1. Introduction

Nanoparticles (NPs) have revolutionized the fields of material science and medicine. Catalysis (Norouzi *et al*., 2020), sensor technology (Prosposito, Burratti, & Venditti, 2020), site-specific medication delivery (Gisbert-Garzarán *et al*., 2020), imaging, and cancer treatments (Ren *et al*., 2020) are all areas where they are used. Unfortunately, hazardous solvents are used in the majority of physicochemical approaches for the synthesis of metallic nanoparticles. The by-products of these activities pose severe environmental danger (Lee & Nagajyothi, 2011). As a result, researchers have recently become interested in the synthesis of metal nanoparticles using natural materials such as bacteria, parasites, yeast, seaweeds, and plants (Dayma, Mangrola, Suriyaraj, Dudhagara, & Rajesh, 2019). Natural compounds originating from plants have made a significant contribution to the treatment of illnesses. Bioactive principles can be found in natural compounds derived from plants. They are unique to each plant, which supports their medicinal use as analgesics, anticancer drugs, anti-inflammatory agents, antihyperglycemic agents, and lipolytic agents. As a result, phytoconstituents remain as an important source of modern medications (Cross, Jin, Lu, Rao, & Gimzewski, 2011). Biomolecules derived from plants can interact with a wide range of other substances *via* a number of chemical processes (Quideau, Deffieux, Douat-Casassus, & Pouységu, 2011). Apart from their therapeutic potential, many plants and phytoplanktons are employed to remediate wastewater because of their chelating and antibacterial activities (OoKolawole, Oguntoye, Agbede, & Olayemi, 2006). In addition, tanning action of plant polyphenols has been used in the leather business (Quideau *et al*., 2011). Their efficacy, on the other hand, is restricted by their limited hydrophilicity and stability. Natural products are frequently viewed as vulnerable medication candidates due to their high dosage requirements and frequent administration (Bilia *et al*., 2017).

Despite the benefits of biomolecules, plant resource exploitation is still in its early stages. In recent years, the scientific community has turned their attention to the production of plant-based functional nanoparticles (Criado, 2015). Aside from the minimum effort required for production, the plant-based nanoparticles are biocompatible and biodegradable (Ovais *et al*., 2016). As a result, green synthesized nanoparticles have also been investigated in the field of nanomedicine. Because of its shape, biophysical characteristics, and stability, production and use of silver and silver nanoparticle based materials has gained attention in various fields (Silva, Pereira, & Bonatto, 2019), Pesticides (Ramos-Delgado, Hinojosa-Reyes, Guzman-Mar, Gracia-Pinilla, & Hernández-Ramírez, 2013), poisonous dyes (Kamran, Bhatti, Iqbal, Jamil, & Zahid, 2019), environmental sensors (Sulaiman *et al*., 2015), heavy metal removal (Nasehi, Mahmoudi, Abbaspour, & Moghaddam, 2019; Nasehi, Moghaddam, Abbaspour, & Karachi, 2020; Yari, Abbasizadeh, Mousavi, Moghaddam, & Moghaddam, 2015), and mosquito control (Aina, Owolo, Lateef, Aina, & Hakeem, 2019) are all examples of applications for green synthesized silver nanoparticles. The qualities of green synthesized nanoparticles, on the other hand, are influenced not only by the phytoconstituents contained in the plant, but also by the reaction conditions used during synthesis. Different plants have been accounted for the synthesis of metallic nanoparticles using plant extracts. However, there are still a large number of plant metabolites that have yet to be studied.

The main goal of this research is to produce silver nanoparticles using aqueous extracts of *Curcuma zanthorrhiza* Roxb. and *Curcuma aromatica* Salisb., as well as to evaluate its diverse catalytic, antimicrobial, antioxidant, and *in vitro* and *in vivo* anticancer properties. The toxicity of the silver nanoparticles produced have also been investigated. The phytochemicals derived from these plants could act as both reducing and stabilizing agents and assist in the formation of nanoparticles. Furthermore, the approach used for nanoparticle synthesis is rapid and environmentally friendly. To establish the synthesis of silver nanoparticles, UV-Visible spectroscopy experiment has been carried out. FTIR investigations have been carried out to ensure the nature of phytochemicals involved in the reduction and stability of nanoparticles. The crystalline nature of silver nanoparticles has been investigated using X-ray diffraction techniques. The size and shape of the nanoparticles have been studied using HR-TEM and FESEM. Energy dispersive X-ray analysis has been used to characterize the elemental properties (EDX) of nanoparticles. DLS has been used to investigate the hydrodynamic size of the synthesized silver nanoparticles, while BET analysis has been used to determine its surface area. HR-LCMS analysis of nanoparticles demonstrated the chemical nature of biomolecules capped over the AgNPs.

