

## USE OF CARBOHYDRATES IN THE SYNTHESIS OF SYSTEMS CONTAINING SILVER NANOPARTICLES.

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**Annotation:** This article provides information on methods of synthesis of silver nanoparticles, methods of solution stabilization, and morphology of the obtained colloidal solution. Silver nitrate salt as the main substance, sodium citrate as a reducing agent, glucose, hydrazine, and carbohydrates as a stabilizer were used in the researches on the methods of obtaining silver nanoparticles. The formation of a silver nanoparticle colloidal system was studied in the experiments.

By controlling the reaction conditions during the synthesis of silver nanoparticles, nanoparticles of different shapes and sizes can be prepared. The dependence of the shape and size of silver nanoparticles on the concentration of the obtained silver salt and the nature of the stabilizer was studied.

**Key words:** silver nanoparticles, reducing agent, carbohydrate, solution, stabilizer, stability, colloid system, chemical reduction, colloid system aging.

## KUMUSH NANOZARRACHALARI TUTGAN TIZIMLARNI SINTEZ QILISHDA UGLEVO DLARDAN FOYDALANISH

**Annotatsiya:** Ushbu maqolada kumush nanozarrachalarini sintez qilish usullari, eritmani stabillashtirish usullari, olingan kolloid eritmani morfologiyasi haqida ma'lumotlar keltirilgan. Kumush nanozarrachalari olinish usullari bo'yicha olib borilgan tadqiqotlarda asosan asosiy modda sifatida kumush nitrat tuzi, qaytaruvchi modda sifatida natriy sitrat, glukoza, gidrazin va barqarorlashtiruvchi sifatida uglevodlardan foydalanilgan. Tajribalarda kumush nanozarrachasi kolloid sistemasi hosil bo'lishi o'rganilgan.

Kumush nanozarrachalari sintezi davomida reaksiya sharoitlarini nazorat qilish orqali turli shakl va o'lchamdagi nanozarrachalarni tayyorlash mumkin. Kumush nanozarrachalarning shakli va hajmi olinadigan kumush tuzining konsentratsiyasiga, barqarorlashtiruvchining tabiatiga bog'liqligi o'rganilgan.

**Kalit so'zlar:** kumush nanozarrachalari, qaytaruvchi modda, uglevod, eritma, barqarorlashtiruvchi, barqarorlik, kolloid sistema, kimyoviy qaytarish, kolloid tizim eskirishi.

## ИСПОЛЬЗОВАНИЕ УГЛЕВОДОВ В СИНТЕЗЕ СИСТЕМ, СОДЕРЖАЩИХ НАНОЧАСТИЦЫ СЕРЕБРА

**Аннотация:** В данной статье представлена информация о методах синтеза наночастиц серебра, методах стабилизации растворов и морфологии полученного коллоидного раствора. В исследованиях по методам получения наночастиц серебра использовали нитратную соль серебра в качестве основного вещества, цитрат натрия в качестве восстановителя, глюкозу, гидразин и углеводы в качестве стабилизатора. В экспериментах изучалось образование коллоидной системы наночастиц серебра.

Контролируя условия реакции при синтезе наночастиц серебра, можно получать наночастицы различных форм и размеров. Исследована зависимость формы и размера наночастиц серебра от концентрации полученной соли серебра и природы стабилизатора.

**Ключевые слова:** наночастицы серебра, восстановитель, углевод, раствор, стабилизатор, стабильность, коллоидная система, химическое восстановление, старение коллоидной системы.

### Introduction.

Creation of metal nanoparticles with defined dimensions (1-100 nm) in nanochemistry is one of the promising directions of modern nanotechnology today. The number of studies devoted to the synthesis of silver nanoparticles (AgNZ) and its properties is also growing rapidly. Although silver nanoparticles have stronger optical properties than gold nanoparticles, colloidal systems without stabilizers wear out quickly, so the synthesis and stabilization of colloidal silver nanoparticles is one of the urgent issues.

This is evidenced by the large-scale production of precious metal nanomaterials in the last few decades and their use in various fields based on their unique physical, chemical and biological properties. In addition, silver nanoparticles with thin or very small dimensions have increased the scientific interest of researchers due to their unusual properties compared to ordinary metal. Colloidal particles exhibit excellent electrical conductivity, catalytic activity, chemical stability, and antimicrobial activity due to their quantum size effects and surface effects. These properties have led to a wide range of applications for silver nanoparticles, such as refrigerators, dishwashers, rice cookers, plastic wrap, cutting boards, vacuum bottles, plastic buckets, and trash cans.

