Facile Synthesis of Silver Nanoparticles of Aqueous Extract of Bhut Jolokia a Cultivar of *Capsicum chinense* Jaqc and its Antibacterial Effect

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Abstract: The article explores a novel method of synthesizing silver nanoparticle using aqueous extract of *Capsicum chinense* Jaqc. The capsaicinoid alkaloids and polyphenols served as an reducing and stabilizing agent in the formation silver nanoparticles. The formation of silver nanoparticle was confirmed by the surface Plasmon resonance which occurred at 430 nm. A gradual colour change of the reaction medium occurred from colourless to pale yellow tinge followed by pale red and then to intense reddish brown colour. The completion of nanoparticle synthesis occurred at 6 hr, as further increased in reaction time showed a marginal rise in the intensity of colour. The characterization of the formed silver nanoparticle was carried out using UV Visible Spectrophotometry and Transmission Electron microscopy. The antibacterial studies were carried out using well diffusion technique using pure culture of *Escherichia coli*, which showed an inhibition zone of 11.8 mm at a dosage of 70 µg/ml.

Keywords: Silver nanoparticles, *Capsicum chinense* Jaqc, Antibacterial, Bhut Jolokia, *Escherichia coli*.

1. INTRODUCTION

Silver finds its root in the microbial and wound infection treatment from ancient times. Due to the advancement in material sciences, fabrication of nano range materials proved worth for itself in the field of medical, optical sciences and metallurgy. In the nano range the material exhibited different chemical, physical and optical properties when compared to parent material. Though a wide range of methodologies are available for synthesizing the nanomaterial viz: physical, chemical, mechanical and biological processes. The biological process adopts green method of nanoparticle synthesis and they are less energy intensive which operates at ambient pressure. Among the biological method of nanoparticles synthesis plant extracts derived from various plant parts of interest are gaining importance due to the biocompatibility and environmental friendly [1, 2].

Capsicum chinense Jaqc (Bhut jolokia) an interspecific hybrid of *Capsicum chinense* and *Capsicum frutescens* and belongs to the and Solanaceae family. Bhut jolokia also known as ghost pepper, ghost chili pepper, ghost chili and ghost jolokia are cultivated in the Northeast Indian states of Arunachal Pradesh, Assam, Nagaland and Manipur. The hydroxyl group position and amide moiety and length in the aromatic ring plays an important role maintaining the pungency of chili fruits. The sharp pungency taste of *Capsicum* arises due to the capsaicinoid alkaloids namely capsaicin and dihydrocapsaicin. *Capsicum w*hen used at minimum levels in the usual diet, they widely decrease the serum, myocardial and aortic cholesterol levels [3-5]. Silver nanoparticles were synthesized using Capsicum annuum L. extract. The results showed that with the increase in reaction time polycrystalline AgNP's converted into single crystalline structure [6]. Synthesis of silver nanoparticles and organometallic disk were carried out using aqueous extracts of Capsicum annuum var. aviculare (piquin) fruits [7]. However, there was no report available on the synthesis of Silver nanoparticles using Bhut Jolokia the cultivar of Capsicum chinense and hence, the present work was carried.

2. MATERIALS AND METHODS

2.1. Collection and expression of *Capsicum chinense* Jaqc

Fresh samples of *Capsicum chinense* Jaqc was procured from Assam Market. The sample was sealed in the sterile zip lock cover and transported to lab within 24 hr. About 30±0.3 g of *Capsicum chinense* Jaqc was grinded using double distilled water and the aqueous extract was filtered using muslin cloth and then using Whatman 40 filter paper. The filtrate served as a reducing and stabilizing agent in the synthesizing silver nanoparticles.

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2.2. Procedure for Synthesizing Silver Nanoparticles

To 25 ml of 1 mM solution of silver nitrate under continuous stirring condition, 10 ml of *Capsicum chinense* Jaqc extract was added drop wise. The reaction was carried out 37±2°C till the reaction was completed. Within few minutes of the addition of *Capsicum chinense* Jaqc to the silver nitrate solution a slight yellow tinge was observed, which confirmed that the initiation of nanoparticles formation. Thereafter as the reaction progressed the colour changed into pale red followed by intense reddish brown at the end of the reaction.

2.3. Characterization of Silver Nanoparticles

The surface plasmon resonance of the nanoparticles was measured using UV-visible spectroscopy. The size and shape of the formed nanoparticles were determined using transmission electron microscopy.

2.4. Well Diffusion Method

The antibacterial activity of the synthesized silver nanoparticles was investigated in well diffusion method against pure strain of *Escherichia coli* procured from HI-MEDIA, INDIA. The investigation was carried out by dissolving silver nanoparticles in 3% dimethyl sulfoxide, which served as a stock solution. Suitable aliquots of nanoparticles was injected into the well to represent 10 to 100 µg/ml in steps of 10. The zone of inhibition was measured during the incubation period.

3. RESULTS AND DISCUSSION

The synthesis of silver nanopartciles was carried out by adding *Capsicum chinense* Jaqc extract was added drop wise to 25 ml of 1 mM solution of silver nitrate under complete mixed condition at pH 6.9 ± 0.2 at 37±2°C. With the increase in reaction time the formation of silver nanoparticles were confirmed by the colour the reaction mixture. The surface plasmon resonance of the formed nanoparticles were established using UV-visible spectrophotometer which showed a maximum absorbance at 430 nm (Figure **1**). Initially the peak was broad; with the increase in reaction time a sharp peak was observed. The initiation of nanoparticles formation was confirmed by observing the colour change from colourless to pale yellow at 3 min followed by pale by red at 30 min and reddish brown colour at the end of the reaction. Moreover after a reaction period of 6 hr the intensity of the peak did not show further rise, which confirmed the completion of the reaction. To confirm the reaction period further 5 ml of *Capsicum chinense* Jaqc was added and its absorbance was measured after a reaction period of 30 min. During this period no futher increase in absorbance was noticed, hence the added extract shall serve as a stabilizing agent in the reaction mixture.

