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Synthesis and study of the properties of composite materials based on cellulose and chitosan containing various therapeutic agents. Part 4. Study of the processes of destruction of dressings based on modified cellulose in conditions simulating a purulent-necrotic wound

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Abstract

The creation of systems for the targeted delivery of drugs to the affected organ is currently one of the most promising areas in the development of systems with the controlled release of an active substance. Polysaccharides are widely used as drug carriers. However, most of them are chemically inert and require preliminary functionalization to interact with physiologically active compounds (therapeutic agents – TA). A simple and effective method of introducing reactive groups is the periodic oxidation of the polysaccharide by the Malaprade reaction. Dialdehyde cellulose – DAC is a product of periodate oxidation of cellulose - and its derivatives undergo destruction in water and weakly acidic and weakly alkaline solutions, whereas cellulose is insoluble in water and resistant to the weak solutions of acids and alkalis action. The degradation products of Cel and DAC were studied by the method IR spectroscopy, chromatographic methods, and using capillary electrophoresis. From the data presented and given earlier, it follows that when our composite material is placed in a liquid medium, the hydrolytic destruction of the drug immediately begins. It may be due to the rupture of both the carrier-TA bonds (carriers of DAC, Cel, Ct) and the destruction of the matrix itself. Under the conditions of the organism, it can also be joined by biological destruction – destruction (of both carriers and immobilized TA) under the action of the body's enzymes. Using IR spectroscopy, the cellulose carriers were studied before and after

incubation in a 1/15M PB medium (pH 6.2 and 37 ºC) for 48 hours. From the data obtained, it follows that, first of all, for the DAC samples, significant changes in the spectrum are visible in the region of 1800-1600 and 900 cm^{-1}. The results of the experimental toxicological studies of the samples of the used cellulose materials allow us to conclude that the studied samples do not have toxic, hemolytic, allergenic effects, as well as mutagenic activity.

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References

[1] A.A. Lin, B.I. Sokolov, D.M. Slepnev. Pharmaceutical market: production of medicines in Russia. *Problems of Modern Economics.* **2013**. No.1(45). (Russian)
[2] N.F.S. Watson, W. Hodgkin. Wound dressings. *Surgery (Oxford).* **2005**. Vol.23. No.2. P.52-55.
[3] J. Ramundo, M. Gray. Enzymatic wound debridement. *Journal of Wound Ostomy & Continence Nursing.* **2008**. Vol.35. No.3. P.273-280.
[4] A.A. Belov, A.A. Vaniushenkova, E.E. Dosadina et al. New textile dressings based on biodegradable polymers containing proteinases for the treatment of wounds and burns. *Wounds and Wound Infections.* **2018**. Vol.5. No.1. P.16-26. (Russian)
[5] A.I. Kestner. Immobilized enzymes. *Chemistry Success.* **1974**. Vol.43. No.8. P.1480-1511. (Russian)
[6] A.A. Belov Textile materials containing immobilized hydrolases for medical and cosmetic purposes. Receiving. Properties. Application. *LAP LAMBERT Acad. Pub., GmbH & Co. KG, Germany.* **2012**. 242p. (Russian)
[7] A.A. Belov. Development of industrial technologies for obtaining new medical materials based on modified fiber-forming polymers containing biologically active protein substances. *PhD Thesis (Doctor Level on Technical Sciences). Moscow: MUCTR.* **2009**. 385p. (Russian)
[8] A.A. Belov, E.E. Dosadina. Interaction between chitosan solutions, cellulose carriers and some of the multienzyme complexes. *International Journal of Bioorganic Chemistry.* **2017**. Vol.2. P.51-60.
[9] A.A. Vaniushenkova, E.E. Dosadina, S.N. Ivanova, S.V. Kalenov, N.S. Markvichev, and A.A. Belov. Synthesis and study of the properties of composite materials based on cellulose and chitosan containing various therapeutic agents. Part 3.Hydrolytic destruction of dressings based on dialdehydecellulose. *Butlerov Communications.* **2019**. Vol.59. No.8. C.47-59. DOI: 10.37952/ROI-jbc-01/19-59-8-47 (Russian)
[10] S. Coseri et al. Oxidized cellulose – Survey of the most recent achievements. *Carbohydrate Polymers.* **2013**. Vol.93. No.1. P.207-215.
[11] P. Calvini, A. Gorassini, & A.L. Merlani. On the kinetics of cellulose degradation: looking beyond the pseudo zero order rate equation. *Cellulose.* **2008**. Vol.15. P.193.
[12] G.E. Krichevsky. Chemical technology of textile materials: a textbook for universities in 3 volumes. *Moscow: RosZITLP.* **2000**. 436p. (Russian)
[13] M. Singh, A.R. Ray, P. Vasudevan. Biodegradation studies on periodate oxidized cellulose. *Biomaterials.* **1982**. Vol.3. P.16-20.
[14] Charles J. Knill, John F. Kennedy. Degradation of cellulose under alkaline conditions. *Carbohydrate Polymers.* **2003**. Vol.51. P.281-300.
[15] S. Dumitriu. Polysaccharides in Medicinal Applications (1st ed.). *Routledge.* **1996**.

