Biosynthesis of Silver nanoparticles using Aqueous Extract of Ginger and Turmeric Combination and its Antibacterial Activity against *Salmonella typhi*

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Abstract

The current study presents the synthesis of silver nanoparticles (AgNPs) employing aqueous extracts of ginger (Zingiber officinale) and Turmeric (Curcuma longa) as a reducing and capping agent. UV-visible spectroscopy, Fourier-transform infrared spectroscopy, and Scanning electron microscopy were used to characterize the produced AgNPs. AgNPs were made by reducing aqueous solution of $AgNO_3$ (1mM) using aqueous extract of Zingiber officinale and Curcuma longa combination. The agar well diffusion method was used to assess the antibacterial potency of the test samples against Salmonella typhi. Synthesis of AgNPs was validated after 24 hours when the reaction mixture turned brown. UV-visible spectroscopy revealed a 412 nm spectrum, which is typical of AgNPs. The biosynthesized AgNPs' FTIR spectrum revealed strong absorption peaks at ~ 3300 cm^{-1}, 2100 cm^{-1}, 1630 cm^{-1}, indicating the existence of OH–stretching, C=N–stretching, and NH–stretching, respectively. The SEM investigation revealed that the size of AgNPs-CBLE was in the 20-30 nm range. The result of the antibacterial activity revealed that biosynthesized AgNPs showed a greater antibacterial activity than the crude aqueous extract of Zingiber officinale and Curcuma longa combination against Salmonella typhi with zones of inhibition of 25 mm and 20 mm respectively. However, the conventional drug used had a zone of 38 mm against the test pathogen. This study suggested that AgNPs synthesized using aqueous extract of Zingiber officinale and Curcuma longa combination could be a promising choice for the control Typhoid fever.

Keywords: Ginger and Tumeric, blended extracts, Silver nanoparticles, Antibacerial activity, *Salmonella typhi*

Introduction

Ginger and Tumeric belonging to family *Zingiberaceae* are herbaceous plants used as dietary spices (Prasad & Aggarwal, 2011). However, because of their antibacterial, antioxidant, growth promotion, and immune stimulant qualities, ginger and turmeric have been demonstrated to be beneficial in the treatment of diseases in people, poultry, and aquaculture (Ike et al., 2019). Natural agents, on the other hand, are being advocated for use in nanoparticle synthesis because their use directly as medications is challenging due to a lack of quality in manufacturing, commerce, and prescription (Gloria, Anthony , Emmanuel & Samuel , 2017). Nanoparticles are small particles having a diameter of 1 to 100 nanometers. In comparison to its bulk structure, the nanoscale material exhibits unique, novel and improved physical and chemical properties due to the larger ratio of surface areas per volume of the material or particle (Khan, Saheed, Khan, 2019). According to Henry et al., (2019), metal nanoparticles especially silver nanoparticles are the most commonly investigated nanoparticle materials. This could be because of their broad spectrum of applications as antibacterial, antifungal, antioxidant, anticancer, and anti-inflammatory medicines (Muhammad et al., 2012). AgNPs have been synthesized utilizing a variety of physical and chemical processes, however due to the difficulties connected with these procedures, researchers' curiosity has been sparked to look for new ways to make them (Rai et al., 2021). The biological process, often known as "Green synthesis," is a new and substantially safer strategy for AgNPs (Bedloviová, 2022). Green synthesis uses materials that are environmentally friendly, nontoxic, and safe, such as plant extract, fungi, bacteria and enzymes, to make silver nanoparticles. These materials have a number of benefits, including being ecologically friendly and compatible with pharmaceutical and other biomedical applications (Sharma, Kanchi, Bisetty, 2019). Plant extracts are chosen over other biological sources because of their widespread availability and large range of reducing metabolites, which help to create nanoparticles with improved characteristics (Aboyewa, Sibuyi, Meyer, Oguntibeju, 2021). In this study, aqueous extract of ginger and turmeric combination was used to make Ag nanoparticles and an attempt was made to evaluate its antibacterial potency against *Salmonella typhi*. There is no earlier report on the green synthesis of AgNPs using ginger and turmeric combination.

