A REVIEW ON GREEN SYNTHESIS OF NANOPARTICLES USING MEDICINAL PLANTS FROM GHANA

MAJOR PROJECT REPORT

TO BE SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF TECHNOLOGY

IN

INDUSTRIAL BIOTECHNOLOGY

SUBMITTED BY

ERIC BINEY

(2K20/IBT/13)

Delhi Technological University, India

Under the supervision of

Dr. Prakash Chandra

Assistant Professor

DEPARTMENT OF BIOTECHNOLOGY

DELHI TECHNOLOGICAL UNIVERSITY, DELHI

(FORMERLY DELHI COLLEGE OF ENGINEERING)

BAWANA ROAD, NEW DELHI-110042

JUNE, 2022

DECLARATION

I, Eric Biney, Roll Number: 2K20/IBT/13. Student of M.Tech (Department of Biotechnology), hereby declare that the project Dissertation title "**A review on green synthesis of nanoparticles using medicinal plants from Ghana**" which is submitted by me to the Department of Biotechnology, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of degree of Master of Technology, is original and not copied from any source without proper citation. This work has previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Eric Biney

Roll Number: 2K20/IBT/13 Date: Jun, 2022

Department of Biotechnology Place: Delhi

Delhi technological University

Department of Biotechnology Delhi Technological University

CERTIFICATE

I hereby certify that the Project Dissertation titled "**A review on green synthesis of nanoparticles using medicinal plants from Ghana**" which is submitted by **Eric Biney, Roll No: 2K20/IBT/13**. Department of Biotechnology, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Dr Prakash Chandra
Supervisor
Assistant Professor
Department of Biotechnology
Delhi Technological University

Dr Pravir Kumar
Head of Department
Delhi Technological University

ACKNOWLEDGEMENT

I wish to communicate my profound feeling of appreciation and obligation to ***Dr Prakash Chandra****,* ***Assistant Professor, Department of Biotechnology, Delhi Technological University, Delhi****; for presenting the present point and for his moving direction, the productive and significant idea all throughout this work.*

I'm generously grateful for his direction and backing during my undertaking. His capable information also, master oversight with unswerving persistence fathered my work at each stage, for without his warm love and support, the satisfaction of the assignment would have been very troublesome.

I wish to thank ***Dr Pravir Kumar, Professor, and Head of the Department of Biotechnology, Delhi Technological University*** *for his constant motivation and providing able guidance.*

I might likewise want to broaden my sincere appreciation towards every one of the individuals from the ***Department of Biotechnology, Delhi Technological University, Delhi,*** *for unwarrantedly helping me in the fruitful consummation of the venture.*

Finally, am grateful to ***Indian Council for Cultural Relation (ICCR) under the government of India****, for the support throughout this studies*

I'm truly energetic about the entirety of my companions for their ideas and moral help during my visit in India.

Eric Biney

Roll No: 2K20/IBT/13
Department of Biotechnology
Delhi Technological University

A REVIEW ON GREEN SYNTHESIS OF NANOPARTICLES USING MEDICINAL PLANTS FROM GHANA

ABSTRACT

The use of nanoparticles (NPs), particularly those containing silver, gold, cobalt, and zinc, as antimicrobial, anticancer, drug delivery, contrast, and bio imaging specialists has transformed the medical field. Their abilities, which are attributed to their physicochemical properties, have gained prominence in a variety of innovative fields. Despite the fact that NPs can be delivered via extensive physical and synth*et*ic m*et*hods, an organic m*et*hodology using common materials has recently been developed. With the growing interest in safe and effective nanomaterials, the organic approach combining microorganisms and plants is preferred over physical and substance techniques for nanoparticle union. Plants certainly stand out among these bio-elements, as evidenced by their ability to reduce and s*et*tle NPs in a single one-pot convention. Ghana is home to 5% of West African plant species, making it an important supporter of the global environmental landscape. Despite the reported commitment of Ghana plants, particularly in home grown medication, not many of these plants have been investigated for the honorable metallic nanoparticles union. This study gives an outline of a couple of critical Ghanaian restorative plants that have been utilized in the combination of m*et*allic nanoparticles. The improved organic properties of biogenic m*et*allic nanoparticles validate their use in medicine. In this project, a larger portion of Ghana's plant biodiversity should be investigated for the presence of m*et*allic nanoparticles and approved for their potential to be converted into future Nano medicine.

LIST OF TABLES

LIST OF FIGURES

Table of Contents

CHAPTER 1

1.0 INTRODUCTION

Scientist have long been attracted by NPs (which has a size scope of 1 to 100 nm) and they are now utilized in an assortment of disciplines' including medicine, agriculture and engineering(Rajeswari*et* al, 2018; Yin *et* al, 2022). Nanomaterial's' vast range of practical applications can be attributed to its nonlinear optical device, catalytic, electric, biomedical science, chemical industries and space industrial properties(Iqbal *et* al., 2021; Jadoun *et* al., 2021). A researcher by name Ahamad *et* al., (2021); Mansuriya & Altintas*et* al, (2021); Nangare & Patil, (2020)mentioned that physical qualities, drug-gene delivery, optoelectronic devices, photo electrochemical application, and drug-gene delivery. Mechanics, optics, biological science, and chemical engineering are only a few examples, According to a survey conducted by the National Cancer Institute (NCI) in the United State of America (USA), natural products research inspired 61% of the 887 small molecule novel chemical entities approved as medications worldwide b*et*ween 1981 and 2002.A range of both tangible and chemical techniques can be applied to synthesis NPs with desired properties(Naveed Ul Haq *et* al., 2017; Prabhu & Poulose, 2012). These approaches atthe other hand, are complex, costly, time consuming, and possible harmful in relation to the environment and living organisms(Kishor *et* al., 2021; Thakare *et* al., 2021). The need to lessen the possibility of negative consequences of nanomaterial's generated via physical and chemical means pathways have promoted researchers to look towards biological entities(Schneider *et* al., 2022). Microorganisms and plants' ability to convert metal ions into NPs revealed a simple, quick, cost effective and environmentally acceptable method for nanoparticles synthesis(Irshad *et* al., 2021; Waris *et* al., 2021). Metallic salts can be reduced to nanoparticles by microorganism like microbes, fungus and yeast (NPs)(Ibisanmi et al., 2022; Nadeem *et* al., 2022). These microorganisms produce proteins, chemicals, diminishing cofactors, peptides, and natural mixtures that are significant in the decrease of metallic salts into NPs.(Aboyewa *et* al., 2021a). These mixtures have a varieties bacterial for instance,*Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Candida albicans* have been utilized in the assembling of NPs(Al-Shabib *et* al., 2020; Celebi *et* al., 2020; Simbine *et* al., 2019; A. Singh *et* al., 2020). Plants are by a wide margin the most essential natural parts for NPs synthesis, because of their broad overflow and absence of pathogenicity, which

gives them a benefit over other organic sources(Castronovo *et* al., 2021). Plant mediated synthesis is mild, environmentally friendly, cost effective, and time efficient, with natural antioxidants and bioactive substances functioning as lessening, covering and stabilising agent (Gebresilassie & Engida, 2021; Iqbal *et* al., 2021). With the concern, natural resources are protected, while chances for sustainable growth are created(Zhang *et* al., 2021). Several research have demonstrated that various plant species can be applied to successful synthesis biogenic NPs (Soni *et* al., 2021). In comparison to their bulk counterparts, the NPs demonstrates dramatically different properties, in addition better bioactive (Mahana *et* al., 2021; Rafeeq *et* al., 2022). Despites growing knowledge of plant mediated NPs and reports of prospective advantages, this field of study is till underdeveloped (Chandrasekaran *et* al., 2019; Cunningham *et* al., 2018; Patra *et* al., 2018). In reality , over 67% of the total populaceof the world uses herbs and restorative plants to treat an assortment of illnesses, including diabetes, hypertension, malignant growth, and tuberculosis (Kakudidi *et* al., 2016; Perme *et* al., 2013). As stated by Ahmed *et* al., 2021; Balunas et al., 2005; Dowlath *et* al., (2021). Plants are answerable for roughly 60% of all synthetic medications utilised in clinical trials, emphasising the importance of restorative plants. In Ghana, is estimated that traditional healers utilising medicinal plants offer over 70% of healthcare (Danquah *et* al., 2021; Dorothy *et* al., 2022; Kwame, 2021). Ghana is abode of 5% of West African tree species, including 3000 plants having important therapeutic properties(Okigbo & Frances, 2021; Sah *et* al., 2021). Despite this richness and anticipated benefits of plant interceded NPs, Ghana therapeutic plants are still general underutilised for NPs synthesis (Danquah *et* al., 2021). Plant locally to Ghana recently been discovered, including;*Parkia biglobosa*,*Azadirachta indica*,*Mormodica* Charantia, *Ocimum Gratissimum*, *Solanum Torvum*, *Papaya*Leaves, *Alchornea cordifolia*,*Trichilia monadelpha, Adansonia digitata* and *Mangifera indica* NPs were made using these materials. When looked at to their respective plant extracts, these types of nanoparticles with diameters ranging from 5-50 nm were revealed to have strong antibacterial activity.Given the huge capability of plants as elective wellsprings of lessening specialists with upgraded bioactivities, on-going studies into Ghana's restorative plant stores will be critical. The following article gives a quick description of some powerful Ghanaian medicinal herbs that can be utilized to make nanoparticles. With this revision, intensive examination may be coordinated towards Ghanaian plants in order to generate

normal and successful nano items that would change a wide scope of innovations and ventures, including drugs, food beauty care products, development, medication, designing, and numerous others.