[16] Qingxi Hou, Wei Liu, Zehua Liu, Bo Duan, Liangliang Bai, Characteristics of antimicrobial fibers prepared with wood periodate oxycellulose. *Carbohydrate Polymers.* **2008**. Vol.74. Iss.2. P.235-240.
[17] Z.A. Rogovin. Chemistry of cellulose. *Moscow: Chemistry.* **1972**. P.125-244. (Russian)
[18] V.V. Chernova, I.F. Tuktarova, E.I. Kulish. Enzymatic hydrolysis of chitosan films in water and physiological solution. *Applied Biochemistry and Microbiology.* **2016**. Vol.52. No.5. P.525-530.
[19] K. Kiene et al. Self-assembling chitosan hydrogel: A drug delivery device enabling the sustained release of proteins. *Journal of Applied Polymer Science.* **2018**. Vol.135. No.1. P.45638.
[20] Reclamation of chitinous materials by bromelain for the preparation of antitumor and antifungal materials. *Bioresource Technology.* **2008**. Vol.99. Iss.10. P.4386-4393.
[21] U.J. Kim, S. Kuga, M. Wada, T. Okano, T. Kondo. Periodate oxidation of crystalline cellulose. *Biomacromolecules.* **2000**. Vol.1. P.488-492.
[22] Q.G. Fan, D.M. Lewis, K.N. Tapley. Characterization of Cellulose Aldehyde Using Fourier Transform Infrared Spectroscopy. *Journal of Applied Polymer Science.* **2001**. Vol.82. P.1195-1202.
[23] N.M. Bikales, L. Segal. Cellulose and cellulose derivatives. 2nd ed.; *Wiley-Interscience: New York.* **1971**. P.893.
[24] S.Y. Oh, D.I. Yoo, Y. Shin, H.C. Kim, Y.S. Chung, W.H. Park, J.H. Youk. Crystalline structure analysis of cellulose treated with sodium hydroxide and carbon dioxide by means of X-ray diffraction and FTIR spectroscopy. *Carbohydrate Research.* **2005**. Vol.340. P.2376-2391.
[25] J. Bocker. Chromatographie Instrumentelle Analytik mit Chromatographie und Kapiliarelektrophorese. *Wurzburg, Germany: Vogel Industrie Medien GmbH & Co KG.* **1997**. (in German)
[26] A.A. Vanyushenkova, E.E. Dosadina, A.A. Belov. Products of hydrolytic destruction of medical wound-healing polysaccharide materials containing proteolytic enzymes as one of the reasons for enzyme inactivation under conditions that simulate a purulent wound. *Proceedings of the XIX annual youth conference with international participation IBCP RAS-UNIVERSITIES BIOCHEMICAL PHYSICS. ALTIGRAPHICS LLC Moscow.* **2019**. Vol.13. P.49-52. (Russian)
[27] Anna A. Vaniushenkova, Natalia V. Khabibulina, Alexander N. Morozov, Alexey A. Belov. Synthesis and study of the properties of composite materials based on cellulose and chitosan containing various therapeutic agents. Part 4. Study of the processes of destruction of dressings based on modified cellulose in conditions simulating a purulent-necrotic wound. *Butlerov Communications.* **2021**. Vol.66. No.6. P.66-75. DOI: 10.37952/ROI-jbc-01/21-66-6-66 (Russian)