2. METHODOLOGY

The samples used in this study (ginger and turmeric) were obtained from the market and validated by a botanist at Covenant University. Analytical grade reagents and chemicals were used.

2.1 *Extract Preparation*

The samples; Ginger and Tumeric were rinsed under the running tap, peeled and chopped into tiny pieces.The method of Ogori et al., 2021 was followed to obtain the aqueous extract. In brief, 50g each of ginger and turmeric were blended together, filtered, labeled as BEGT and stored at -20 ^{O}C till further use.

2.2 *Phytochemical Analysis*

The phytochemical contained in the aqueous extract of ginger and turmeric combination (BEGT) were identified and quantified using standard methods (Adewolu, Adenekan, Uzamat &Ajayi, 2021)

2.3 *Synthesis of Silver nanoparticles*

BEGT (10 ml) was added to a flask containing 1 mM $AgNO_3$ solution (90 ml) and left to incubate for 24 hours in the dark.

2.4 *Characterization of biosynthesized AgNPs*

A UV-Vis spectrophotometer was used to confirm the bioreduction of Ag+ into AgNPs-BEGT between 200 and 600 nm. The biosynthesized AgNPs' FTIR spectra was obtained between 350 and 4400 cm-1 using a Nicolet IS5 model from Thermos Scientific with a resolution of 0.4cm-1. The size of the biosynthesized nanoparticles was determined via SEM examination of MS-AgNPs.

2.5 *Antibacterial Property*

BEGT and AgNPs-BEGT were investigated for antibacterial efficacy against Samonella typhi. The test organism used in this investigation was a clinical isolate obtained from the University of Lagos Microbiology Laboratory.

2.5.1 *Antibacterial Assay*

The antibacterial potency of the test substances was determined using Abhay and Rupa's (2016) Agar well diffusion method with minor modifications. In a nutshell, the roll-palm approach was employed to thoroughly mix 1ml of calibrated test organism (*Salmonella typhi*) already seeded into warm agar before pour plating. It was then allowed to solidify. A cork borer was used to bore 10 mm diameter wells into the solidified agar. About 150 µl of AgNPs-BEGT, 100% BEGT, and 6.25 g/ml of Levofloxacin were poured into the wells and left to stand for several hours to allow for proper diffusion. After a 24-hour incubation period at 37°C, the plate was examined for zones of inhibition.

3. RESULT

3.1 *Phytochemical screening*

TABLE 1: Qualitative phytochemical screening of aqueous extract of ginger and turmeric combination (BEGT)

TEST	BEGT
Steroid	+
Terpernoid	-
Reducing sugar	+
Tannin	+
Anthraquinone	-
Saponin	+
Flavonoid	+
Cardiac glycoside	+
Phenol	+
Phlobatanin	+

Note; + = present, - =Not present

TABLE 2: Quantitative phytochemical screening of aqueous extract of ginger and turmeric combination (BEGT)

TEST	BEGT
Steroid	27.43 ± 0.16
Terpernoid	-
Reducing sugar	29.46± 0.23
Tannin	23.54 ± 0.2
Anthraquinone	
Saponin	40.475 ± 0.525
Flavonoid	40.835 ± 0.135
Cardiac glycoside	29.535± 0.21
Phenol	32.825 ± 0.275

Note: Values are represented as mean ± SEM of duplicate

3.2 *Silver nanoparticles' Biosynthesis*

The reaction mixture of $AgNO_3$ and BEGT was noticed to be dark brown after 24hrs of incubation (Figure 1).This color change is indicative of the successful reduction Ag^+ to Ag^0 by BEGT to form AgNP-BEGT.