1.1 The application of Nanoparticles

Nano medicineis a branch of science concerned with the creation, modification, modulation, and implementation of materials on the Nano scale (1-100 nm)(Modi *et* al., 2022; Nayak *et* al., 2021; Verma, 2021). In view of their uniquephysiochemical, optical, magnetic, and biological features, NPs have drawn a large amount of consideration in earlier decades(Passos & Saraiva, 2018). Bulk materials lack their qualities, which are mostly dictated by their huge surface region to volume proportion and size. In view of this, these special qualities are being investigated for use in their ecological, water, food, biochemical, and space enterprises (Passos & Saraiva, 2018; Wagner *et* al., 2014). NPs, especially those made of honourable metals like silver and gold, NPs have been widely considered in an assortment of biomedical areas (Ding *et* al., 2020; Mahato *et* al., 2019; Su *et* al., 2019).Tissue designing, medical services, medication conveyance, and quality conveyance are only a couple of models (Elkhoury *et* al., 2019; Fernandes *et* al., 2018; Mohajeri, 2018; Ryu *et* al., 2021). This section will provide a high level outline of the topic ofGhanaian medical plants used the application of nanoparticles.

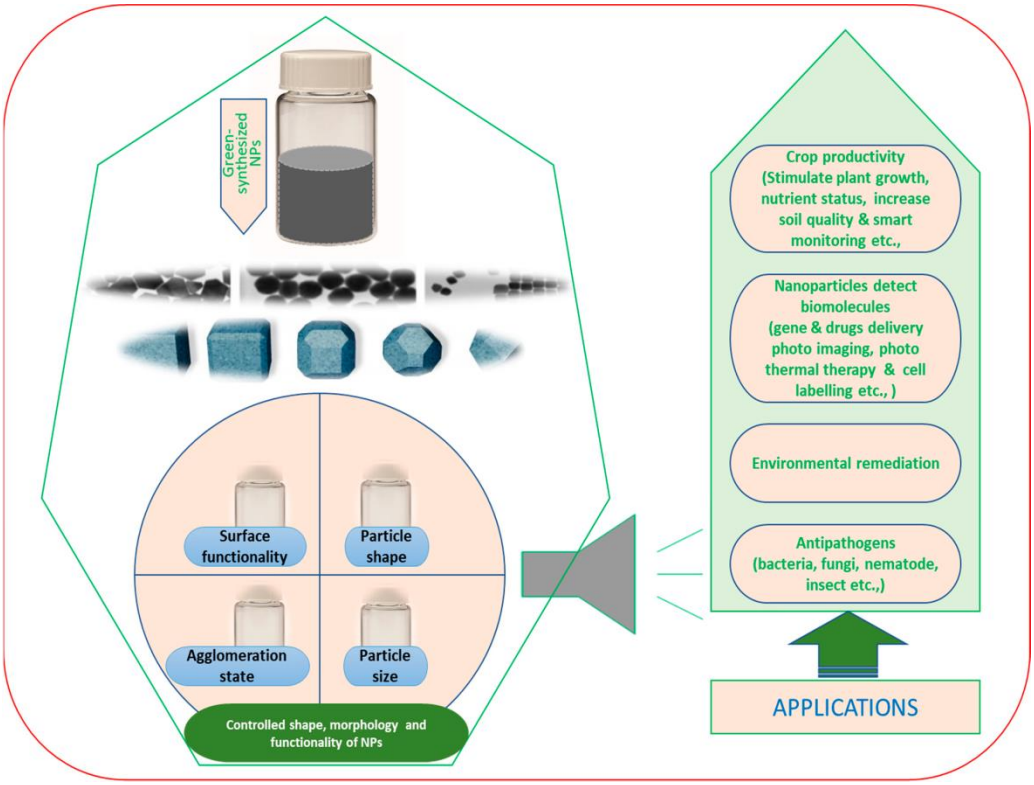


Figure 1*: An overview diagram shows synthesized nanoparticles (NPs) produced via the green route for various biological applications. The different sizes, shapes and surface bio-functionalized NPs are developed in a controlled way for the target application. Adapted from* (Khan *et* al., 2022)

1.2 Silver Nanoparticles (AgNPS)

On account of their remarkable physical, synthetic, and organic properties, AgNPs have piqued researchers' curiosity (Jabbar *et* al., 2021; Shukur, 2021). Their integral features have been thoroughly investigated for pragmatic and clinical purposes, especially as helpful and demonstrative specialists (Dadfar *et* al., 2019; Ondua *et* al., 2019; Tyavambiza, Elbagory, *et* al., 2021; Yang *et* al., 2020). AgNPs offer interesting antibacterial exercises against a broadly range of microorganisms, according to previous and new research Abdellatif *et* al., (2021) and as directed by Asadi *et* al., (2021), antibacterial agents, AgNPs are employed in water sanitization and wound dressing. It has likewise been expressed that they make in the creation of paints, disinfections and various kitchen appliance (Asare-Donkor *et* al., 2019). AgNPs have additionally been displayed to have remedial ramifications with regards to antiviral, antifungal, anticancer, and antibacterial exercises (Chakravarty & Vora,

2021). AgNPs are being utilized in the drug and restorative businesses as antimicrobial specialists, in addition to medical implants and bone cement to guard against infection(Chakravarty & Vora, 2021; Spirescu *et* al., 2021).

Figure 2*: Synthesis of AgNPs through Green synthesis method Adopted by (Jain et al*., 2021)

1.3 Gold Nanoparticles (AuNPs)

The optical and compound elements of AuNPs ,then again, have provoked scientists' curiousity in late many years (Saarnio, 2021). It has been established that they can be utilized as indicative and helpful specialists in a scope of clinical areas (Banat *et* al., 2006; Mahomoodally, 2013; Modi *et* al., 2022). AuNPs are utilized as medication transporters, and against angiogenic specialists, bio imaging specialists, contrast specialists, photothermal specialists, and medication conveyance specialist. Antibacterial movement of AuNPs was inspected, and it was discovered that they were productive against both gram-positive and gram-negative bacterial strains (Govindaraju & Yun, 2018; Y. Kumari *et* al., 2019). AuNPs can move and convey hydrophobic and hydrophilic prescriptions, peptides, antibodies, and atoms drug to the growth area while in no way hurting to typical or contiguous tissues (Dreaden *et* al., 2012; Mitchell *et* al., 2021; X. Yu *et* al., 2016). Furthermore, AuNPs provides a platform for various moi*et*ies to be attached to their surfaces, making them useful as drug delivery agents(Amina & Guo, 2020; Siddique & Chow, 2020). To improve anticancer effects, AuNPs can be imbued with therapeutic molecules(Brown *et* al., 2010; Anil Kumar *et* al., 2012). There have been reports of procedures including attaching specific peptides to receptors that are only expressed by sick cell (Agoglia *et* al., 2020; Cao *et* al., 2021). On pancreatic (Panc-1) and colon (Caco) cancer cells, AuNPs-conjugates were found to enormously work on the selectivity of helpful prptides (Onani *et* al., 2017; Wang *et* al., 2019). Biosynthesized AuPNs have been

shown in prior and contemporary research to have huge focusing on and selectivity against an assortment of disease cells without the need of any additional mixtures (Wang *et* al., 2019).

1.4 Metal Oxide Nanoparticles

In physical science and material science designing, endlessly copper (II) oxide NPs have a wide scope of utilizations (Probe *et* al., 2020; Shashanka *et* al., 2019). They're powerful antimicrobials with outstanding disinfectant capabilities against a diversity of pathogenic pathogens (Artasensi *et* al., 2021; Yaragalla *et* al., 2021). Iron oxide nanoparticles have been used in an assortment of natural applications, including quality treatment, undifferentiated organisms, disease and atherosclerosis(Friedrich *et* al., 2021; Hernández *et* al., 2020). Anticancer, antifungal, antibacterial and designated drug conveyance specialists have all been produced using these nanoparticles(Eid & Hawash, 2021; Hussein & Abdullah, 2021). Antimicrobial and anticancer properties of zinc oxide nanoparticles (ZnO NPs) are deep rooted (Amuthavalli *et* al., 2021; Zolfaghari & Noghabi, 2022). Food bundling, wastewater treatment, and some private consideration merchandise have all profited from them (Cetkovi´ *et* al., 2022; Nikiema & Asiedu, 2022). To forestall and restrict the development of microbes on food items, ZnO NPs were used as additives in food bundling (Dey *et* al., 2022; Oladzadabbasabadi *et* al., 2022). Furthermore, Onyszko *et* al., (2022); Perera *et* al., (2022). Also compared to other m*et*als oxide NPs, ZnO NPs have a higher toxicity towards bacteria.

1.5 Synthesis of Metallic Nanoparticles

Because of the proceeded with utilization of NPs, Kanti *et* al., (2021); Mehta & Macgillivray, (2022).They likewise give a record of an assortment of current applications; the procedure for producing them must be safe in other to gain greater control of desired physicochemical and bio-useful properties. For their amalgamation, an assortment of approaches and variations have been investigated(Mustapha *et* al., 2022). NPs have been used and adjusted throughout the years to empower their use in an assortment of disciplines, including farming and clinical(S. Singh *et* al., 2022). Hierarchical and base up systems have been created for the blend of NPs, the hierarchical technique decreases mass material important to

NPs, though the base up strategy collects more modest material into the fundamental nanostructure(Kanti *et* al., 2021; Mehta & Macgillivray, 2022; Onyszko *et* al., 2022; Perera *et* al., 2022). As presented in figure 1, these strategies are further divided into physical, substance, and organic NP production m*e*thods. Physical approaches mostly use a top-down approach, in which bulk materials are broken down pieces by pieces to produce fine split NPs (Jadhav *et* al., 2021; Patra & Baek, 2014). Mechanical strain, electrical and radiation energy, softening, vanishing and buildup techniques are utilized in the actual strategies to produces NPs. Fume buildup, spray, laser removal, pyrolytic, high-energy ball processing, laser pyrolysis, latent gas buildup and mechanical squashing processes are a couple of models (Hassan *et* al., 2015; Jadhav *et* al., 2021; Patra & Baek, 2014; Zeb *et* al., 2021). Natural and inorganic synth*e*tic substances, for example, sodium citrate, essential hydrogen, sodium borohydride, hydrazine, dim*e*thylformamide, and ascorbate are utilized as decreasing specialists in the compound strategies for the combination of NPs (Dawadi *et* al., 2021). Substance cycles, for example, sol-gel, aqueous, synth*e*tic fume testimony, microemulsion, and polyol are regularly used (Shafiee *et* al., 2021).

