SYNTHESIS OF SILVER NANOPARTICLE USING FRESH TOMATO POMACE EXTRACT

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Received 16 February 2014; accepted 03 March 2014

Abstract

Tomato is one of the most popular vegetable, used as a salad, in food preparations like juice, soup, sauce, ketchup or puree. Commercial processing of tomato in food industry produces a large amount of waste at various stages. Tomato waste is also known as Tomato Pomace which is a mixture of tomato peels, crushed seeds, pulp, core culls and unprocessed green tomatoes that remain after the processing of tomato. During processing 10 to 30% of the raw tomato weight becomes waste. The wet pomace contained 33% seed, 27% skin, 40% pulp while the dried pomace contained 44% seed, 56% pulp and skin. Tomato seeds, the major component of pomace, contained a good quantity of proteins and lipids. The skin, another important component of pomace, was utilized for extracting the red pigment using organic solvent. Due to these properties, tomato pomace is used for the synthesis of silver nanoparticles. Nanoparticles were characterized by UV-VIS spectroscopy, Scanning electron microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FTIR). The antibacterial activity against a panel of five bacteria was also investigated for nanoparticles.

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INTRODUCTION

Fresh tomato pomace is a residue, which is the main by-product available after processing of tomato. The processing of tomato yields nearly 50 percent of the fresh tomato pomace. Fresh tomato pomace has high moisture content spoils quickly and costly to transport. In order to overcome this problem, eco-friendly, safe and reliable method of utilizing the fresh tomato pomace was carried out by synthesizing Silver Nanoparticles. Nanoparticle was used which has several important applications in the field of biolabelling, sensors, drug delivery system (Mann and Ozin, 1996), filters and also possesses antimicrobial activity (Ingle et al., 2008). It is well known that several plant extract and many microorganisms like algae, bacteria and fungi produce nanoparticle. But, the research on fruit waste for the synthesis of nanoparticle was not observed.

MATERIALS AND METHODS

1. Preparation of Fresh Tomato Pomace Extract

Fresh Tomato Pomace that remains after extraction of juice was used for the preparation of extract. 20g of fresh tomato pomace was added into 100ml of deionised water and boiled for 10 minutes. The content was cooled for few minutes. It was then filtered using whatman filter paper No.1 and filtrate was used for the synthesis of Nanoparticle.

2. Synthesis of Silver Nanoparticle from Tomato Pomace

10ml of freshly prepared filtrate was added with 90ml of aqueous solution of 1mM silver nitrate for reduction of Ag⁺ ions and incubated at room temperature and the colour change was observed.

3. Characterization of Silver Nanoparticles

The characterization of silver nanoparticles was carried out by different techniques such as SEM, UV-Vis and FTIR analysis.

SEM Analysis

Electron microscopy is commonly used method of characterization (Cao, 2004). It is used for morphological characterization at the nanometer to micrometerscale (Schaffer et al., 2009). Sample of SEM was prepared by placing the drop of silver nanoparticle suspension over carbon coated grid then it was dried, examined and photographed in SEM (FEI*LEM – 30) at Instrumentation lab, Pondicherry University, Puducherry, South India.

UV-Vis Spectrophotometer

The UV-Vis spectroscopy is another commonly used technique (Pal et al., 2007). It is used for characterizing the various metal nanoparticles in the size range of 2 to 100
nm. Spectrophotometric absorption measurements in the wavelength ranges of 400-450 nm (Huang and Yang, 2004) and 500-550 nm (Shankar et al., 2004) are used in characterizing the silver and gold nanoparticles, respectively.

The silver nanoparticle sample were subjected to optical measurements, which were carried out by using a UV-Vis spectrophotometer (U-2010 Spectrophotometer) and scanning the spectra between 300 and 700 nm at the resolution of 1 nm.

**Fourier transform infrared spectroscopy (FTIR)**

FTIR spectroscopy is useful for characterizing the surface chemistry (Chithrani et al., 2006). Organic functional groups (e.g., carbonyls, hydroxyls) attached to the surface of nanoparticles and the other surface chemical residues are detected using FTIR.

In FTIR analysis the samples were recorded in the range of 1000-4000cm⁻¹ at a resolution of 4 cm⁻¹.

**Antibacterial activity of Silver Nanoparticles (Agar well diffusion assay)**

Agar well diffusion assay was used to evaluate the antibacterial activity of silver nanoparticle against *B. subtilis, P. vulgaris, C. albicans, Pseudomonas, S. aureus* on PDA. 30μl of sample was added in all the wells. These plates were incubated for 24 hours to measure the zones of inhibition. The assay was performed in triplicates.