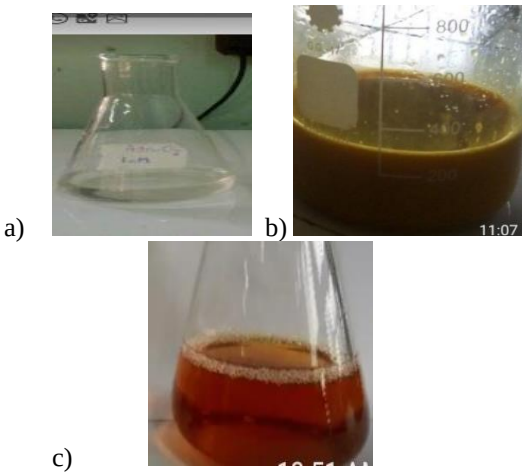


Figure 1; (a) $AgNO_3$ solution (b) BEGT (c) $AgNO_3$+BEGT; AgNPs-BEGT

3.3 *Silver Nanoparticles' Characterization*

3.3.1 UV-Visible Spectroscopy

Ultraviolet-visible (UV-Vis) analysis was carried out on reaction media; $AgNO_3$ and BEGT and a maxima peak of 412nm which is characteristic of silver nanoparticles was detected (Figure 2).

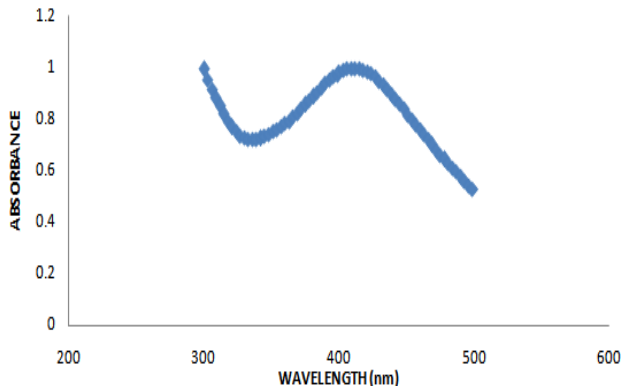


Figure 2: UV- vis spectrum of $AgNO_3$ + BEGT (AgNPs-BEGT)

3.3.2 FTIR spectra of AgNPs-BEGT

The biosynthesized AgNPs' FTIR spectrum revealed strong absorption peaks at ~ 3300 cm−1, 2100 cm−1, 1630 cm−1, indicating the existence of OH–stretching, C=N–stretching, and NH–stretching, respectively. The participation of phenolic compounds in the reduction and capping of AgNPs-BEGT is explicitly established by OH–bond stretching.

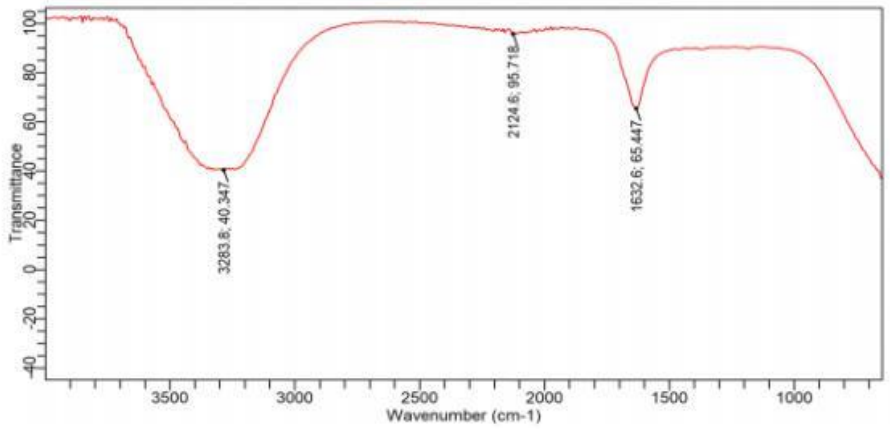


Figure 3: Fourier Transformed Infrared spectrum of AgNPs-BEGT

3.3.3 Scanning electron microscope image of AgNPs-BEGT

Scanning electron microscope was used to determine the size of the biosynthesized AgNPs. AgNPs-BEGT were unevenly granulated and heavily aggregated, as seen in Figure 3 below, according to the SEM micrograph. SEM examination revealed that the AgNPs were between 20 and 30 nm in size.