Silver nanoparticles have long been known to have antibacterial properties. For this reason, it was used in medicine, water and air purification, food production, cosmetics, clothes and basic household items. Silver nanoparticles can be used against some microbes that are not affected by the ionic state of silver. Based on this, it is possible to show differences in its size, volume and mass. Silver nanoparticle is bactericidal against more than 500 pathogenic microbes and has a bacteriostatic effect. At the same concentration, it was determined that nanosilver's ability to kill bacteria is 1500 times higher than that of phenol, and 3.5 times higher than that of sublimate. The wide range of antimicrobial effects of nanosilver, the fact that most pathogenic organisms cannot resist it, its low toxicity, and the fact that it does not cause allergic reactions have increased the interest in many countries of the world to study the physical and chemical properties of nanosilver and to find optimal conditions for its synthesis is going.

Mainly physical and chemical methods of synthesis of silver nanoparticles are widely used. The chemical method is mainly carried out by chemical reduction using various reducing agents.

Chemical reduction of silver salts using sodium tetrahydroborate (borohydride) or sodium citrate is one of the traditional methods. The use of sodium borohydride is explained by its relatively high reactivity (compared to citrate and carbohydrates), ease of use (superior to physical methods) and low toxicity (compared to hydrazine and hydroxylamine).

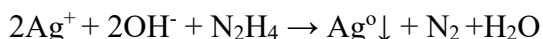
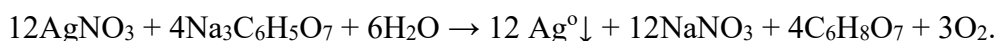
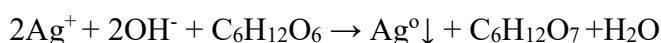
One of the main methods of obtaining nanoparticles is the chemical reduction method. The advantage of chemical reduction methods is that they do not require complex equipment, and provide the ability to control the size and external structure of nanoparticles.

**Methods.** For the synthesis of silver nanoparticles (AgNZ), silver nitrate was used as the main substance, glucose, sodium citrate and hydrazine were used as reducing agents, and solutions containing starch were used as stabilizers. Reactions were carried out at room temperature by adding equal volumes of reducing solutions to the solution of stabilizer (starch (potato and corn)) and silver nitrate mixture, with constant stirring of the solutions.

**Results and their analysis.** First, stabilizers - 1% solutions of starch (potato and corn) were prepared. Then a silver nitrate solution with a concentration of 500 mg/ml was prepared. 0.1 M solutions of sodium citrate, hydrazine and glucose were prepared as reducers. Results and their analysis. First, stabilizers - 1% solutions of starch (potato and corn) were prepared. Then a silver nitrate solution with a concentration of 500 mg/ml was prepared. 0.1 M solutions of sodium citrate, hydrazine and glucose were prepared as reducers. Results and their analysis. First, stabilizers - 1% solutions of starch (potato and corn) were prepared. Then a silver nitrate solution with a concentration of 500 mg/ml was prepared. 0.1 M solutions of sodium citrate, hydrazine and glucose were prepared as reducers.

16 different samples were prepared at 0°C and 20°C by adding stabilizers and silver nitrate solutions to the prepared mixtures, with constant stirring, from equal volumes of reducing solutions.

In experiment 1, 1% solutions of Starch (corn) and 0.1 M solutions of reducing agents sodium citrate, hydrazine and glucose were used as stabilizers at 0°C. Nanosilver systems were obtained by reducing silver nitrate solutions in the presence of a reducing agent (Table 1). The following reactions occurred:



The color of systems with a 1% solution of starch (corn) as a stabilizer showed a color change in 24 and mainly in 48 hours. This color change indicates that nanosilver is produced.

Table 1

| №  | The main substance | reducing agent | Stabilizers         | State of change                                                                                                | Temperature | Picture                                                                               |
|----|--------------------|----------------|---------------------|----------------------------------------------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------|
| 1. | AgNO <sub>3</sub>  | Glucose        | 1 %li Starch (corn) | The solution was cloudy for 48 hours.                                                                          | 0°C         |  |
| 2. | AgNO <sub>3</sub>  | sodium citrate | 1 %li Starch (corn) | After 24 hours, the solution first became yellowish, then after 48 hours, the solution thickened and darkened. | 0°C         |  |

|    |                   |           |                     |                                                                                                 |     |                                                                                     |
|----|-------------------|-----------|---------------------|-------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------|
| 3. | AgNO <sub>3</sub> | Hydrazine | 1 %li Starch (corn) | At 24 hours, the solution first became cloudy, and then at 48 hours, the solution turned brown. | 0°C |  |
| 4. | AgNO <sub>3</sub> |           | 1 %li Starch (corn) | After 48 hours in the solution, it turned light brown.                                          | 0°C |  |

In experiment 2, 1% starch (potato) solutions and 0.1 M solutions of reducing agents sodium citrate, hydrazine and glucose were used as stabilizers at 0°C. Nanosilver systems were obtained by reducing silver nitrate solutions in the presence of a reducing agent (Table 2). In this 2nd experiment, the same reactions as in the 1st experiment take place. A change was observed for 24 hours in the system where sodium citrate was used as a reducing agent. The remaining solutions (glucose and hydrazine with and without reducing agent) change was observed after 48 hours.

