Aspergillus fumigatus an Effective Metabolic System for the Biosynthesis of Silver Nanoparticles: Fabrication and Characterization of Silver Nanocomposites

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ABSTRACT

Biosynthesis of nanomaterials have become a major interest in the field of nanotechnology. Nanoparticles have an emerging application in drug delivery system due to the target specificity and less reactive. Among a variety of nanoparticles, metallic nanoparticles especially silver nanoparticle and silver-based nanocomposites have dual advantage in targeted drug delivery and antimicrobial effect. Conventionally, nanoparticle synthesis requires chemical treatment to synthesize nanoparticles. Herein, the study focuses on the synthesis of silver nanoparticles using fungal metabolic system and the development of silver nanocomposites. The biosynthesized nanoparticles and the developed nanocomposites were characterized using advanced analytical techniques. Metallic based nanocomposites were tested for their antimicrobial effectiveness. The results proposed that metallic-polymer based nanocomposite system exhibited broad antibacterial spectrum.

Keywords: Biosynthesis, Nanoparticles, Silver nanocomposites, Antimicrobial efficacy.

INTRODUCTION

Nanocomposite is a unique class of multiphase nanostructured material that has at least one phase in nanoscale dimension. They exhibit unique physiochemical properties that makes them a plausible competitor against different types of synthetic therapeutic agents and therefore they could possibly be used as a drug delivery system. There are numerous types of nanocomposites which are generally classified based on their unique structure and matrix type. Some of them are recognized as polymer-based nanocomposites while, others are categorized as non-polymer-based nanocomposites (Thangavel *et al*., 2019). Among various types of polymer-based nanocomposites, metal/polymer nanocomposites (metallic nanocomposites) have gained enormous attention due to their immense range of applications (Al-Jumaili *et al*., 2019). Metallic nanoparticles have previously exhibited distinctive physical, chemical, and biological properties along extraordinary antimicrobial potential even when very low doses of metallic nanoparticles are used (Kim *et al*., 2017). Silver, copper and gold nanoparticles have previously been employed as potent antimicrobial agents against a broad range of microorganisms. Additionally, to diminish any cytotoxic effect of metallic nanoparticles and to increase their antimicrobial potential, they are layered with a range of biocompatible organic matrices. This strategy has led in the development a variety of metallic nanocomposites with an array of blend for different biopolymers. Among natural polymers, chitosan is a biopolymer that belongs to the family of aminopolysaccharide which have exhibited credible antimicrobial potential with several biomedical applications (Riley *et al*., 2012).

Due to multiple functionalities, both the metallic nanoparticles and the biopolymers have gained attention of the investigators in order to use them in the field of biomedicine for efficient control of infections that are mostly caused by multidrug resistant microorganisms (MDROs).

OBJECTIVES

The objectives of the study are as follows;

- Biosynthesis of silver nanoparticles using fungal biomass.
- Fabrication and characterization of silver nanoparticle.
- Antimicrobial potential of the biosynthesized silver nanocomposites against various pathogenic bacteria.

METHODOLOGY

Production of Fungal Biomass

The fungal strain *Aspergillus fumigatus* KIBGE-IB33 was used under static conditions for the production of fungal biomass.

Biosynthesis of Silver Nanoparticles

Cell free extract was used for the biosynthesis of silver nanoparticles. Silver nitrate was incorporated in the cell free for biosynthesis of silver nanoparticles

Characterization of Biosynthesized Silver Nanocopmosite

The biosynthesized nanocomposite was characterized using the following analytical techniques:

- Fourier Transform Infra-Red Spectroscopy (FTIR)
- Scanning Electron Microscopy (SEM)
- Energy Dispersive X-ray (EDX)
- Dynamic Light Scattering (DLS)
- UV-Vis Spectroscopy

Antimicrobial Potential of Biosynthesized Silver Nanocomposite

Agar well diffusion technique was carried out to determine the minimum inhibitory concentration and fractional inhibitory concentration against various pathogenic bacterial strains.

RESULTS / CONCLUSIONS

Silver nanoparticles could be synthesized using different procedures, but majority of the procedures are not cost effective because they consume large amount of energy and the nanoparticles formed during chemical synthesis which easily gets agglomerated. Conversely, synthesis of silver nanoparticles using biological means is considered as an ecofriendly approach. The results showed the synthesis of silver nanoparticles by *A. fumigatus* KIBGE-IB33 which was capable of reducing more silver nitrate as compared to other strains.

The pre-synthesized silver nanoparticles were used as the nanomaterial for the fabrication of polymer-based nanocomposites by using a bioactive polycationic biopolymer under the influence of microwave irradiation. This type of fabrication method has become a remarkable approach not just, because it stabilizes the metal element in a nanocomposite system but also effectively reduces the rate of agglomeration of nanoparticles.

For the initial confirmation of the synthesized silver nanoparticles and the fabricated Silver nanocomposites, UV-visible spectroscopy was used. The maximum absorbance at 420 nm clearly confirmed the presence of silver nanoparticles (Figure **1**).

Antimicrobial potential of silver nanoparticles and fabricated nanocomposite system was studied against various multidrug resistant microorganisms. Table **1** demonstrated the antimicrobial potential of both nanomaterials along with the calculated MIC and FIC values of nanocomposite system only against some

prominent pathogenic indicator strains. Results indicated that silver nanocomposites exhibited strong antibacterial activity against both Gram's negative and Gram's positive bacterial strains.

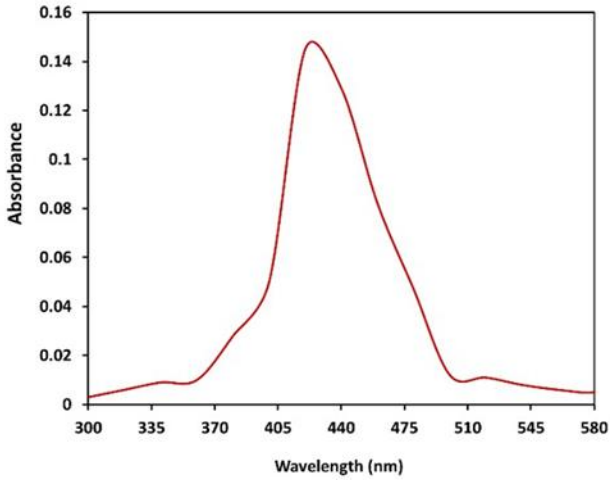

Figure 1. UV-Vis Spectra of Biosynthesized Silver Nanocomposite.

Table 1. Antimicrobial Activity of Biosynthesized Silver Nanocomposite.

Microorganisms	Minimum Inhibitory Concentration	Fractional Inhibitory Concentration (FIC)
Enterrococcus faecalis	1.56±0.03	0.02
Salmonella typhimurium	3.12±0.06	0.40
Listeria monocytogenes	7.8±0.15	0.03
Pseudomonas aeruginosa	12.5±0.25	0.06

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