In the field of catalysis, promising new possibilities based on nanotechnology methods are developing. Catalyst synthesis that is efficient, size regulated, and cost effective is thus extremely important. Nanocatalysts have been found to offer novel catalytic features, such as increased reactivity and selectivity, when compared to their bulk counterparts (Das, Patra, Debnath, Ansari, & Shin, 2019). The catalytic efficiency of synthesized nanoparticles (CZAgNPs and CAAgNPs) in the degradation of ionic dyes (Malachite Green and Coomassie Brilliant Blue), by photons (sunlight and UV light irradiation) have been investigated in this study. The properties of synthesized nanoparticles were further investigated to validate their role as nanocatalyst by analyzing the degradation of azo dyes (Orange G, Methyl Orange, Eriochrome Black T, and Congo Red) using sodium borohydride as a reductant. UV-Visible spectral analysis has been used to investigate the reduction patterns of various dyes. The quantitative and qualitative analysis of the degradation products has been ascertained using HR LCMS analysis.

Metal nanoparticles have antibacterial properties that have been used to treat a number of different infections. Nanoparticles can bind to microorganisms more effectively due to their small size and large surface area. In light of the potential applications of silver nanoparticles in many biomedical domains, the antibacterial properties of synthesized CZAgNPs and CAAgNPs have been examined using the disc diffusion method and the broth microdilution assay. The antifungal properties have been investigated by the poisoned food protocol. *In silico* molecular docking experiments ratify the potential of AgNP capped biomolecules to effectively bind to the membrane proteins Diaminopimelate epimerase of gram negative bacteria, Gat D – α glutamine amidotransferase of gram positive bacteria and fungal protein 3 Isocitrate lyase of *Aspergillus niger.*

Biomedical applications of nanoparticles are becoming more widespread. However, we still don't know much about how these nanoparticles affect living cells or function as biochemical indicators. It is therefore vital to encourage research into the toxicity and biochemical parameters of silver nanoparticles. In this investigation, the antioxidant potentials of plant extracts and synthesized nanoparticles have been assessed using *in vitro* DPPH assay. The Trypan Blue Exclusion method in DLA and EAC cell lines, as well as the MTT assay in MCF -7 cell lines, have been used to assess the short-term *in vitro* cytotoxicity of plant extracts and the as synthesized silver nanoparticles. CZAgNPs have been tested *in vivo* for acute and sub-acute toxicity. Oxidative stress is one of the most important elements in the development of chronic and degenerative diseases such as ageing, cancer, and immunological suppression (Russo *et al*., 2012). Phytochemicals with antioxidant activity can be found in a variety of plants (Zhang *et al*., 2015). Plant-based antioxidants are regarded as an essential source of therapeutic agents in comparison to current medications because of their low cost, ease of availability, and lack of side effects. Antioxidants can protect the body from the oxidative damage caused by free radicals. Antioxidants function as oxygen scavengers or react with free radicals to slow down the oxidation process (Lobo, Patil, Phatak, & Chandra, 2010). The protective impact of green synthesized silver nanoparticles on Swiss albino mice intoxicated with sodium fluoride has been examined using an *in vivo* antioxidant assay. Cancer continues to be a major public health concern in both developed and developing countries. The potential of CZAgNPs in inhibiting the rapid growth and proliferation of both DLA and EAC tumor models has been investigated in this study. To further substantiate the cytotoxic properties of the synthesized silver nanoparticles, *in silico* molecular docking investigations has been conducted.

The utilization of rhizome extracts of *C. zanthorrhiza* and *C. aromatica* to synthesize silver nanoparticles, which is a cheap, renewable, and conveniently available resource, is unique in this study. The findings reveal that the silver nanoparticles synthesized are an appropriate nanocatalyst with promising activity and stability. Furthermore, the antimicrobial, antioxidant, and antiangiogenic activities of the as synthesized silver nanoparticles alluded their chemotherapeutic potential in the field of nanomedicine.