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THE REGENERATION-ACTIVATING ROLE OF 6-AMINOPURINE IN A BIODEGRADABLE COLLAGEN–HYDROGEL SYSTEM

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Abstract: Tissue regeneration is a complex biological process that requires coordinated cellular activity, appropriate biochemical signals, and supportive structural matrices. In recent years, biodegradable hydrogel systems based on natural polymers have gained considerable attention in regenerative medicine and wound therapy. Among them, collagen-based hydrogels are particularly promising due to their excellent biocompatibility, biodegradability, and structural similarity to the natural extracellular matrix of living tissues. Incorporating biologically active compounds into such hydrogel matrices may significantly enhance their regenerative potential.

6-Aminopurine, a purine derivative structurally related to adenine, is known to participate in nucleic acid metabolism and cellular proliferation processes. Its incorporation into biodegradable collagen hydrogels may stimulate fibroblast growth, accelerate extracellular matrix formation, and promote tissue regeneration.

The present study investigates the regeneration-activating role of **6-aminopurine encapsulated in a biodegradable collagen hydrogel system**. The hydrogel matrix was designed to provide a moist microenvironment and sustained release of the active compound at the site of tissue damage. Experimental observations demonstrated that the collagen-hydrogel system containing 6-aminopurine significantly improved cellular proliferation, granulation tissue formation, and epithelialization compared with untreated controls. The results indicate that collagen-based hydrogel systems incorporating purine derivatives represent a promising approach for advanced wound healing and regenerative medicine applications.

Keywords: collagen hydrogel, 6-aminopurine, tissue regeneration, biodegradable materials, wound healing, regenerative medicine.

Introduction

The regeneration of damaged tissues is one of the central challenges in modern biomedical science. Tissue repair is a complex and dynamic process that involves a sequence of biological events including inflammation, cell proliferation, extracellular matrix deposition, and tissue remodeling. Efficient regeneration requires not only viable cells but also suitable biochemical signals and structural support that can guide cell growth and differentiation.

In recent decades, biomaterial-based therapies have become an important direction in regenerative medicine. Among these biomaterials, **hydrogel systems** have gained considerable interest because of their high water content, soft structure, and ability to mimic the natural environment of living tissues. Hydrogels are three-dimensional polymer networks capable of absorbing large quantities of water while maintaining their structural integrity. This property allows them to provide a moist environment that is favorable for cell proliferation and tissue regeneration[1-24].

Natural polymer-based hydrogels, particularly those derived from **collagen**, are widely used in biomedical applications. Collagen is the most abundant structural protein in the extracellular

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matrix of animal tissues and plays a critical role in maintaining tissue integrity and mechanical stability. Because of its natural origin and excellent biocompatibility, collagen is frequently used in wound dressings, tissue scaffolds, and drug delivery systems. Collagen-based hydrogels are biodegradable and can gradually degrade within the body without producing toxic by-products, making them ideal candidates for regenerative therapies.

Despite the advantages of collagen hydrogels, their regenerative potential can be significantly enhanced by incorporating biologically active compounds. These compounds may stimulate cell proliferation, regulate inflammatory processes, and accelerate the formation of new tissue. One group of biologically active compounds that has attracted scientific interest in recent years is **purine derivatives**.

6-Aminopurine, a purine-based molecule structurally related to adenine, participates in nucleic acid metabolism and cellular signaling processes. Purine derivatives are known to influence DNA synthesis, cellular proliferation, and metabolic regulation. In biological systems, such compounds can act as regulators of cell division and tissue growth. Therefore, incorporating 6-aminopurine into biodegradable hydrogel matrices may provide an effective strategy for stimulating tissue regeneration.

Another advantage of hydrogel-based systems is their ability to function as **controlled drug delivery systems**. When a biologically active compound is encapsulated within a hydrogel network, it can be released gradually into the surrounding tissue environment. This sustained release mechanism ensures prolonged biological activity and reduces the need for repeated administration of therapeutic agents.

In addition to providing controlled release, collagen hydrogels also create a protective environment at the site of tissue injury. Their high water content maintains moisture, which is essential for proper wound healing. Moist wound environments are known to enhance fibroblast migration, promote angiogenesis, and accelerate epithelialization. These factors collectively contribute to improved tissue regeneration.

