

Microbial infections remain one of the most significant challenges in modern medicine, particularly in the treatment of wounds and skin injuries. The increasing resistance of microorganisms to conventional antibiotics has stimulated the search for alternative antimicrobial materials and drug delivery systems. One promising approach is the development of **nanostructured hydrogels**, which can serve as carriers for biologically active compounds.

Hydrogels are three-dimensional polymer networks capable of absorbing and retaining large amounts of water. Their structural characteristics allow them to maintain a moist environment at the site of application while providing controlled release of encapsulated substances. Because of these properties, hydrogels have been widely applied in wound dressings, tissue engineering, and drug delivery technologies[1-24].

6-Aminopurine, a purine derivative structurally related to adenine, plays an important role in nucleic acid metabolism and cellular growth processes. Purine-based compounds have also demonstrated biological activities including antimicrobial, anti-inflammatory, and regenerative effects. Encapsulation of such compounds into nanostructured hydrogels can improve their stability, enhance their bioavailability, and provide prolonged antimicrobial action.

The aim of this study was to investigate the **antimicrobial activity of 6-aminopurine derivatives incorporated into nanostructured hydrogel matrices** and to evaluate their potential use as antimicrobial materials.

Materials and Methods

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Nanostructured hydrogels containing **6-aminopurine derivatives** were synthesized using biocompatible polymer matrices capable of forming stable three-dimensional networks. The polymer components were dissolved in an aqueous buffer solution and mixed under controlled temperature conditions. A calculated concentration of the 6-aminopurine derivative was then added to the mixture to obtain a homogeneous dispersion.

Cross-linking agents were introduced to initiate polymer network formation, resulting in a nanostructured hydrogel system. The prepared hydrogels were characterized by measuring their swelling capacity, structural stability, and release kinetics of the encapsulated compound.

Antimicrobial activity was evaluated using standard microbiological techniques. Several representative pathogenic microorganisms were selected, including Gram-positive and Gram-negative bacteria as well as fungal strains. Microbial cultures were grown under controlled laboratory conditions and exposed to hydrogel samples containing the active compound.

The antimicrobial effectiveness of the hydrogel system was assessed by measuring the **inhibition zones**, microbial growth suppression, and colony-forming unit reduction. Control samples without the active compound were also analyzed for comparison.

Results and Discussion

The experimental results demonstrated that the **nanostructured hydrogel containing 6-aminopurine derivatives exhibited significant antimicrobial activity** against several tested microorganisms. The inhibition zones observed around the hydrogel samples indicated effective suppression of microbial growth.

One of the key advantages of the nanostructured hydrogel system was the **controlled and sustained release** of the biologically active compound. Unlike conventional antimicrobial agents that may lose effectiveness rapidly, the hydrogel matrix allowed gradual diffusion of the 6-aminopurine derivative into the surrounding medium. This prolonged release maintained antimicrobial activity over an extended period.

The hydrogel structure also created a physical barrier that limited microbial colonization. Its high water content provided favorable conditions for tissue regeneration while simultaneously restricting microbial growth. These combined effects contributed to the enhanced antimicrobial performance of the hydrogel system.

Another important observation was that the incorporation of 6-aminopurine derivatives into the hydrogel matrix improved the stability of the compound and prevented rapid degradation. This property is particularly beneficial for biomedical applications such as wound treatment, where long-term antimicrobial protection is required.

Overall, the findings suggest that **nanostructured hydrogels loaded with purine derivatives represent an effective antimicrobial platform** capable of combining drug delivery with regenerative properties.

Conclusion

The study confirmed that **nanostructured hydrogels encapsulating 6-aminopurine derivatives possess considerable antimicrobial activity** against pathogenic microorganisms. The hydrogel matrix provides a controlled release system that prolongs the biological activity of the compound and enhances its stability.

The combination of antimicrobial action, high biocompatibility, and moisture-retaining properties makes these hydrogel systems promising materials for biomedical applications, particularly in wound care and infection control. Future studies should focus on optimizing hydrogel composition, evaluating cytotoxicity, and performing in vivo experiments to further explore their clinical potential.

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