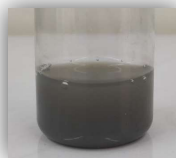
Table 2

| №  | The main substance | reducing agent | Stabilizers           | State of change                                                                                                | Temperature | Picture                                                                               |
|----|--------------------|----------------|-----------------------|----------------------------------------------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------|
| 1. | AgNO <sub>3</sub>  | Glucose        | 1 %li starch (potato) | A light brown color appeared in the solution for 48 hours.                                                     | 0°C         |  |
| 2. | AgNO <sub>3</sub>  | sodium citrate | 1 %li starch (potato) | After 24 hours, the solution first became yellowish, then after 48 hours, the solution thickened and darkened. | 0°C         |  |
| 3. | AgNO <sub>3</sub>  | Hydrazine      | 1 %li starch (potato) | Cloudiness was observed in the solution for 48 hours.                                                          | 0°C         |  |

|   |                   |  |                       |                                                 |     |                                                                                     |
|---|-------------------|--|-----------------------|-------------------------------------------------|-----|-------------------------------------------------------------------------------------|
| 4 | AgNO <sub>3</sub> |  | 1 %li starch (potato) | The solution turned light brown after 48 hours. | 0°C |  |
|---|-------------------|--|-----------------------|-------------------------------------------------|-----|-------------------------------------------------------------------------------------|

In experiment 3, 1% solutions of starch (corn) and 0.1 M solutions of reducing agents sodium citrate, hydrazine and glucose were used as stabilizers at 20oC. Nanosilver systems were obtained by reducing silver nitrate solutions in the presence of a reducing agent (Table 3). In this 3rd experiment, the same reactions as in the 1st experiment take place. The change in solutions was mainly observed after 48 hours.

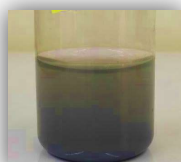
Table 3

| № | The main substance | reducing agent | Stabilizers      | State of change                                                              | Temperature | Picture                                                                               |
|---|--------------------|----------------|------------------|------------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------|
| 1 | AgNO <sub>3</sub>  |                | 1% starch (corn) | The solution was turbid for 48 hours.                                        | 20°C        |   |
| 2 | AgNO <sub>3</sub>  | Hydrazine      | 1% starch (corn) | The solution was turbid for 48 hours.                                        | 20°C        |  |
| 3 | AgNO <sub>3</sub>  | Glucose        | 1% starch (corn) | For 48 hours, a change to a light brown color was observed in the solution.  | 20°C        |  |
| 4 | AgNO <sub>3</sub>  | sodium citrate | 1% starch (corn) | The solution turned light brown for 24 hours and then darkened for 48 hours. | 20°C        |  |

In experiment 4, 1% solutions of starch (potatoes) and 0.1 M solutions of reducing agents sodium citrate, hydrazine and glucose were used as stabilizers at 20oC. Nanosilver systems were obtained by reducing silver nitrate solutions in the presence of a reducing agent (Table 4). In this

experiment, the same reactions as above occur. The change in solutions was observed after 24 hours.

Table 4

| № | The main substance | reducing agent | Stabilizers          | State of change                                              | Temperature | Picture                                                                               |
|---|--------------------|----------------|----------------------|--------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------|
| 1 | AgNO <sub>3</sub>  |                | 1% starch (potatoes) | The solution turned light brown in 24 hours.                 | 20°C        |    |
| 2 | AgNO <sub>3</sub>  | Glucose        | 1% starch (potatoes) | The solution turned light brown after 24 hours.              | 20°C        |    |
| 3 | AgNO <sub>3</sub>  | Hydrazine      | 1% starch (potatoes) | Cloudiness was observed in the solution for 24 hours.        | 20°C        |  |
| 4 | AgNO <sub>3</sub>  | sodium citrate | 1% starch (potatoes) | The solution turned light brown for 24 hours, then darkened. | 20°C        |  |

According to the results obtained above, it can be recognized that nanosilver synthesis was carried out in all experiments. A change in the color of the solution indicates the formation of silver nanoparticles. The change in the color intensity of solutions from light to dark is explained by the increase in the size of silver nanoparticles.

The main physicochemical parameters affecting the synthesis of AgNZ are temperature, composition and concentration of solutions, neutral reaction medium, duration of reaction and intensity of mixing solutions. Parameters such as metal ion concentration, solution composition, and reaction time mainly affect the size, shape, and morphology of AgNZs.

### Conclusion.

Silver nanoparticles were synthesized from aqueous solutions at room temperature and 0°C by chemical reduction method. Factors affecting the stability of synthesized silver nanoparticles were studied. The decrease in dispersity of silver nanoparticles is mainly explained by the increase

in color intensity. The shape and size of silver nanoparticles depend on the concentration of the silver nitrate solution, the nature of the stabilizer and reducing agent, and the temperature.

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