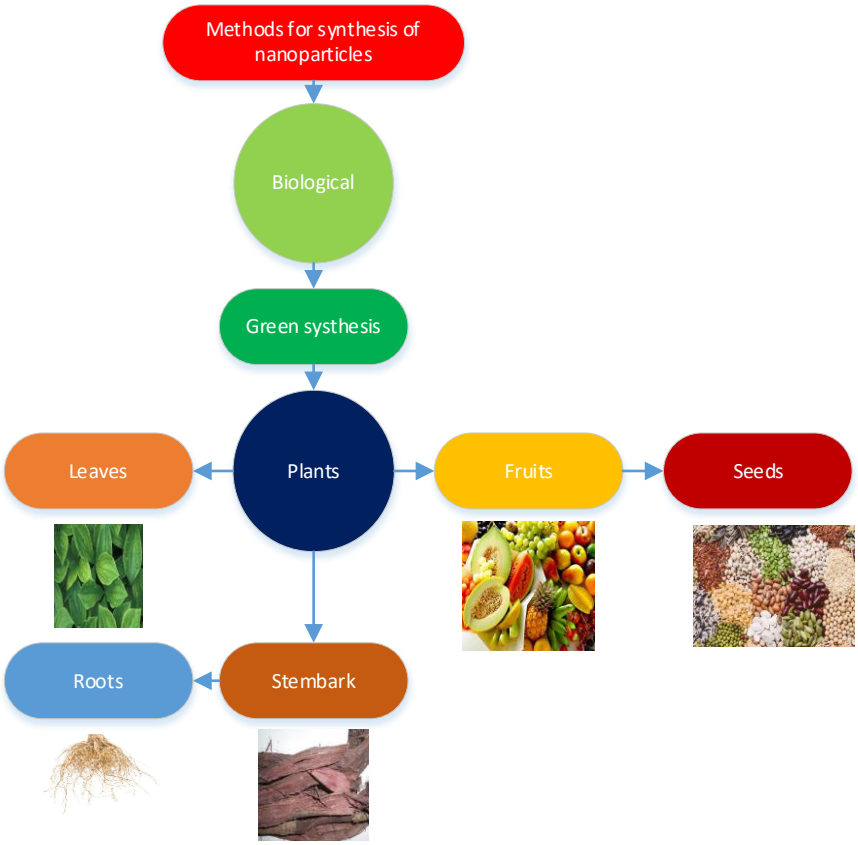


Figure 3: *Flow chart diagram of different approach and methods for synthesizing nanoparticles*

1.6 Problem statement and justification

Nanotechnology has become a critical need in the modern era, and green nanoparticle synthesis has several advantages over other methods. Nano biotechnology is a developing field that contributes too many aspects of human life, such as the development of nanoscale drug systems or Nano medicine for disease diagnosis and treatment. Drug candidates, lead compounds, and drugs are primarily derived from medicinal plants. This study describes the environmental synthesis of various nanoparticles (NPs) using an aqueous bark, leaf, stem root and seeds extract of medicinal plant. Because of the toxicity and cost taking part in the use of nanoparticle synthesis methods of physical and chemical nature, scientists have begun to employ biological techniques. As a result, the current study used an eco-friendly method by extracting medicinal plant leaves, stems, bark, and seeds as a reducing and stabilising agent. Despite recent advances, there is scarcity of effective treatments for aging-related diseases. Nano medicine can be used to target ageing pathways. According to research, the ageing process is associated with increased oxidative stress and related systemic inflammation. The utilization of therapeutic plants for mending traces all the way back from the start of time (Bussmann *et al*., 2006). The connection among man and his quest for drugs in nature traces all the way back to antiquated times, as proven by composed archives, protected landmarks, and, surprisingly, unique plant medicine (Chaachouay *et al*., 2022; Dafni *et al*., 2021).Current science has perceived their dynamic activity, and it has remembered for present day pharmacotherapy an assortment of plant-based drugs known to old human advancements and utilized for centuries (Cahill & McNickle, 2011). Customary medication is as often as possible the main open and reasonable treatment accessible in agricultural nations (Luyckx *et al*., 2021). Customary medication is utilized as the essential medical services framework by up to 80% of the African populace. Plant-inferred compounds have been and keep on being a significant wellspring of mixtures for drugs (Banerjee *et al*., 2021). Customary medication is characterized by the WHO as "the aggregate of data, capacities, and practices in view of speculations, convictions, and encounters native to various soci*et*ies, wh*et*her reasonable/not, utilized in the upkeep of wellbeing as well as the counteraction, analysis, improvement, or treatment of physical and mental sickness"(Lowe *et al*.,

2021). Therapeutic items decide the possibilities for drug creation, zeroed on plant substances. The presentation exploration of restorative, swe*et*-smelling, endemic and taking everything into account, significant plants is the main variable that permits you to utilize the most extravagant plant ass*et*s of our country with greatest effectiveness (Ketan & Dhatariya, 2004; Veeresham, 2012). It has been established by hundreds of years of clinical practice that phyto preparations in order to treat various sicknesses are not second rate compared to manufactured analogs regarding productivity, and outperform them without any secondary effects, less harmfulness and gentle activity (Povydysh *et al*., 2021). The most widely recognized method of concentrating on the presentation of restorative and fragrant plants utilizing current examination strategies opens up wide possibilities for the turn of events and creation in Africa of current and compelling therapeutic arrangements from natural therapeutic unrefined substances, furnished with a solid home grown unrefined substance base (Choudhury *et al*., 2021).From here onward, indefinitely quite a while, the development of presented plants has been broadly utilized in different enterprises, which extend the foundation of territorial plant ass*et*s. Herbs have been used in the treatment of diseases and the revitalization of body systems in Africans, Egyptian, Chinese, Greek, and Roman civilizations (Gurkov & Morley, 2021; Probst *et al*., 2021). Plants have enormous potential for use as medicinal plants. In Traditional medicinal plant widely used by people from all walks of life, both directly as folk medicines in various indigenous systems of medicine such as Vedic literature, herbal, and allopathic, and indirectly in pharmaceutical preparations (Romano *et al*., 2021; J. Yu *et al*., 2021). Africa is home to approximately 2.5 million plant species, with thousands of them claiming medicinal properties against human diseases (Barros-Rodríguez *et al*., 2021). Although traditional healers have used medicinal plants to treat ailments for hundreds of years, there has always been debate in scientific circles about their therapeutic efficacy. (Adeleye *et al*., 2021). As a result, the pharmacological activity of many research has studies medicinal plants, despite the fact that the overwhelming majority of medicinal plants have y*et* to be investigated for phytochemical content constituents and pharmacological effects (M. K. Hasan *et al*., 2021; Khazaei *et al*., 2021).

1.7 RESEARCH QUESTION

The research work pursue to answer the following question

1. What are the profile of the major phytochemical, metallic nanoparticles, nanoparticles size and nanoparticle bioactivity in medicinal plant?
2. What are the synthesis procedure of medicinal plant using nanotechnology?
3 What are some therapeutic plant in Ghana

1.8 RESEARCH OBJECTIVES

The main research objective is assessing the nanoparticle reducing potential of medicinal plant in Ghana

Specific Objective

1. To identify the profile of the major phytochemical, metallic nanoparticles, nanoparticles size and nanoparticle bioactivity in medicinal plant.
2. Synthesis procedure of medicinal using nanotechnology
3. Determine the natural utilization of some therapeutic plant in Ghana

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Literature review of Medicinal plant in Africa

The utilization of therapeutic plants for mending traces all the way back to the beginning of time (Bussmann & Sharon, 2006). The connection among man and his quest for drugs in nature traces all the way back to antiquated times, as proven by composed archives, protected landmarks, and, surprisingly, unique plant medicine (Chaachouay *et* al., 2022; Dafni *et* al., 2021).Current science has perceived their dynamic activity, and it has remembered for present day pharmacotherapy an assortment of plant-based drugs known to old human advancements and utilized for centuries(Cahill & McNickle, 2011). Customary medication is as often as possible the main open and reasonable treatment accessible in agricultural nations (Luyckx *et* al., 2021). Customary medication is utilized as the essential medical services framework by up to 80% of the African populace. Plant-inferred compounds have been and keep on being a significant wellspring of mixtures for drugs(Banerjee *et* al., 2021). Customary medication is characterized by the World Health Organization (WHO) as "the aggregate of information, abilities, and practices in view of speculations, convictions, and encounters native to various societies, whether reasonable/not, utilized in the upkeep of wellbeing as well as the counteraction, analysis, improvement, or treatment of physical and psychological sickness"(Lowe *et* al., 2021). Therapeutic items decides the possibilities for drug creation, zeroed on plant substances. The presentation exploration of restorative, sweet-smelling, endemic and for all intents and purposes significant plants is the main variable that permits you to utilize the most extravagant plant assets of our country with greatest effectiveness (Ketan & Dhatariya, 2004; Veeresham, 2012). It has been shown by hundreds of years of clinical practice that phytopreparations for the treatment of various sicknesses are not second rate compared to manufactured analogs regarding productivity, and outperform them without any secondary effects, less harmfulness and gentle activity (Povydysh *et* al., 2021). The most widely recognized method of concentrating on the presentation of restorative and fragrant plants utilizing current examination strategies opens up wide possibilities for the turn of events and creation in Africa of current and compelling therapeutic arrangements from natural therapeutic unrefined substances, furnished with a solid home grown unrefined substance base(Choudhury *et* al., 2021).From here onward, indefinitely quite a while,