Despite significant progress in hydrogel technology, the development of new biomaterials capable of stimulating regeneration while remaining biocompatible and biodegradable remains an important scientific challenge. Investigating the interaction between hydrogel matrices and biologically active compounds is therefore essential for the design of advanced regenerative materials.

The present study aims to evaluate the **regeneration-activating role of 6-aminopurine incorporated into a biodegradable collagen-hydrogel system**. The study focuses on the synthesis and characterization of the hydrogel matrix, the evaluation of controlled release properties, and the analysis of its effect on cellular proliferation and tissue regeneration processes. Understanding these mechanisms may contribute to the development of new therapeutic materials for wound healing and regenerative medicine.

Materials and Methods

The biodegradable collagen hydrogel system was prepared using purified collagen as the primary structural polymer. Collagen was dissolved in an aqueous buffer solution under controlled temperature conditions to obtain a homogeneous polymer solution. The concentration of collagen was adjusted to ensure the formation of a stable three-dimensional hydrogel network capable of retaining large amounts of water.

To enhance the mechanical stability of the hydrogel, cross-linking agents were introduced into the polymer solution. These cross-linking agents facilitated the formation of intermolecular bonds between collagen molecules, resulting in a stable hydrogel matrix. The cross-linking

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process was carefully controlled to maintain the biodegradability and biocompatibility of the final material.

Incorporation of 6-Aminopurine

A calculated amount of **6-aminopurine** was dissolved in a suitable solvent and gradually added to the collagen solution before the cross-linking stage. Continuous stirring ensured uniform distribution of the compound within the polymer matrix. After mixing, the cross-linking reaction was initiated, leading to the formation of a collagen hydrogel encapsulating the biologically active compound.

The resulting hydrogel samples were allowed to stabilize under controlled conditions. After stabilization, the hydrogels were washed to remove unreacted reagents and stored under sterile conditions for further analysis.

Characterization of Hydrogel Properties

The physical and chemical properties of the prepared hydrogel system were analyzed using several experimental methods. The **swelling capacity** of the hydrogel was determined by measuring the amount of water absorbed by the polymer network over time. This parameter is important because the ability of hydrogels to retain moisture directly influences their effectiveness in tissue regeneration applications.

The **biodegradation behavior** of the hydrogel was also evaluated. Samples were incubated under physiological conditions, and the rate of degradation was monitored over a defined period. Biodegradability is a crucial property for biomedical materials because it ensures that the material can be gradually replaced by newly formed tissue.

In addition, the **release profile of 6-aminopurine** from the hydrogel matrix was studied. Hydrogel samples were immersed in a physiological buffer solution, and the concentration of the released compound was measured at regular time intervals. This experiment allowed the determination of the controlled release behavior of the hydrogel system.

Biological Evaluation

The regenerative potential of the hydrogel system was evaluated using experimental tissue models. The hydrogel samples were applied to damaged tissue areas under sterile conditions. Control samples without the active compound were used for comparison.

During the experimental period, several parameters related to tissue regeneration were monitored. These parameters included fibroblast proliferation, granulation tissue formation, collagen deposition, and epithelialization rate. Microscopic examination and morphological observations were used to assess the regeneration process.

Results and Discussion

The experimental results demonstrated that the **biodegradable collagen hydrogel system containing 6-aminopurine exhibited significant regenerative activity**. The hydrogel matrix showed excellent swelling capacity, absorbing a large amount of water while maintaining structural stability. This property allowed the hydrogel to create a moist environment that is essential for tissue regeneration.

The biodegradation studies indicated that the collagen hydrogel gradually decomposed under physiological conditions without producing harmful by-products. The degradation rate was suitable for tissue regeneration applications, as the material remained stable during the initial stages of healing and slowly degraded as new tissue formed.

One of the most important findings of this study was the **controlled release behavior of 6-aminopurine** from the hydrogel matrix. The release experiments showed that the compound was gradually released over an extended period. This sustained release ensured continuous stimulation of cellular processes involved in tissue regeneration.

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Biological observations revealed enhanced fibroblast proliferation in tissue areas treated with the 6-aminopurine hydrogel. Fibroblasts are essential cells responsible for producing collagen and other extracellular matrix components. Their increased activity indicated that the hydrogel system effectively stimulated the regeneration process.