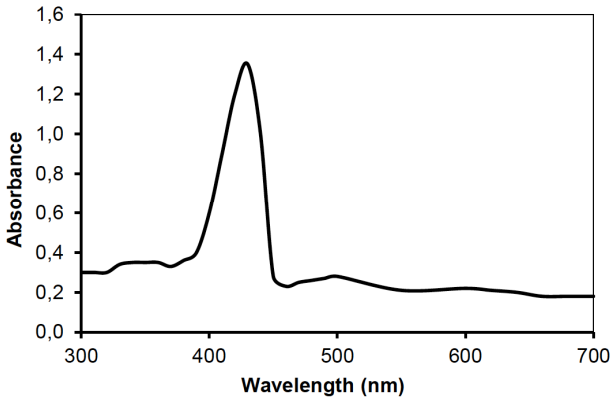

Figure 1: UV-visible spectrum of silver nanoparticles synthesized from *Capsicum chinense* Jaqc.

The transmission electron microscopy (TEM) revealed the size and shape of the synthesized nanoparticles as shown in Figure **2**. The average size of the synthesized nanoparticles had a size ranged between 20 to 40 nm resembling spherical shape. The selected area electron diffraction (SAED) pattern shows the Scherrer rings, having a characteristic pattern of fcc crystal structure. The sharp diffraction pattern of the ring shows crystalline nature of the material (Figure **3**). Earlier researcher had stated that silver nanoparticles when synthesised using alcoholic extract of Capsicum frutescence, resulted in monodispersed particles of 20-25 nm having a surface plasmon resonance band at 385-435 nm [8].

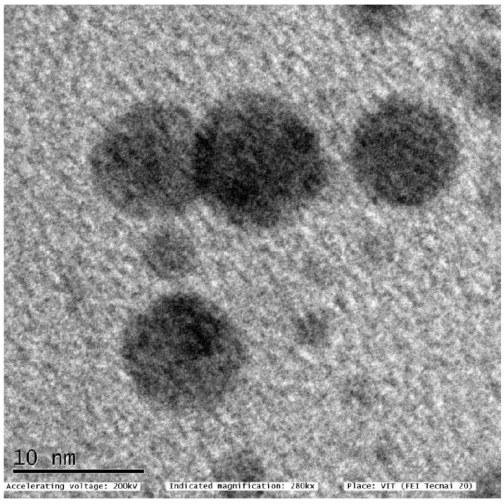

Figure 2: Transmission electron microscopy image of AgNP's synthesized from *Capsicum chinense* Jaqc.

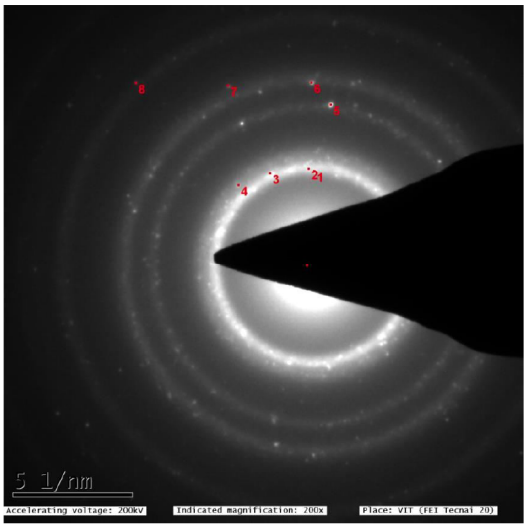

Figure 3: SAED pattern of AgNP synthesized from *Capsicum chinense* Jaqc.

The antibacterial activity of silver nanoparticles was tested against *Escherichia coli* strain using well diffusion method. The zone of inhibition was remarkable at a dosage of 70 µg/ml silver nanoparticles resulting in 11.8 mm (Figure **4**). The possible mechanism of inhibition could be due to penetration of silver nanoparticles into the cell wall and disturbing the metabolic reaction when inside cell.

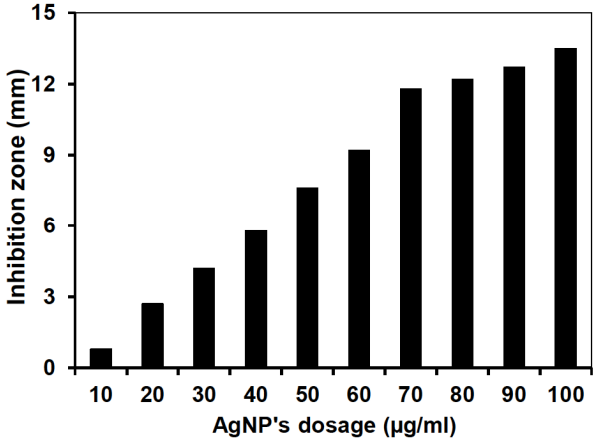

Figure 4: Inhibitory effect of silver nanoparticles in well diffusion methods againt *E. coli.*

4. CONCLUSION

A novel biosynthesis method was adopted in the synthesis of silver nanoparticles using aqueous extract of *Capsicum chinense* Jaqc. The formed silver nanoparticles showed a perfect spherical shape with 20-40 nm size range. The AgNP's were effective against *Escherichia coli* which proved its antibacterial activity. Being an environmentally benign approach it has no hazardous chemicals are utilized during the synthesis. Silver nanoparticles find wide application as broad-spectrum antimicrobial in medical and textile products

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