**RESULTS AND DISCUSSION**

1. **Synthesis of Silver Nanoparticle**

The colour change was noted by virtual observation in fresh tomato pomace extract incubated with aqueous solution of silver nitrate. It started to change colour from colourless to light brown and then brownish red colour due to the reduction of Ag⁺ ions, this exhibit the formation of silver nanoparticles. In the fig A represents the Initial, B & C indicates that the reaction mixture after 15 minutes and one hour of incubation. The intensity of colour increases with increase in time and after one hour there is no significant change in colour was observed due to the completion of reaction.

2. **Characterization of Silver nanoparticles**

Nanoparticles are generally characterized by their size, shape, surface area and dispersity (Jiang et al, 2009). The common techniques of characterizing nanoparticles are as follows:

**SEM**

SEM was used to view the morphology and size of silver nanoparticle. SEM image showed the high density nanoparticle synthesized by fresh tomato pomace extract were relatively spherical in shape. This confirmed the development of silver nanostructures. The SEM image showed the nanoparticle in the range of 70 -80 nm. This size of particle confirms the presence of nanoparticle.

**UV-Vis Spectroscopy**

UV-Vis Spectroscopy could be used to examine the size and shape of controlled nanoparticle in aqueous suspension (Wiley et al, 2006).

The confirmation of formation and stability of silver nanoparticle was monitored by using UV-Vis spectral analysis, for which after completion of reaction (after 1-2 hour) the sample were removed and subjected to UV-Vis spectra measurement. The extract with silver nitrate showed the sharp peak around 450 nm (Fig 3) with high absorbance which is very specific of silver nanoparticles. The broadening of the peak indicated that particle were polydispersed.
Fourier Transform Infra Red Spectroscopy (FTIR)

FTIR spectrum used to analyse the functional group present in fresh tomato pomace extract. The Silver Nanoparticles was confirmed by changes occurred in the FTIR spectrum after synthesis. The fig showed the peaks between 1053 cm\(^{-1}\) to 3904 cm\(^{-1}\).

The peaks at 1458 cm\(^{-1}\), 1629.40 cm\(^{-1}\), and 1638 cm\(^{-1}\) shows the symmetric stretching vibration of \(-\text{COO}\) (Shiv Shankar et al, 2003), stretch vibration of \(\text{C=C}\) (Huang et al, 2007) and the reduction of silver ion to silver nanoparticles. The peaks at 2344 cm\(^{-1}\), 2923 cm\(^{-1}\), and 3423 cm\(^{-1}\) represents the asymmetric stretching for \(\text{C-H}\) (Nune et al, 2009), stretching vibration of \(\text{C-H}\) and water & OH absorption frequency (Wang et al, 2007).

Antibacterial activity of Silver Nanoparticle

The reaction mixture were centrifuged at three different speed i.e., 5000, 10,000 and 15,000rpm and the particles were collected. The collected Silver Nanoparticle were three average size and it ranges as 250nm, 135nm and 80nm in 5000, 10,000 and 15,000 rpm respectively. These particles were used in well about 50\(\mu\)l were loaded in each well and then antibacterial activity was tested.

The maximum zone of inhibition was observed at 15,000rpm for all the bacterial strain when compared to 5000 and 10,000rpm. This is because, when the speed of rotation increases, the size of Silver Nanoparticles deposited becomes smaller and viceversa. If the size of nanoparticles is smaller it shows the greater activity against bacterial strain.

Silver nanoparticles synthesized utilizing fresh tomato pomace extract showed higher antibacterial activity against *Shigella, Pseudomonas* and *Staphylococcus* in all the rotation. The other bacterial strain such as *Vibrio chlorae* and *Klebsiella* showed minimum inhibitory effect. Antimicrobial activity of silver nanoparticles has also reported against *Vibrio chlorae, Staphylococcus aureus* and *Pseudomonas aeruginosa* (Prabhu et al, 2010).

**Table 1:** Antibacterial activity of silver nanoparticles

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Zone of Inhibition (mm)</th>
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<tbody>
<tr>
<td></td>
<td>5000 rpm</td>
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<tr>
<td><em>Shigella</em></td>
<td>16</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>19</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>14</td>
</tr>
<tr>
<td><em>Klebsiella pneumonia</em></td>
<td>13</td>
</tr>
<tr>
<td><em>Vibrio chlorae</em></td>
<td>11</td>
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</tbody>
</table>

CONCLUSIONS

Tomato Pomace is a byproduct in the Tomato processing industry is capable of synthesizing Silver Nanoparticle. It showed good antibacterial activity towards resistant pathogens. Moreover, the process for the production of Silver Nanoparticle is environmental friendly and free from organic solvents and toxic chemicals. So, it is one of the effective recycling process to utilize the tomato waste.

ACKNOWLEDGEMENT

The author is grateful to the University Grants Commission for providing necessary fund to carry out this research work.

REFERENCES


Source of support: Nil; Conflict of interest: None declared