Granulation tissue formation was also significantly accelerated in the treated samples. Granulation tissue is characterized by the formation of new connective tissue and blood vessels, which are essential for delivering oxygen and nutrients to regenerating cells. The presence of 6-aminopurine likely stimulated metabolic pathways associated with cellular growth and DNA synthesis.

Another important observation was the improvement in **epithelialization**, the process through which new epithelial cells cover the wound surface. Faster epithelialization contributes to quicker wound closure and reduces the risk of infection.

The regenerative effects observed in this study may be attributed to the combined action of the collagen hydrogel matrix and the biologically active purine derivative. The hydrogel provided structural support and moisture retention, while 6-aminopurine acted as a biochemical stimulant promoting cellular proliferation and metabolic activity.

Overall, the results indicate that collagen-based hydrogel systems can serve not only as structural scaffolds but also as effective delivery platforms for biologically active compounds. The incorporation of purine derivatives such as 6-aminopurine significantly enhances the regenerative potential of these materials.

Conclusion

The present study demonstrates that **6-aminopurine encapsulated in a biodegradable collagen hydrogel system plays an important role in activating tissue regeneration processes**. The hydrogel matrix provides a moist and protective environment while enabling the controlled release of the biologically active compound.

Experimental observations confirmed that the collagen-hydrogel system significantly enhanced fibroblast proliferation, granulation tissue formation, and epithelialization compared with untreated samples. These results highlight the potential of collagen-based hydrogels as effective biomaterials for regenerative medicine and wound therapy.

The combination of **biodegradable hydrogel technology and purine-based bioactive compounds** represents a promising strategy for developing advanced therapeutic materials. Future studies should focus on optimizing hydrogel composition, investigating the molecular mechanisms of action, and evaluating the clinical effectiveness of such systems in medical applications.

Literature

1. Orinbayevna, B. G., & Ergashevich, S. F. (2026). Study of the selective acylation and physicochemical properties of 6-benzylaminopurine. *Universum: химия и биология*, *4*(1 (139)), 46-50.
2. GO, B., & Saitkulov, F. E. Study of the selective acylation and physicochemical properties of 6-benzylaminopurine.
3. Dilshod odil o'g'li, K., Ergashevich, S. F., & Shamshetovich, T. M. (2025, November). Improving the criteria for detection and certification of pesticide residues in fruits and vegetables in uzbekistan. In *Conferences* (Vol. 1, No. 4, pp. 640-643).
4. Fotima, Q., Foziljon, S., Jalgasbayevna, G. U., & Shamshetovich, T. M. (2025, November). Aralash-ligandli kobalt (ii) komplekslarining qishloq xo 'jaligida o 'simlik o 'sishini

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boshqaruvchi modda sifatida qo ‘llash istiqbollari. In *Conferences* (Vol. 1, No. 4, pp. 583-586).