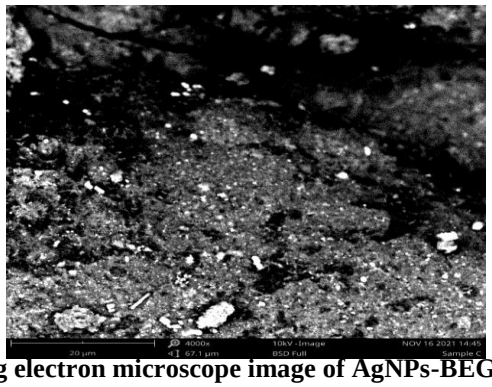


Figure 4: Scanning electron microscope image of AgNPs-BEGT

3.4 *Antibacterial Activity*

The result of the antibacterial activities of BEGT, AgNPs-BEGT and Levofloxacin against *Salmonella typhi* is shown below.

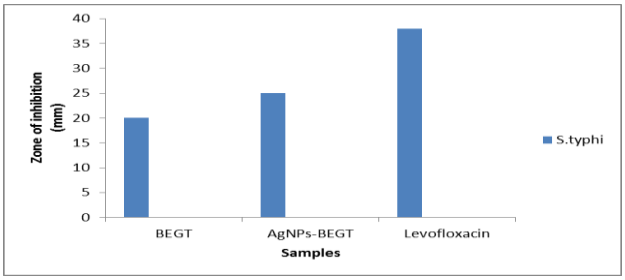


Figure 5: Inhibition Zone Diameter (mm) of BEGT, AgNPs-BEGT and Levofloxacin against *Salmonella typhi*

4. DISCUSSION

The invention of a dependable and cost-effective approach for the synthesis of metallic nanoparticles, according to Kirubha & Alagumuthu, 2015, is a critical milestone in the field of nanotechnology application. Aqueous extracts of ginger and turmeric were used to make silver nanoparticles in this work. The color change from grey to dark brown confirmed the synthesis. Silver nanoparticles have been established to have a striking color of yellow to brown due to the activation of surface plasmon vibration in the particles (Ahmad et al., 2022). The biosynthesized AgNPs had a UV-visible spectrum of 412 nm (Figure 2), which is typical of AgNPs. Several biosynthesized AgNPs have been reported to have similar absorption spectra (Olugbemi-Adesipe, 2019). The biosynthesized AgNPs' FTIR spectrum (Figure 3) revealed strong absorption peaks at ~ 3300 cm−1, 2100 cm−1, 1630 cm−1, indicating the presence of OH– stretching, C=N– stretching, and NH–stretching, respectively. Through OH–bond stretching, the involvement of phenolic compounds in the bioreduction of Ag+ as well as the capping/stabilization of biosynthesized nanoparticles is specifically established. This backs up the results of the phytochemical screening of the ginger-turmeric aqueous extract. A similar FTIR spectrum of biosynthesized AgNP has been reported by Mickymaray, 2019. The SEM investigation revealed that the size of AgNPs-CBLE was in the 20-30 nm range. This size range has been observed for several biosynthesized AgNPs (Ogunmodede, Johnson, Osunlana, Olarenwaju & Ndu-Okeke, 2019; Jyoti, Baunthiyal & Singh, 2016).The antibacterial activity's result revealed that AgNPs biosynthesized had a zone of inhibition of 25 mm against *Salmonella typhi*, which was higher than the crude aqueous extract of ginger and turmeric combination, which had a zone of inhibition of 20 mm. The conventional medication, on the other hand, had a zone of 38 mm. The antibacterial activities reported in this study for the aqueous extract of ginger and turmeric combination as well as the biosynthesized AgNPs are higher than those reported in the literature for aqueous extracts of ginger and turmeric singly or silver nanoparticles synthesized using ginger and turmeric separately (Renugadev, Naveen & Valli, 2017;Emmanuel, Ehinmitan, Bodunde & Joseph, 2021).

5. CONCLUSION

The findings of this study show that silver nanoparticles can be successfully produced utilizing a ginger-turmeric extract blend. After thorough pharmacological examination, the biosynthesized AgNPs can be employed as an effective medication against *Salmonella typhi.*

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