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EXPERIMENTAL STUDY OF THE BIOCIDAL EFFECT OF NANOSILVER

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ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ БИОЦИДНОГО ДЕЙСТВИЯ НАНОСЕРЕБРА

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The study demonstrated the effectiveness of nanosilver (linear particle size 10–20 nm) in the form of a patented composition. This form showed high bactericidal and fungicidal activity against gram-positive, gram-negative bacteria and candida in minimal concentrations.

Keywords: silver nanoparticles, bacteria, fungi

В исследовании продемонстрирована эффективность наносеребра (линейный размер частиц 10–20 нм) в виде запатентованной композиции, которое показало высокую бактерицидную и фунгицидную активность против грамположительных, грамотрицательных бактерий и кандид в минимальных концентрациях.

Ключевые слова: наночастицы серебра, бактерии, грибы

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ATCC – American Type Culture Collection
ISO – International Organization for Standardization
MIC – minimum inhibitory concentration

The development of nanotechnology has given impetus to the development of new areas of healthcare, biotechnology, and additive technologies. Among other things, highly effective silver nanoparticles have been obtained that are more active in the 1–100 nm range than other biocides for some antibiotic-resistant strains of microorganisms with good wound-healing properties [1, 2]. Experimental data and clinical observations with the possibility of modification of application conditions allow assuming a reduction of quantitative load of silver nanoparticles, with the case of removal of the po-

tential of undesirable reactions when they are used [2, 3].

The study aimed to determine the minimum bactericidal concentration of the nanosilver preparation for gram-positive, gram-negative bacteria and fungi.

Material and Methods. The activity of a 0.1 % solution of silver nanoparticles with a linear size of 10–20 nm in a matrix of 0.6 % sodium alginate in an aqueous medium (99.3 %) (patent UA N10539) against international test strains of bacteria with a known level of antibiotic resistance was studied: Staphylococcus aureus ATCC 25923; Escherichia coli ATCC 25922; Candida albicans CCM885.

The antibacterial and fungicidal activity was assessed by determining the minimum inhibitory concentrations (MIC) for each microorganism by diluting it in a liquid nutrient medium following ISO 20776-1:2006 and the National Standard GOST R ISO 20776-1-2010.

Monitoring of the experiment results was carried out after 24 hours by two methods: taking into account the formation of biofilms in the studied solution and the method of sowing the studied contents on the peptone agar. The positive result of biofilms was determined as the absence of the formation of a biofilm in a liquid nutrient medium with a bactericidal concentration of the preparation.

The second control of the experiment is the sowing of agar to detect the lack of growth of micro-organisms in a liquid medium containing nanosarbiral, which confirms the bactericide of the drug concentration. The result was taken into account after 24 hours for the presence or absence of growth of colonies on the agar by sectors corresponding to the holes of the tablet with a particular concentration of the drug under study.

The mathematical processing on a personal computer using the statistical program Statistica 6.0 (StatSoft Inc., USA) was applied. The nature of the distribution was determined using the Shapiro – Wilk test, and, with a normal distribution, Student's t-test was used.

Results and Discussion. In the course of the study, the ability to form a biofilm on the surface of a liquid nutrient medium without a studied composition containing silver nanoparticles is shown for all test strains. After 24 hours of exposure to microorganisms in a liquid medium and after passage and incubation on agar, at least 108 CFU/ml of S. aureus, E. coli, or Candida strains were detected, indicating good growth qualities of the studied cultures.

When evaluating the activity of the various concentrations of the composition with silver nanoparticles, the following bactericidal activity values for microorganism control strains were found:

– for S. aureus and E. coli strains, MIC 50/90 values were 0.01–0.09 mg/ml;

– for Candida, MIC 50/90 values were 0.06–0.35 mg/ml.

Five passages were carried out with each culture of strains of microorganisms according to the proposed method, and in all cases, identical results for each strain were obtained.