the development of presented plants has been broadly utilized in different enterprises, which extend the foundation of territorial plant ass*et*s. Herbs have been used in the treatment of diseases and the revitalization of body systems in Africans, Egyptian, Chinese, Greek, and Roman civilizations (Gurkov & Morley, 2021; Probst *et* al., 2021). Plants have enormous potential for use as medicinal plants. In African, medicinal plants are widely used by people from all walks of life, both directly as folk medicines in various indigenous systems of medicine such as Vedic literature, herbal, and allopathic, and indirectly in pharmaceutical preparations(Romano *et* al., 2021; J. Yu *et* al., 2021). Africa has approximately 2.5 million plant species, and thousands of them have been claimed to have medicinal properties against human diseases(Barros-Rodríguez *et* al., 2021). Although traditional healers have used medicinal plants for hundreds of years to treat ailments, there has always been a question in scientific circles about their therapeutic efficacy(Adeleye *et* al., 2021). As a result, the pharmacological action of numerous restorative plants has been considered, despite the fact that by far most of restorative plants have yetto be investigated for phytochemical constituents and pharmacological effects(M. K. Hasan *et* al., 2021; Khazaei *et* al., 2021).

2.2 Plants with antimicrobial activities

The use of plant extracts and phytochemicals, both of which have antimicrobial properties, is extremely important in therapeutic treatments(Ishaque *et* al., 2021; Kebede *et* al., 2021). Plant removes were utilized to treat different sicknesses, and this is the foundation of all African medical systems(More *et* al., 2021). However, when contrasted with the advanced medical system, this area is not as developed, owing to a lack of scientific documentation in this field(Narchin *et* al., 2018; Newaz *et* al., 2021).The majority of a medicinal plant's pharmacological activity is found in its auxiliary metabolites, which are smaller molecules than the primary molecules such as proteins, sugars, and lipids (Alq*et*hami & Aldhebiani, 2021; Hashim *et* al., 2021). These regular items give pieces of information for the development of new underlying sorts of antimicrobial and antifungal chemicals that are relatively safe for humans(Alq*et*hami *et* al., 2021; M. Ishaque *et* al., 2021).

2.3 Plant with Antioxidant Potentials

Natural antioxidants and their association with health benefits have gotten a great deal of consideration lately(Chang *et* al., 2021). Plants are expected sources of natural antioxidants, and they produce a vari*et*y of antioxidative compounds with therapeutic potential(Gutiérrez-Del-río *et* al., 2021; Mejía-Giraldo *et* al., 2022). Cancer prevention agent based drug definitions are utilized to prevent and treat a broad range of complex diseases(Liu *et* al., 2022).*Parkia biglobosa* and*Papaya* Leaves extricates were found to have DPPH rummaging action in watery, m*et*hanol, and *et*hanol removes(Badu *et* al., 2012).The alcohol–water extract of *Trichilia monadelpha* leaves exhibited radical scavenging activity for 1, 1-diphenyl-2-picrylhydrazyl radical and superoxide anion radical(Pizon *et* al., 2018).

CHAPTER THREE

3.0 MATERIALS AND METHODS APPLIED IN NANOSYNTHESIS

3.1 Some procedure applied in Nano synthesis by other literature

New and solid pieces of different plants were taken from various territories of Ghana. The plants were washed completely first with faucet water followed by refined water to eliminate every one of the peripherals and undesirable apparent particles, and dried at room temperature. Around 20g of the different parts of the plants was moved into 250ml Erlenmeyer flagons containing 250ml refined water and bubbled for around 25 min. the concentrate was then sifted two times through Whatman channel paper to eliminate particulate matter and to g*et* clear arrangement which was then refrigerated at 4 degree Celsius for additional investigations (Onochie *et* al., 2020; Tashi *et* al., 2016). In every single step sterility conditions were kept up with for the viability and exactness of the outcomes**.**

3.2 Silver nanoparticles synthesis

Fluid arrangement (1mM) of silver nitrate was ready in 250ml Erlenmeyer cups and leaf concentrate of changing focus going from 1-3ml was added for decrease into Ag+ particles. The responses were done in obscurity (to stay away from photograph enactment of AgNO3) at room temperature. The vari*et*y change of the blend from faint light to yellowish brown to ruddy brown to colloidal brown was observed intermittently at a time period minutes. Compl*et*e decrease to Ag+ particles was affirmed by the adjustment of vari*et*y from dull to dim grayish brown. The arrangement of silver nanoparticles was besides affirmed by spectrophotom*et*ric (Aritonang *et* al., 2019)

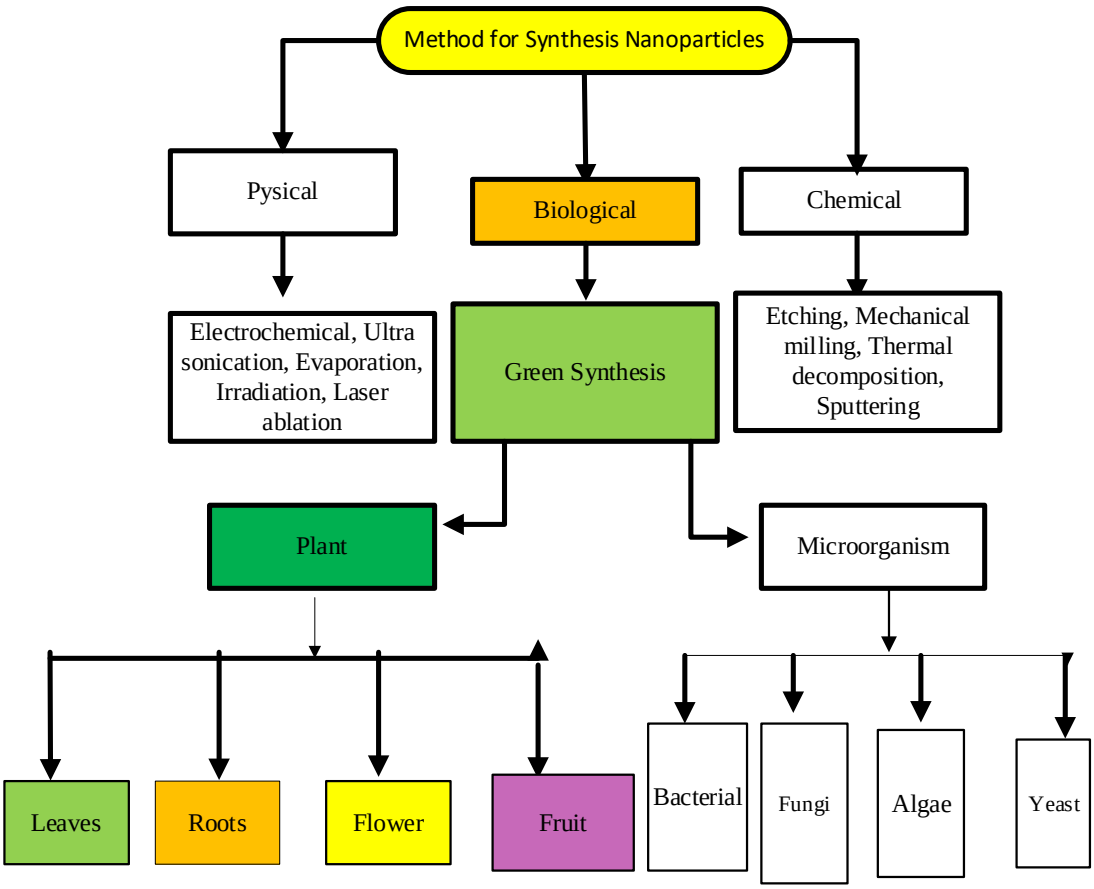
3.3 UV-Vis Spectra analysis

Tests (100ul) of the suspension were gathered to screen the finishing of bio reduction of Ag+ in fluid arrangement followed by weakening of the examples with 1ml deionised water and ensuing sweep in UV-Vis spectra, b*et*ween 350-550nm in a spectrophotom*et*er(Parkin Elmer, Lambda 900)

3.4 FTIR Spectroscopic analysis

FTIR spectroscopic examinations were done to explore to conceivable bio-lessening specialists present in the concentrate. The spectra of concentrates were recorded when adding silver nitrate.

