**Project Summary**

**Title of the Project:** Synthesis of silver nanoparticles using Tollen’s reagent.

**Funded by:** UGC-BSR

**Project Student:** Mr. Deepak Rase  
Email: mr.deep28@gmail.com  
Mobile: 9657211448

**Project Guide:** Mr. Narayan P. Firke  
Assistant Professor in Chemistry  
Department of Chemistry  
Ferguson College, Pune - 411004  
Email: npfirke@gmail.com  
Mobile: 9881607411

**Introduction:**

Nano refers to $10^{-9}$ scale for measurement, so nanoscience is the study of the structure having size close to $10^{-9}$. The behavior of these particles is the function of their size.\(^1\)\(^2\) These nanoparticles are abbreviated as NPs. NPs are found to have interesting properties and application in field of science and technology. Nanostructures are existed in nature more before human start exploring them, e.g. feather of peacock or oil drops spread on water exhibiting color. NPs are produced in laboratory scale and in industry now days. Recent, studies shows bioavailability of the nanoparticles made by leaves extract of *Ocimum* species is more than that of synthetically capped nanoparticles.\(^3\)

**Synthesis of nanoparticles:** There are two methods of synthesis of silver nanoparticles as follows\(^4\)\(^5\)\(^6\)

1. **Chemical and Physical synthesis of nanoparticles:**
2. **Biosynthesis of AgNPs from bacteria and fungi**

**Application**

NPs and its technology have already impacted our day-today activities. NPs are found more applications in field of computing, defense, electronics, information storage, medicines\(^7\). In particular, metal nanoparticles like silver and gold\(^8\) have been found as exciting application in field of catalysis and material science.
Our approach

We synthesized the nanoparticles from Tollens’ reagent as source of silver ion and reducing sugar D-Glucose. The nanoparticles thus produced were capped with surfactant sodium dodecyl sulfate. The size of the nanoparticles was determined by UV spectra.  

Experimental

The steps involved in preparation of silver nanoparticles from Tollens’ reagent.

Preparation of Tollens’ reagent involves following steps.

I) First a few drops of dilute sodium hydroxide are added to some aqueous silver nitrate. The OH\(^-\) ions convert the silver aquo complex form into silver oxide, Ag\(_2\)O, which precipitate from the solution as a brown solid:

\[
2 \text{AgNO}_3 + 2 \text{NaOH} \rightarrow \text{Ag}_2\text{O (s)} + 2\text{NaNO}_3 + \text{H}_2\text{O}
\]

II) In the next step, sufficient aqueous ammonia is added to dissolve the brown silver(I) oxide. The resulting solution contains the [Ag(NH\(_3\))\(_2\)]\(^+\) complexes in the mixture, which is the main component of Tollens’ reagent. And sodium hydroxide is reformed again:

\[
\text{Ag}_2\text{O (s)} + 4 \text{NH}_3 + 2\text{NaNO}_3 + \text{H}_2\text{O} \rightarrow 2 \text{[Ag(NH}_3\text{)}_2\text{]}\text{NO}_3 + 2 \text{NaOH}
\]

A. For concentration of \(10^{-3}\) M Tollens’ reagent solution in 100 ml of water requires

\[
1 \text{ M in } 1000\text{ml} \equiv 169.8731 \text{ gm AgNO}_3
\]

\[
10^{-3} \text{ M in } 100\text{ml} \equiv 0.01698731 \text{ gm AgNO}_3
\]

B. For concentration of \(10^{-4}\) M Tollens’ reagent in 25 ml of water requires \(V_1\) ml from \(10^{-3}\) M Tollens’ reagent solution

As we have,

\[
M_1 \times V_1 = M_2 \times V_2
\]

\[
10^{-3} \times V_1 = 10^{-4} \times 25
\]

\[
V_1 = (10^{-4} \times 25) / 10^{-3}
\]

\[
V_1 = 2.5 \text{ ml}
\]

C. Similarly,

For concentration of \(10^{-5}\) M Tollens’ reagent in 2.5 ml of water requires 2.5 ml from
$10^{-4}$ M Tollen’s reagent solution
For concentration of $10^{-6}$ M Tollen’s reagent in 2.5 ml of water requires 2.5 ml from $10^{-5}$ M Tollen’s reagent solution

Structure of sodium dodecyl sulfate surfactant

![Structure of sodium dodecyl sulfate surfactant](image)

$\text{C}_{12}\text{H}_{25}\text{NaO}_4\text{S}$
Exact Mass: 288.13712
Mol. Wt.: 288.37927

Procedure for preparation of the silver nanoparticles: To Tollen’s reagents of concentration $10^{-3}$ M, $10^{-4}$ M, $10^{-5}$ M and $10^{-6}$ M, 50 mg of sodium dodecyl sulfate surfactant and 20 mg D-glucose was added sequentially. The solutions were stirred and kept at 60 °C for half an hour. The yellow-red colour was observed in the flask having concentration $10^{-3}$ and $10^{-4}$ M. The UV spectra of these solutions were recorded on UV-1700 (Shimadzu Make) instrument.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Concentration/M</th>
<th>UV$_{max}$/ nm</th>
<th>Absorbance</th>
<th>Particle Size/ nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$10^{-3}$</td>
<td>429</td>
<td>0.5869</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>$10^{-4}$</td>
<td>435</td>
<td>0.1978</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>$10^{-5}$</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>$10^{-6}$</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Result and discussion:
The spectroscopic evaluation of Tollen’s reagent, Silver NPs $10^{-3}$M, Silver NPs $10^{-4}$M was done on UV- spectrophotometer. The results obtained reveals, the Tollen’s reagent having concentration $10^{-3}$ showed absorption at 429 nm with 0.5869 absorbance; whereas, Tollen’s reagent having concentration $10^{-4}$ showed absorption at 435 nm with 0.1978 absorbance.
Figure 1: (From Left) Stock solution of Tollen’s reagent $10^{-3}$ M, Silver NPs $10^{-3}$ M, Silver NPs $10^{-4}$ M.

Figure 2. The extinction (scattering + absorption) spectra of silver nanoparticles with diameters ranging from 10-100 nm at mass concentrations of 0.02 mg/mL. (The graph adopted from Sigma-Aldrich product document.)
Table 1:

<table>
<thead>
<tr>
<th>Size of silver nanoparticles/ nm</th>
<th>Wavelength Absorbed/ nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>396</td>
</tr>
<tr>
<td>20</td>
<td>408</td>
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<td>40</td>
<td>420</td>
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<td>50</td>
<td>440</td>
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</tbody>
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Figure 3: Calibration Curve obtained from experimental observation Table 1. From above calibration curve the size of synthesized silver NPs were determined.

Conclusion

The silver nanoparticles of size 43 nm and 48 nm were obtained from Tollen’s reagent having concentration $10^{-3}$ M and $10^{-4}$ M respectively. The D-Glucose can be used as a reducing reagent and sodium dodecyl sulfate as capping reagent in synthesis of silver NPs.

References


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