The result of biofilm detection in a liquid medium with E. coli culture with the addition of a concentration of 0.01 mg/ml of the nanosilver composition under study can be considered attractive. The subsequent passage on agar of the contents of the medium, however, did not reveal the growth of microorganisms. This fact can be regarded as the presence of Escherichia coli strains in a liquid nutrient medium when exposed to nanosilver at a given concentration, which, at the same time, lose their ability to be cultivated on agar. We can talk about the formation of either a bacteriostatic effect of the studied drug or a new impact of nanosilver particles in relation to E. coli strains.

The MIC 50/90 values for each microorganism control strain studied indicate a significant microbicidal potential for nanomera. Silver in the nanoscale range of 10–20 nm in the matrix of 0.6 % sodium alginate in an aqueous medium has an antibacterial and fungicidal effect at low concentrations, which may be due to the larger specific surface of nanoparticles in this composition and the increased area of contact of nanosilver with microorganisms [4]. Hence the possibility of reducing the toxic effect of silver as a metal a hundred times while maintaining its bactericidal properties, including for the remaining viable but uncultivable micro-organisms [2, 5]. Nanosilver offers a wide opportunity to create highly effective drugs and their wide use in medicine and other areas of human activity.

Conclusions. The results show a high bactericidal and fungicidal activity of the composition containing a 0.1 % silver nanoparticle solution with a linear size of 10–20 nm in a 0.6 % sodium alginate matrix in an aquatic medium with respect to staphylococcus strains, Escherichia coli and Candida with a known level of antibiotic resistance.

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DEVELOPMENT OF THE ADHESIVE PROCESS IN THE ABDOMINAL CAVITY USING PLASTIC DEVICES IN LAPAROSCOPIC SURGERY

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РАЗВИТИЕ СПАЕЧНОГО ПРОЦЕССА В БРЮШНОЙ ПОЛОСТИ ПРИ ИСПОЛЬЗОВАНИИ ПЛАСТИКОВЫХ ДЕВАЙСОВ В ЛАПАРОСКОПИЧЕСКОЙ ХИРУРГИИ

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The study examined the risk of developing adhesions in the abdominal cavity using modern plastic devices used in endoscopic interventions. Two equivalent groups were formed out of 80 rats. In the first group, 40 rats were injected with a sterile fragment of classical endoscopic bag through a puncture of the anterior abdominal wall, while in the second one (40 rats) – sterile plastic was used for 3D printing in medicine. The animals were removed from the experiment on the 30th and 90th days. After the macroscopic determination of the development degree of the adhesive process, the parietal and visceral peritoneum was taken out, followed by IHC examination. As a result of the study, it was found that the plastic, which is a part of endo bags and 3D printing plastic, does not lead to the formation of viscero-parietal adhesions associated with the development of the adhesive process. Thus, using various plastic devices for 3D printing in the abdominal cavity is safe. However, additional research is needed.

Keywords: adhesions, abdominal cavity, experiment, endoscopic device, 3D printing, laparoscopy

В исследовании изучался риск развития спаечного процесса в брюшной полости в эксперименте при использовании современных пластиковых девайсов, применяемых при эндоскопических вмешательствах. Из 80 крыс были сформированы 2 равнозначные группы. В I группе – 40 крыс, которым выполняли введение через прокол передней брюшной стенки стерильного фрагмента классического эндоскопического мешка, во II группе (40 крыс) – стерильного пластика, используемого для 3D-принтинга в медицине. Животные выводились из эксперимента на 30 и на 90 сутки. После макроскопического определения степени развития спаечного процесса выполняли забор париетальной и висцеральной брюшины с последующим ИГХ-исследованием. В результате проведенного исследования установлено, что пластмасса, входящая в состав эндоконтейнеров и пластика 3D-принтинга, не приводит к формированию висцеро-париетальных адгезий, ассоциированных с развитием спаечного процесса. Таким образом, использование в брюшной полости различных девайсов из пластика для 3D-принтинга является безопасным. Однако необходимо проведение дополнительных исследований.

Ключевые слова: спайки, брюшная полость, эксперимент, эндоскопическое устройство, 3D-принтинг, лапароскопия

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