Flow chart of proposed methodology for Synthesis of Nanoparticles



3.5 Nanotechnology for the Environment

Nanotechnology for environment is an interesting and rapidly developing field of science and innovation that incorporates green chemistry and principles and has the possibility to help human sustainability, protection, and general saf*et*y (Gurtu & Sharma, 2021; Soltys *et* al., 2021).To diminish threats to human wellbeing and climate, the green science philosophy presents a positive way to manage the amalgamation, handling, and utilize less risky synth*et*ic substances (Kurniawan *et* al., 2021; Sabatini *et* al., 2019; Sheldon, 2018). The method necessitates a thorough comprehension of the basic materials, into particularly as far as their transformation nanomaterials, and ensuring bioactivities there are safe for humans and other environment (Duta *et* al., 2021; Islam *et* al., 2021).On the perspective, nanoparticles can be created from natural resources with the certain of minimising potential dangers(Amiri *et* al., 2021; J. Liu *et* al., 2022).Biological entities are progressively being utilized as reducing, capping, and stabilizing agent in the union of NPs(Hamouda *et* al., 2019).Microorganisms and plant products are used a lessening specialistin this m*et*hodology (Mohammadi *et* al., 2022), presenting healthy and environmental friendly for human and animal (Mohammadi *et* al., 2022).Microorganisms, for example, bacterial, parasites, green growth, and infections are progressively being read up as lessening specialist for NP union by normal item scientists(Tilahun Bekele *et* al., 2021).Microorganisms use catalysts created by their cellular m*et*abolism to convert m*et*allic particles to their equivalent nanoparticles are in two directions or categories, the intracellular process, in which m*et*als particles are caught and diminished inside the microorganism, extracellular course, in which particles are diminished on the external layer of the microbial cell or in the medium (Ali *et* al., 2020; Ovais *et* al., 2018). Due to their capacity to discharge immense measure of chemicals and their capacity to get through m*et*al poisonousness to a more prominent level, organisms, at some point known as bionano processing plants have purportedly been used to diminish gold particles to AuNPs (Das *et* al., 2017). Yeast like C.albicans amd algae like Sargassum wightii have been utilized to effectively union stable AuNPs, making them appealing contender for nanoparticles creation(Chaudhary *et* al., 2020; Rahman *et* al., 2019). Bacterial are potentially promising bio-plants for nanoparticle creation because they can survive weighty m*et*al harmfulness stress (Tripathi *et* al., 2018). In another investigation,

K.pneumoniae, E. coli, and Enterobacte cloacae culture supernatants were utilised as decreasing specialists for the fast production of AgNPs(Monowar *et* al., 2021). NPs have undoubtedly been endowed with antibacterial as well as anticancercapibilities by microorganisms (Liang *et* al., 2019). Apparently, the complex experimental procedures for disengagement, culture readiness, and upkeep have put this strategies to the test (Sant *et* al., 2021).This and other constraints have boosted NP synthesis from plant sources (Madkour, 2017).Subsequently, plant-interceded union is gaining traction, providing a faster and more controllable alternative to green and microbial sources(Aken & Doty, 2009;Madkour, 2017). Plants' ability to bioaccumulate heavy m*et*al suggests that theyhave been used to the conversion of metal particles to NPs(Sun *et* al., 2021). Alfalfa sprounts were reputedly of m*et*al particles containing m*et*al particles in to utilized the producton of AuNPs(Espinosa *et* al., 2020). Following that, many plant species as well as an assortment of bioactive substances,such as gold, silver, zinc, iron, copper, and platinum, have been researched for the making of NPs. NPs are decreased and the s*et*tled in plants by an assortment of substances like proteins, amino acids, polysaccharides, and phytochemicals which incorporates flavonoids, alkaloids, tannin, and polyphenols(Ahmad *et* al., 2019; Thakkar *et* al., 2010). Union and cleansing are quicker and simpler with the plant-inferred m*et*hods than with the microbial-interceded approach (Ahmad *et* al., 2019; Dao *et* al., 2020).

3.6 The Synthesis of Plant Mediated Nanoparticles

The idea that plant can bio accumulate and decreases m*et*al particles has opened up the chance of utilizing them as an elective m*et*hodology for the making of MNPs(Ng'uni *et* al., 2018). Plant mediated union of NPs blend has advantages over microbes mediated approach in synthesis in wording of simplicity, cost-effectiveness, speed, and non-pathogenicity(Sabu *et* al., 2019).Several plant in Ghana have been accounted for to employed in theproductionof MNPs, for example*Zingiber officinale*, *Acalypha indica*, *Ficus benghalensis*, *Galenia Africana*, and *Terminalia mantaly*(Aboyewa *et* al., 2021b; Das *et* al., 2017). Separate from the plant parts, for example, leaves, blossoms, roots, stem, bark and natural products are added to a watery arrangement of metal to begin the combination cycle(Bao *et* al., 2021). Sugar, flavonoids, protein, catalyst, polymer, and natural corrosive are on the whole

phytochemicals found in plant remove that go about as diminishing and s*ett*ling specialists (Aarthye & Sureshkumar, 2021; Shafey, 2020)Bio decrease process includes alkaloids, polyphenols, terpenoids, polysaccharides, amino acids, natural acids, and h*et*erocyclic mixtures (Chougle *et* al., 2021; Santos-aberturas & Vior, 2022), and then again, assume a significant part in the covering and solidness of biosynthesized NPs. The particular interaction and plant parts associated with plant intervened manufactured NPs are at this point unclear (Tadele *et* al., 2021; Tsekhmistrenko *et* al., 2021) . proposed number of possible processes have been presented (Philip, 2010) as presented in Figure 2. Bioreduction stage happen during NP blend, in which bioactive synth*et*ic compounds found in plant extricates convert m*et*als particles/salts from monovalent to divalent oxidation state to zero valent levels (Chakraborty *et* al., 2022; Malik *et* al., 2014; Sudrip*et* Sharma *et* al., 2020). After was, the nucleation of the reduced atoms occurs, as evidenced by physical observation of colour difference in the reaction media (Gao *et* al., 2021).Bioreduction and nucleation progress, a development stage arises, in which more modest particles precisely cooperate to produce bigger, all the more thermodynamically stable particles(Fadil *et* al., 2022).

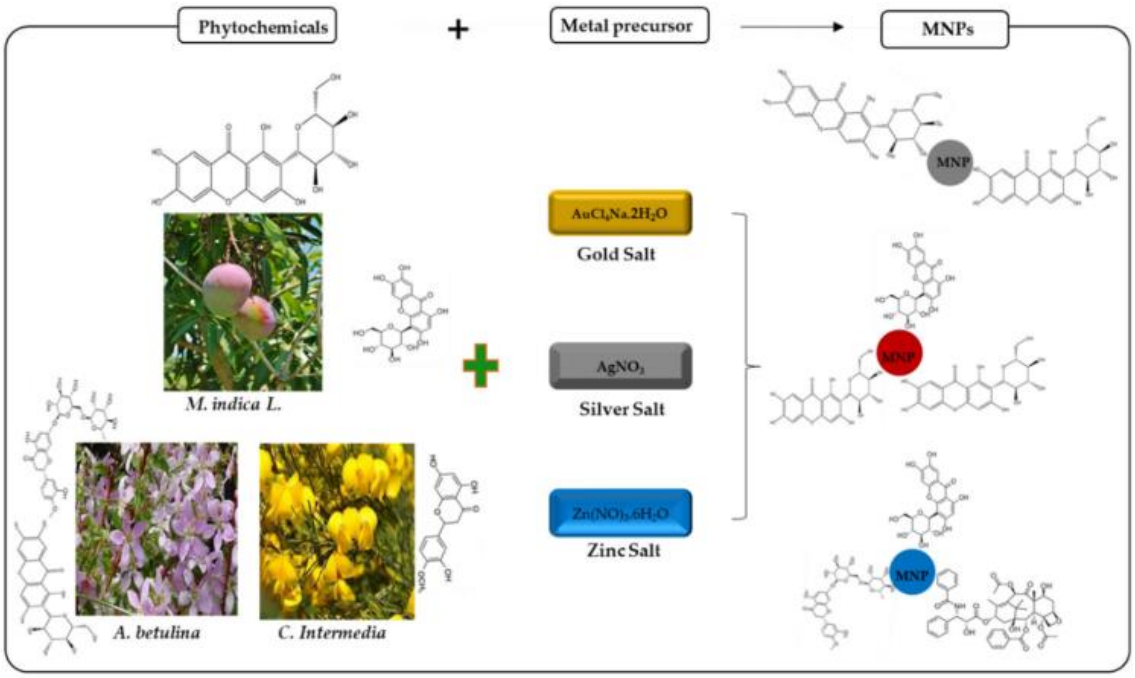


Figure 4. *Plant separate are utilized to amalgamation NPs. A few plant remove with solid reductive capacity effectively convert metallic particles, like silver, zinc, and gold particles to metallic nanoparticles. Adapted from (Dykas et al., 2022; Tran et al., 2022)*

3.7 NATURAL UTILIZATION OF SOME THERAPEUTIC PLANT IN GHANA

3.7.1 Ghana Medicine Plant Biodiversity

Local Markets are the primary commercial hub for products and services, along with a sources of restorative plants for both conventional medication practioners and the general population(Prado *et* al., 2022; Walusansa *et* al., 2022). These mark*et*places serve as gathering and disseminating point for empirical knowledge about plant resources, assisting in the preservation of local knowledge about medicinal plants (Mahomoodally, 2013). With more than 35000 different plant species known, Africa is a mainland wealthy in regular biodiversity (Kumari *et* al., 2021).This isn't shocking given Africa's heat and humidity, and it is notable that plants gather huge optional m*et*abolites as a characteristic m*et*hod for making due in troublesome climate (Mahomoodally, 2013).Recently, there has been a spike in curiosity about Africa's understudied restorative plants, with over 55% of recent papers focusing on African therapeutic plants and their bioactivities (Sulaiman *et* al., 2018).Despite growing research interest, commercialization of African plants is as y*et* far off. Only 82 African plants are partially or fully commercialised, according to global evolution of commercialized medicinal plants (Amartey, 2018) , In Europe and Asia countries commercialization is at an all-time high (Ospina-Alvarez *et* al., 2022). For millennia, plants have been an essential wellspring of medication in many nations like Ghana, and Ghana a nation of long history of customary recuperating, is a home to just about 25000 blossoming plant species (Sunil Kumar *et* al., 2015).

