Наносистеми, наноматеріали, нанотехнології
Nanosistemi, Nanomateriali, Nanotehnologii
2023, т. 21, № 3, сс. 637–641

PACS numbers: 81.20.Ym, 87.19.xb, 87.64.M-, 87.80.Qk, 87.85.jf, 87.85.Rs, 89.60.Ec

Silver Nanodots as Novel Nanomaterial for Safe and Healthy Medical Environment

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Today, the introduction of silver nanoparticles in medical products is rampant and, therefore, their toxic release into the environment gives rise to grave environmental issues. Environmental management is the need of the hour. The objective of this study is to create and harvest silver nanodots of sizes < 20 nm using a simple ingredient like monosaccharide fructose sugar in the lab, to analyse their antimicrobial properties and to find usage by functionalizing them in medical products to enhance their quality. This experimental process following in this study is rapid paced, ecofriendly, toxic free, than the existing conventional methods. These silver nanodots are unique in nature, when it is functionalized with medical products such as textiles and wound dressings. They are found to be toxin free providing a safe and healthy medical environment. Infections are reduced nearly hundred percent due to silver-nanodots' high antimicrobial potential. The toxic release into the environment is near zero, than the rest nanoparticles used in medical products.

Сьогодні впровадження наночастинок срібла у медичні вироби є повсюдним явищем, і тому їхній токсичний викид у навколишнє середовище породжує серйозні екологічні проблеми. Екологічний менеджмент — це вимога часу. Мета цього дослідження полягає в тому, щоб створити та зібрати наноточки срібла розміром < 20 нм з використанням простого інґредієнта, такого як моносахаридний фруктозний цукор, у лабораторії, проаналізувати їхні антимікробні властивості та знайти застосування, функціоналізуючи їх у медичних продуктах для поліпшення їхньої якости. Цей експериментальний процес, описаний у цьому дослідженні, є швидким, екологічно чистим, нетоксичним, аніж наявні традиційні методи. Ці срібні наноточки є унікальними за своєю природою, коли вони функціонують з медичними виробами, такими як текстиль і пов'язки для ран. Встановлено, що вони не містять токсинів, забезпечуючи безпечне та здорове медичне середовище. Інфекції понижуються майже на сто відсотків завдяки високому антимікробному по-

тенціялу срібних наноточок. Токсичний викид у навколишнє середовище близький до нуля, ніж решти наночастинок, що використовуються в медичних виробах.

Key words: silver nanodots, fructose, antibacterial activity, medical environment, health issues, safety measures.

Ключові слова: наноточки срібла, фруктоза, антибактеріяльна активність, медичне середовище, проблеми зі здоров'ям, заходи безпеки.

(Received 25 December, 2022)

1. INTRODUCTION

It is necessary for humans to live in a safe and heathy medical environment, especially, in places, where infections reign supreme like hospitals. The focus of this study was to design silver nanoparticles that will have the desired safe effect on human health and environment [1]. Therefore, silver nanodots were created in the lab, using chemical reduction of simple ingredient like fructose, a novel nanomaterial in materials metrology and synthesis [2–5]. With enhanced antimicrobial activity and reduced toxicity, these silver nanodots are environmentally safe products to be used in medical textiles and products [5, 6]. In this study, it was found that the tiny silver nanodots could be used in medical environment due to their high antimicrobial properties [6–9].

2. MATERIALS AND METHODS

The chemicals used for the study were purchased from Sigma Aldrich. In this synthesis process, a chemical solution was prepared by mixing 0.05 gm of fructose sugar in 100 ml of deionized water taken in a conical flask. Then, a small amount of 0.001 PVA was added to the above solution and stirred by keeping the flask on a magnetic stirrer at room temperature. Another solution of 0.00010 gm of silver nitrate was added to the above mixture drop-by-drop at regular intervals. This addition turned the solution to dark brown within half an hour that is the indication of nanosilver. Thus, the chemical reduction of silver nitrate has taken place at the lab at a very rapid pace. The solution was stable for days together.

3. RESULTS AND DISCUSSION

Antibacterial property of hospital fabrics was tested against clinically isolated pathogens like *E. coli*—the major cause for wound in-

fections by disc diffusion and colony-forming count method.

3.1. Disc Diffusion Method

Silver-nanodots-coated cotton fabrics used for medical purposes were taken. The method was performed in Muller–Hinton agar (MHA) medium as shown in Figs. 1 and 2.

Dried silver-nanoparticles-coated cotton fabrics were cut into 1 cm size in diameter, sterilized at 120°C for 10 min and placed on plates that already inoculated with pathogens *E. coli*, which were then incubated at 37°C for 24 h. The subsequent inhibition zone was measured and was found very high [10–12].

3.2. Colony-Forming Count Method

Dried silver-nanodots-coated cotton fabrics were cut into a square shape with 2 cm. The sample pieces were sterilized by autoclaving in the boiling tube at 120°C for 10 min; then, 1 ml of medium was taken. Finally, 30 µl of 16-h culture of pathogens were inoculated and incubated for 24 h and 48 h at 37°C. An empty fabric was used

Fig. 1. With control.

Fig. 2. *E. coli* inhibition.

TABLE. Count method.

Contact time	*E. coli* impregnated cloth	Pure cloth
0 h	$1.20 \cdot 10^5$	$1.20 \cdot 10^5$
24h	$4.40 \cdot 10^2$	$1.30 \cdot 10^2$
% reduction/increase	99.7% reduction	35.2% increase

as control in all the experiments. After incubation, 0.1 ml of sample was procured from the tubes and tested. The plate was incubated at 37°C for 24 h. The tubes and plate were monitored for bacterial growth [13–15], and the results are given in Table.

4. CONCLUSIONS

Conclusively, it was found silver nanodots, and the medical environment was safe and devoid of infections and did not pose environmental hazards. They inhibit the growth of bacteria and other microorganisms in the hospital environment. Silver nanoparticles are highly bactericidal; therefore, the usage of silver nanodots in medical product and environment is toxic free and hazard less. In addition, the toxicity of silver nanodots depends on various factors, including size, aggregation, composition, crystallinity, surface functionalization, which have to be studied in the future.

ACKNOWLEDGEMENTS

The author expresses her gratitude to Mr. J. Ramanan (SunTec Systems) for his funding and continuous encouragement.

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