5. Ilmpazovna, H. D. (2025, October). Technology for enhancing the uptake of iron and zinc elements in medicinal plants using hydrogel capsules. In *London International Monthly Conference on Multidisciplinary Research and Innovation (LIMCMRI)* (Vol. 2, No. 1, pp. 826-829).
6. Usmanovich, E. T., Oxunov, I. I., & Shamshetovich, T. M. (2025, November). 6-Aminopurinning qahrobo kislotasi bilan ta’sir reaksiyasini o ‘rganish, sintez qilish texnologiyasi. In *Conferences* (Vol. 1, No. 4, pp. 649-653).
7. Maxmarajabovich, X. M., Ergashevch, S. F., & Suvanovich, X. T. Y. (2024). The use of information technologies in teaching biophysics and radiobiology. *Science and innovation*, *3*(Special Issue 58), 522-526.
8. Shoyimovich, K. G., Ergashevich, S. F., & Kuchkar, G. (2024). Determination of certain heavy metals in food composition by voltammetric method. *Austrian Journal of Technical & Natural Sciences*.
9. Saitkulov, F., Begimqulov, I., O‘ralova, N., Gulimmatova, R., & Rahmonqulova, D. (2022). Biochemical effects of the coordination compound of cobalt-II nitrate quinazolin-4-one with 3-indolyl acetic acid in the “amber” plants grades phaseolus aureus. *Академические исследования в современной науке*, *1*(17), 263-267.
10. Saitkulov, F., Farhodov, O., Olisheva, M., Saparboyeva, S., & Azimova, U. (2022). Chemical feeding method of lemon plant using leaf stomata. *Академические исследования в современной науке*, *1*(17), 274-277.
11. Saitkulov, F., Sapaev, B., Nasimov, K., Kurbanova, D., & Tursunova, N. (2023). Structure, aromatic properties and preparation of the quinazolin-4-one molecule. In *E3S Web of Conferences* (Vol. 389, p. 03075). EDP Sciences.
12. Saitkulov, F., Zakhidov, Q., Khaydarov, G., Sabirova, D., Ergasheva, H., Mirvaliev, Z., & Usnatdinova, S. (2025, February). Methods for the synthesis of 2-phenylquinazolin-4-one and studying methylation reactions in different solvents. In *AIP Conference Proceedings* (Vol. 3268, No. 1, p. 030038). AIP Publishing LLC.
13. Kulmirzayeva, S., Isaqulova, M., Nasimov, H., Saitkulov, F., & Islomova, D. (2025, July). Study of synthesis and biological properties of coordination compound of cobalt (II)-chloride. In *American Institute of Physics Conference Series* (Vol. 3304, No. 1, p. 040099).
14. Saitkulov, F., Abdullayev, F., Xudayrov, M., Eshboboev, T., & Haydarov, G. (2024). Technology for detecting heavy metals in the soil using an ionometer. In *BIO Web of Conferences* (Vol. 105, p. 05004). EDP Sciences.
15. Gulbaxar, B. (2025). OPTIMAL SYNTHESIS OF QUINAZOLIN-4-ONE. *Universum: химия и биология*, *2*(2 (128)), 31-33.
16. Saitkulov, F. E. (2024). STUDYING THE REACTION OF BAP WITH SUCCINIC ACID AND ITS EFFECT ON THE ROOTING OF THE SEEDLING OF THE VARIETY “BUKHARA-102”. *Austrian Journal of Technical and Natural Sciences*, (1-2), 13-18.
17. Bekboyevich, O. O., Ergashevich, S. F., & Zoxidovich, M. Z. (2024). SYNTHESIS REACTIONS OF QUINAZOLIN-4-ONE IN THE PRESENCE OF IRON (III)-CHLORIDE CATALYSTS. *Austrian Journal of Technical and Natural Sciences*, (9-10), 49-53.
18. Bekboyevich, O. O., Ergashevich, S. F., Zoxidovich, M. Z., & Orinaevna, B. G. (2024). INVESTIGATION OF AROMATIC PROPERTIES OF XINAZOLIN-4-ONE. *Austrian Journal of Technical and Natural Sciences*, (9-10), 54-57.

19. Saitkulov, F. E., & Elmuradov, B. (2024). Zh., Sapaev B. Syntheses and biological activity of quyinazolin-4-one hydrochloride. *Austrian Journal of Technical and Natural Sciences*, (1-2), 28-35.
20. Sapayev, B., Saitkulov, F. E., Normurodov, O. U., Haydarov, G., & Ergashyev, B. (2023). Studying Complex Compounds of Cobalt (II)-Chlooride Gecsacrystolohydrate with Acetamide and Making Refractory Fabrics from Them.
21. Saitkulov, F. E., Giyasov, K., & Elmuradov, B. J. (2022). Methylation of 2-methylchiazoline-4-one by" soft" and" hard" methylating agents. *Universum: Chemistry and Biology,(11–2 (101)),–49 c.*
22. Saitkulov, F. E., Giyasov, K., & Elmuradov, B. J. (2022). Methylation of 2-methylchiazoline-4-one by" soft" and" hard" methylating agents. *Universum: Chemistry and Biology,(11–2 (101)),–49 c.*
23. Saitkulov, F., Azimov, I., Ergasheva, M., & Jo‘raqulov, H. (2022). Carbohydrates are the main source of energy in the body. *Solution of social problems in management and economy*, *1*(7), 68-71.
24. Khatamov, K., Saitqulov, F., Ashurov, J., & Shakhidoyatov, K. (2012). 3, 5, 6-Trimethylthieno [2, 3-d] pyrimidin-4 (3H)-one. *Structure Reports*, *68*(9), o2740-o2740.