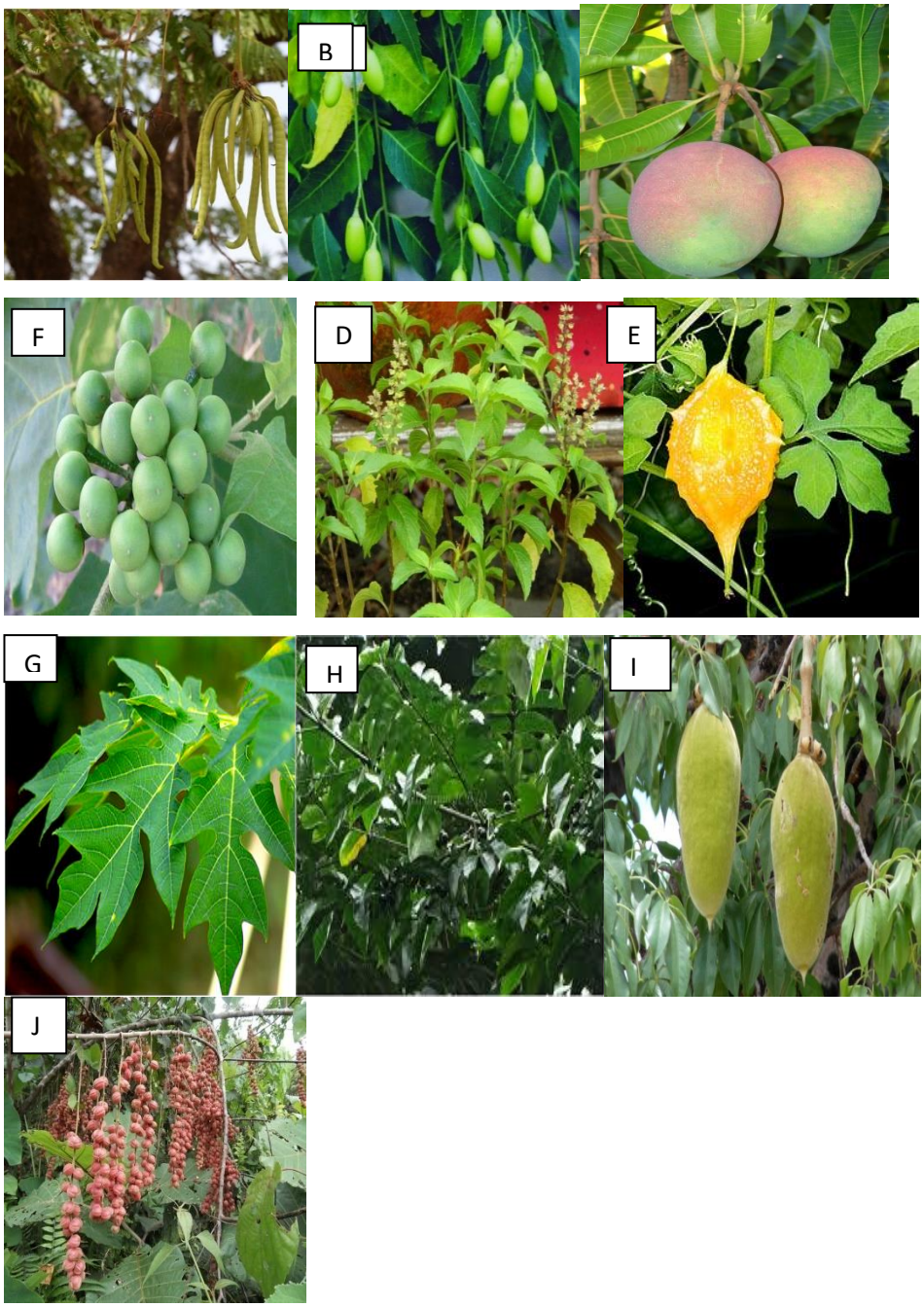


Figure 5: *show medicinal plant found in Ghana. (A) Parkia biglobosa (B) Azadirachta indica (C)Mangifera indica (D) Solanum Torvum (E) Ocimum Gratissimum (F)Mormodica Charantia (G) Papaya Leaves (H)Trichilia monadelpha (I) Adansonia digitata (J) Alchornea cordifolia. (Ofori et al., 2012)*

3.7.2 NPS Synthesis from Medicinal Plant of Ghana and it Application

Traditional remedies are used by majority of people in underdeveloped nations, although traditional medicine is not practised in the say way. Around 71% of new pharmaceuticals approved since 1981 have been derived straightforwardly or in a roundabout way from natural ingredients indicating that nature is the best source of solutions for many health concerns(Newman & Cragg, 2012). Traditional remedies are accepted to be utilized by around 72% of the human population (Calixto, 2005). Since old times, regular items especially those from plant beginning, have generally been a significant restorative plants offer differential helpful properties taking into account their basic inventory of optional m*et*abolites like flavonoids, alkaloids, phenols, terpenoids, tannins, glycosides, quinones, steroids and saponins(Aboyewa *et* al., 2021b; Calixto, 2005; Komlaga *et* al., 2015). These edible plants can be formed into innovative strategies that improve the conveyance and viability of their phytochemicals(Manisha *et* al., 2014). Shine *et* al.,(2020) reported on gold nanoparticle utilizing fluid leaf extricate from Parkia biglobosa. However recent research from pharmaceutical companies suggest that natural products are as yet an important hotspot for the improvement of new chemical entities for some complicated disorders, as they reflect favoured structures picked by evolutionary forces over millions years (Fürstner, 2021; Keith *et* al., 2021). Because of the strong pharmacological actions of plant interceded NPs, it is now more important than ever to zero in on how customary plants may help the pharmaceutical business, particularly in the medication revelation stage (Bhuiyan & Mamur, 2021; Zhang *et* al., 2022). Ghana has large excess of plant with long history of use in customary medication to treat infectious and chronic ailment, necessitating their incorporation in nanotechnology(Pouresmaieli *et* al., 2021; Seepe *et* al., 2021). Plant extracts from Ghana medicinal plants like *Parkia biglobosa*, *Azardirachta indica*, and *Papaya* leaveshave been utilized to synthesis a various NPs(Pouresmaieli *et* al., 2021; Tyavambiza, Dube, *et* al., 2021). Additionally an enormous size of choosingplant species from Ghana's Northern area including *Terminalia avicennioides*, *Ficus gnaphalocarpa*, *Piliostigma thionningi*, *Adansonia digitata*, *Diospyros mespiliformis*, and *Hibiscus sabdariffa* yield AuNPs(Al-Radadi, 2021; Mohd Taib *et* al., 2019). Intriguingly, examinations concerning the antibacterial and anticancer impacts of Ghana plant interceded NPs showed that they were b*et*ter than rough plant

separate(Naegeli *et* al., 2017; Pedrosa *et* al., 2020). In spite of the way that there are a ton ofexcellent indigenous plants used for metallic NPs synthesis, only a handful has been studied for their biological purposes(Prasad *et* al., 2021). Thus, the present review examines the potential for m*et*allic NPs manufacturing and biological uses of 28 powerful plants extensively utilised in Ghana traditional medicine(Imoro *et* al., 2013; Ofori *et* al., 2012).

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

Table 1. List of some selected Ghanaian medicinal plant

Plant Species	**Local Name**	**DiseasesPlant treats**	**Part use**	**Major Phytochemical**	**MNPs**	**NPs Size (nm)**	**NP Bio Activity**
Parkia biglobosa	Dawadawa	Piles, Blood pressure, Barrenness, Gum bleeding, Liver cancer, Diab*e*tes, Ulcer, Gastritis, Hemorrhoid (Odounharo *et* al., 2021)	Bark, leaves, Roots	Alkaloids, Flavonoids, Saponins, Tanins, Phytate, Steroids, Phlobataninins (Ajala *et* al., 2022; Okwunodulu *et* al., 2021)	AgNPs, AuNPs, TiO_2NPs PbNPs (Ajala *et* al., 2022)	12-15	Antimicrobial (Saran *et* al., 2018)
Azadirachta indica	Neem	Fever, Typhoid, Rheumatism, Skin	Leaves, seeds	Glycosides, Saponins, Flavonoids, Tanins	AuNPs Fe_2O_3 NPs	20-30(Yılmaz *et* al., 2022)	Larvicidal Wounds healing and antimicrobial

		rashes					
Mangifera indica	Mango	Hypertension Blood tonic, Bilharzia, Diarrhoea	Leaves, Bark, Seed	Mangiferin, Phenolic, Benzophenones (M. Kumar *et* al., 2021)	AgNPs AuNPs	10-20	Anticancer, Anti-dab*et*ic, Antimicrobial(Huang *et* al., 2019; Jubair *et* al., 2021)
Trichilia monadelpha	Tannuro	Epilepsy, Depression, Psychosis	Bark, Leave	Total phenols, Terpenoids, phytosteroids, Flavonoids (Wilde *et* al., 2013)	N.A	N.A	N.A
Mormodica Charantia	Nyanya	Gonorrhea, measles, Scabies, Malaria	Leaves, seeds	Alkaloids, Tannins, Flavonoids, Cardiac glycosides, Steroids (Shilpi Sharma & Malik, 2012)	AgNPs	20-35	Anticancer, antileukemic (Yan *et* al., 2021)
Ocimum Gratissimum	Nunum	Fungal infection, Fever, Catarrh, Mental illness(K. S.	Seeds Leaves, Whole plant	Tannins, Flavonoids, Alkaloids, Steroids, Oligosaccharides(Ashokkumar *et* al., 2021)	N.A	N.A	Antimicrobial Antifungal (N. Ali & S*et*zer, 2013)

		Prabhu *et* al., 2009; Uba *et* al., 2021)					
Solanum Torvum	Kwahunsusua	Liver and spleen augmentation, Cancer therapy, Cataract in the eye(Darkwah *et* al., 2020)	Leaves, Stem, Root, Fruit	Phenols, Alkaloids, Tannins, Total saponins, Flavonoids (Fernandez & Ruiz, 2021)	AgNPs	8-10	Antimicrobial, Anti-ulcer Anticancer
Alchornea cordifolia	Gyama	Infertility, Prostatitis, Bacterial infection, Ulcer, Diarrhoea, Gonorrhoea	Leaves, Stem, Bark	Flavonoids, Glycoside, Tannins, Resins, Alkaloids (Adeshina *et* al., 2012)	CuONPs, ZnONPs	N.A	Antimicrobial

Papaya Leaves	Borofere	Heart disease, Diab*et*es, Cancer, Dig*et*ion	Leaves, Fruit, Root, Stem, Seeds	Tannins, Steroids, Glycosides, Flavonoids, Saponins (Shubham *et* al., 2019)	CuO	10-70 (Bere *et*al., 2021)	Antimicriobal
Adansonia digitata	Baobab	Fever. Weight loss, Heart dieases Cancer, Autoimmune disorder Sr	Seeds, Stem bark, Leaves, Roots Fruit (Mohammed Bashir *et* al., 2021)	Alkaloids, Flavonoids, Tannins, Terpenoids, and Saponins (Oguntibeju, 2018)	AgNPs	5-24	Antibacterial Antiviral Antitrapanosoma

Table 2: ***Peak wavelength and absorbance of Ag nanoparticles in aqueous extracts of fresh leaves of P. biglobosa and A. cordifolia Concentration***

Concentration mM	Wavelength (nm)	Absorbance
P.biglobosa		
1	452	0.894
2	452	0.937
3	451	1.109
4	441	1.285
5	445	1.736
A.cordifolia		
1	420	0.667
2	438	1.277
3	438	1.691
4	433	2.059
5	450	3.386

The nanoparticles are very polydispersed and a layer of the natural material encompassing the incorporated Ag nanoparticles could make sense of the great scattering of these nanoparticles in arrangement. By and large, the Ag nanoparticles combined utilizing fluid concentrates are very much scattered albeit some of them were noted to be agglomerated. Remarkably, most of the particles in the TEM pictures are not in that frame of mind with one another but rather seemed isolated by the natural layer. Along these lines, TEM pictures obviously demonstrate the covering of Ag nanoparticles with a natural layer. The appearance of a few polyphenolic parts including flavonoids and terpenoids worked with the decrease of Ag particles and furthermore balanced out the outer layer of the resultant Ag nanoparticles (Marslin *et* al., 2018). The Ag particles amount affected the range of the particles. Whenever AgNO3 fixation is expanded to 5mM, an undeniable difference in the size dissemination of nanospheres was noticed (Table 3).

Table 3: Size of Ag nanoparticles produced from various concentrations of AgNO3 using aqueous extracts of fresh leaves of P. biglobosa and A. cordifolia

	Ag nanoparticles size (nm)	
Concentration of AgNO3 solution (mM)	P. biglobosa	A. cordifolia
1	12±2	3.2±1.2
2	15±2.1	4±1
3	17±2.2	6±1.1
4	19±2.5	10±1.3
5	20±3.3	12±2.1

4.1 Mangifera indica

Mangifera indica. is a South Asian native fruit that belongs to the Anacaediaceae family (Alamgeer *et al*., 2018). It is an enormous green tree, valued mainly for its fruits, both green and ripe (Gentile *et al*., 2019; Gianguzzi *et al*., 2021). Approximately 20 varieties of Mangifera indica have been accounted for by Savanna Agriculture Research Institute (SARI) (Muntala *et al*., 2021). It has the potential to mature to 15-30 (49-98 ft) metres tall. The tress grows best in well well-drained sandy loam; it does not grow well in heavy wet soil (Pregitzer *et al*., 2016). The optimal pH of the dirt should be between 5.2 and 7.5 (Adak *et al*., 2019; Asare *et al*., 2022; Imran *et al*., 2021; Raja *et al*., 2005). The main producing countries of *Mangifera indica* including India, China, Thailand, Indonesia, Parkistan, Mexico, Brazil, Bandladesh, West African and the Philipines (Pino *et al*., 2021; Sultana *et al*., 2021). Mangeferin, Phenolic acids, benzophenones, and different cell reinforcements like flavonoids, ascorbic corrosive, carotenoids, and tocopherols have been concentrates in the leaves of the Mangifera indica plant for their medical advantages, which are ascribed to a plenty of phytochemicals, for instance, mangiferin, followed because of phenolic acids, benzophenones, and different disease counteraction specialists like flavonoids, ascorbic destructive and carotenoids (Kumar *et al*., 2021; Salehi *et al*., 2020). The organic exercises leaf of Mangifera indica extricates have been researched, including anti-cancer, anti-diabetes, Anti-oxidant, anti-microbial, and anti-obesity properties, lipid lowering, hepato protection and anti-diarrhoea (Abdel-Khalek *et al*., 2022; Denizkara *et al*., 2021; Kemegne *et*

al., 2018). The nourishing and the Mangifera indica leaf phytochemical profile has in the table above **figure 3**. Further research as concluded by Gharpure *et al*., (2022) various bioactivities of Leaf of Mangifera indica are likewise analyzed inside and out. Mangifera indica leaf, root and bark can be utilised as expect to fix in the improvement of utilitarian food varieties and drug drugs because of their phytochemical profile and gainful impacts (Castellano *et al*., 1971; Gharpure *et al*., 2022; Ghazi *et al*., 2022). However, additional comprehensive clinical examples are still expected to decide the mangifera indica extract's true efficacy (Salazar-camacho *et al*., 2022). *Mangifera indica* blossomes have not been read up for AgNPs synthesis efficiency or broad-spectrum antibacterial action (Donga *et al*., 2020; Kumar *et al*., 2021). Thus, the study's goals were to make AgNPs from mangifera indica flowers extract, describe the biosynthesized AgNPs using various spectroscopic techniques, and test their antibacterial capabilities *(Alabdallah et al*., 2021; Naganthran *et al*., 2022; Panneerselvi *et al*., 2022; Patil *et al*., 2021; Samuel J. Offor *et al*., 2021). Native healers from Ghana utilize the implantation arranged from the leaves, roots furthermore, stem to assuage clogging, nervousness, cough, malaria, eczema, diarrhoea, hypertension and blood pressure (Izzaty *et al*., 2021; Offor *et al*., 2021). *Mangifera indica* seed extract was utilized to make gold nanoparticles (AuNPs), which is regarded as waste and is usually thrown away into the dustbin or the environment (Singh *et al*., 2021). The bioactive compounds in the seed act as a diminishing specialist, permitting AuNPs to orchestrated without the utilization of any other chemicals (Alegria *et al*., 2018; Daruich De Souza *et al*., 2019). Different spectroscopic methodologies were utilized to portray green synthesis AuNPs (Benedec *et al*., 2018). The creation of AuNPs was confirmed by visual variety change from lackluster to ruby red which was further validated by UV-spectra with a maximal absorption at 550 nm (Zhang *et al*., 2015). The XRD techniques demonstrated the translucent nature, while TEM and SAED examination uncovered the round, triangle, and sporadic shape and 19.45 sizes (Kumar *et al*., 2021; Villa *et al*., 2016). Bachheti *et al*., (2020), Likewise recorded that presence of liquor or phenol, carboxylic acids, ketones, amines, fragrant amines, aliphatic amines, alkyl halides, and alkynes are all examples of alkynes Mangifera indica seed was affirmed by FTIR, examination, and these mixtures were answerable for the decrease in terms of gold to AuNPs. Antibacterial, cancer prevention agent, and cytotoxic benefit of green blend AuNPs were tried (Al-Radadi *et al*., 2022; Hosny *et al*., 2022). They had

mild antibacterial, cytotoxic, and cancer prevention agent movement that was portion subordinate (Shahbaz *et al*., 2022). Rather than disposing of Mangifera indica seeds, they can be effectively utilized to union AuNPs, which can be taken advantage of as a characteristic wellspring of antibacterial (Thangadurai *et al*., 2020)

4.2Parkia biglobosa (Dawadawa)

An African locust bean is additionally known as *Parkia biglobosa* or dawadawa as most Ghanaian called it (Ojewumi *et al*., 2021). Is a perennials deciduous tree of family Fabaceae, in the genus *Parkia biglobosa* is found in a variety of the environmemts of West Africa and is essentially developed for cases contain both a sweet mash and significant seeds (Muhammed *et al*., 2021). Where the tree is developed, the pounding and aging of these seeds comprises a significant monetary movement (Choungo *et al*., 2021). Various pieces of the insect bean tree are utilized for therapeutic and food purposes. Parkia biglobosa develops to somew interval of 7 and 20 meters high, sometimes up to 30 meters (Mukhtar *et al*., 2021). The tree is heat proof heliophyte described by thick dim dark earthy colored bark. Each unit can contain up to 30 seeds, the seeds are implanted in a sweet, fine yellow mash (Zannou *et al*., 2018). In West African the bark, roots, leaves, blossoms, organic products, and seeds are ordinarily utilized in conventional medication to treat a broad scope of grievances, both inside and remotely (Ahmed *et al*., 2018). The bark is most utilized followed by the leaves. Restorative applications incorporate the treatment of parasitic contaminations, circulatory framework issues, like blood vessel hypertension, and problems of the respitory framework, stomach related framework and skin. The root decoction is utilized to treat coccidiosis in poultry. To annihilate fish, green cases are squashed and tossed into streams. The plant's phytochemical profile uncovered the existences of saponins, flavonoids, tannins, alkaloids, phenolic which are accepted to be liable for its colossal restorative activities (Yakubu *et al*., 2022). Be that as it may, because of higher substance of hostile to nutritional factors like saponins, tannins, and phytates in the seeds, it can't be consumed in crude, uncooked or unfermented condition. The biosynthesized AuNPs have a solid antibacterial activity against *Entterococcus faecalis*, *Pseudomonas aeruginosa*, *Escherichia coli and Staphylococcus aureus,* repressing their expansion. The abuse of modern wastewater and people groups generally risky ways of life, especially the utilization of

engineered shading specialists in the material, paper, cowhide, and plastics businesses, has raised the worries about color squander water because of numerous manufactured tones are synthetically and thermally stable yet not biodegradable (Sivakumar *et al*., 2013; Thiripuranthagan & Rupa, 2019). To assist with the decline of water contamination in the climate, a few treatments like muck treatment, optional treatment, photocatalysis, and others are used. Squander water treatment is considered fundamental. In any event, these exercises of direct color water release have been seen in a few low-pay countries, and the damage isn't bound to natural annihilation, yet additionally to the wellbeing of people who drink the water. Sparkle *et al*., (2020), announced that utilizing AuNPs had the opportunity to annihilate the normally utilized color, rhodamine B color (RhB), in water.

4.3Azadirachta indica

Azadirachta indica commonly called as neem or nimtree in Ghana also, is called dogoyaro by Nigerians (Njoga *et al*., 2021). It have a place with the mahogany clan Meliaceae (Nerkar & Chakraborthy, 2021). It belong to one of two animal categories in the family Azadirachta, and is local to the Indian subcontinent and the vast majority of nations in Africa (National & Pillars, 2021). *Azadirachta indica* is a quickly developing tree that can arrive at a tallness of 15-20 metres and rarely 35-40 m (115-131 ft) (Mafara & Bakura, 2021). It is deciduous, shedding manyof it leaves during dry winter months (Nxumalo *et al*., 2021). The *Azadirachta indica* is denoted in view of its dry season opposition. It flourishes in sub-dried to sub-moist environments with yearly precipitation going from 400 to 1200 mm (16-47 in). It can be applied to fill in areas where the annual rainfall is lower than 400. For *Azadirachta indica*, an altransonication method was used. Silver salt bioconversion into silver nanoparticles fuelled by *indica* (AgNPs). Using a pad-dry curing process, these nanoparticle were deposited cotton that has been plasma functionalized Polyphenols, triterpenes, carotenoids, flavonoids, steroids, and tannins are only a few others strong antioxidant components found in neem extract (Morgan, 2009). *Azadirachta indica* leaves, flowers, fruits and seeds have chemo preventive and therapeutic potential. Moreover, *Azadirachta indica* extract have be demonstrated to have preferential cytotoxic towards malignant growth cells contrasted with ordinary cells, making them valuable in bringing down poisonousness during disease

treatment. *Azadirachtin* is a fascinating substance because of its compound construction, which required 18 years to tackle and an additional 22 years to integrate, is all around as significant as its organic capacities as a taking care of impediment for some bugs and a development disruptor for most bugs and other athropods. Its action component, structure-development relationships, and biosynthesis are for the most part actually being examined. Silver is one of the most notable attractive nanomaterials, and Azadirachta indica can create 500 tons of AgNPs each year. It has been displayed to make solid inhibitory and bactericidal impacts, as well as antifungal, alleviating, and against angiogenesis exercises in the fields of high mindfulness bimolecular revelation, catalysis, biosensors, and drug. Azadiracht indica AgNPs have exceptional optical, electrical, and warm properties, as well as medication conveyance, diagnostics, imaging, detecting, quality exchange, and tissue designing abilities. The antimicrobial action of Azadirachta indica mix AgNPs takes care of likewise uncovered that the cautious cover with AgNPs had antibacterial properties.

4.4Trichilia monadelpha

Trichilia monadelpha is a kind of evergreen tree that develops to a tallness of 12 to 20 meters and has an enormous open spreading crown (Heads, 2019). Trichilia monadelpha (Melinaceae), also known in Ghanaian language as Otanduro or Tenuba (Nzema), thrives in evergreen and lowland high forest semi-deciduous secondary rainforests, frequently near river banks (Chase *et al*., 2021; De Vitis *et al*., 2020). For many years, Ghanaian traditional medicine has employed preparations (decoctions, infusions, and tinctures) of the plant's stem bark to cure pain, psychoses, epilepsy, and inflammation, and their efficacy has been widely acclaimed in various communities in Ghana (Peprah *et al*., 2019). The ethanolic stem bark portion of *Trichilia monadelpha* contains anti-trypanosomal and antiplasmodial properties in accordance with pharmacological research (Diop *et al*., 2022) There are not any backings or fluting on the straight, barrel-molded bole, which can depend on 50cm long.The tree is frequently used in the neighbourhood, giving palatable oil, drugs, and different things (Sahoo *et al*., 2021). As earlier reported by Wilde *et al*., (2013). Oil ether (PEE), Derivation of ethyl acetic acid (EthE), and ethanol concentrates of Trichilia monadelpha contain cancer prevention agent potential and phytochemical parts (Wilde *et al*., 2013). The reduction power and 2, 2-diphenyl-1-picryl-hydrazyl

revolutionary (DPPH) rummaging tests were utilized to recognize the presence phytochemicals, in addition to concentrates' cell reinforcement limit in vitro. The concentrates' complete phenol content was additionally determined. With presence Trichilia monadelpha a huge optional metabolites was found through phytochemical research. PEE contained alkaloids, terpenoids, phytosterols, lessening sugars, and coumarins. Phytosterols, terpenoids, tannins, alkaloids, diminishing sugars, flavonoids, heart Saponins, glycosides, and anthraquinones were found in EAE, though tannins, alkaloids, terpenoids, phytosterols, decreasing sugars, flavonoids, cardiovascular EthE contained glycosides, anthraquinones, and saponins (Sutoyo *et al*., 2021; Yudhani *et al*., 2021).

4.5 Mormodica Charantia

Momordica charantia is a vegetable derived from Momordica cymbalariac limber plants and belongs to the Cucurbitaceae family. In English, it is commonly referred to as severe gourd or harsh melon. Originally discovered in Southern India and South East Asian countries, it is now seen on the opposite side of the globe. The vegetable incorporates the leafy foods containing elevated degrees of cancer prevention agent properties, phenolic compounds, calcium, potassium, L-ascorbic acid and fiber content (Grover & Yadav, 2004; Shabanzadeh *et al*., 2015). It is notable that Ag-NPs show yellowish earthy coloured tone in fluid arrangement because of excitation on the Surface Plasmon Resonance (SPR) in Ag-NPs (Elmusa *et al*., 2021). The decrease of silver particle (Ag+) to Ag-NPs by utilizing of M. charantia extricates containing of numerous polyphenols and flavones as both lessening and balancing out specialist could be trailed by the shading switch from yellow to diminish brown during the incubating season of 35-45 min at 30°C (Umme Ruman & Poonah Kia, 2021). Momordica charantia is a plant that has a high phenolic content. A biotechnological procedure was utilized to create nanoparticles of silver (Ag NPs) from According to a few studies, Momordica charantia soil products remove. UV/Vis Spectrophotometry, Dynamic Light Scattering (DLS), High Resolution Transmission Electronics Microscopy (HRTEM), and Field Emission Scanning Electron Microscopy (FESEM) are all techniques used to measure light (FESEM), and Fourier Transform Infrared Spectroscopy (FTIR), and X-Ray Diffraction were all procedures used to investigate light (FTIR), and X-Ray Diffraction were used to portray the

fundamental (XRD). Antibacterial properties were found in a cover made of AgNPs. Both the seed and organic product concentrates of M. charantia have uncovered their circular structure utilizing HRTEM. FESEM pictures uncovered Ag-NPs going in size from 20 to 35 nm. Utilizing an UV-noticeable spectrophotometer, Plasmon Resonance on the Surface (SPR) of Ag NPs was focused at 405 nm for seed removal and 402 nm for organic product extrication. The FT-IR information uncovered that phenolic and starch synthetic substances were engaged with the Ag NPs creation Moreover, antibacterial exercises of the delivered Ag nanoparticles have been found against microbes such as E. coli and Pseudomonas aeruginosa. Therefore, Momordica charantia's bioconversion of Ag NPs could be utilised as a possible antibacterial source in the agrarian and food protection businesses to eliminate pathogenic organisms (Elmusa *et al*., 2021; Samuggam *et al*., 2021; Shabanzadeh *et al*., 2015; Sutoyo *et al*., 2021).

4.6 Ocimum Gratissimum

African basil is a type of basil indigenous to Africa (**Ocimum gratissimum**), often known as clove basil or Nunum in Akan (Mante, 2019). Basil is the normal name for any fragrant spice having a spot with the Lamiaceae family's class *Ocimum*, which is notable for its therapeutic, culinary, and sweet-smelling qualities (Boaventura *et al*., 2021; Mante, 2019; Samuggam *et al*., 2021).The name "basil" comes from the Greek word "basilica," and that infers imperial zest (Dafni *et al*., 2020). Plants' helpful powers have been found for quite a while and have been the underpinning of all medicines for ages until the presentation of counterfeit drugs. No matter what the way that delivered drugs have been viable in treatment, the globe is currently encountering a shift toward regular cures due to the numerous and risky secondary effects related with their utilization (Santosh Kumar *et al*., 2020). Plant is notable as carminative, expectorant, and utilized in fix of ailment, loss of motion, epilepsy, loose bowels, sunstroke, flu, gonorrhoea, psychological maladjustment as people medication in Indian and African nations (Bekut *et al*., 2020).

4.7 Solanum Torvum

Solanum Torvum is a critical assortment of angiosperms that records about 1200 species circled all over the globe. It is an erect hedge with a thorny stem that grows up to 3m tall. It is grown all over Ghana and West Africa. Nonetheless, S. torvum

isn't just utilized as food. It is likewise generally utilized in customary medication for in Africa and Asia forestalling and relieving a scope of illnesses. However, S. torvum is used for more than just food. It is also widely used in traditional medicine in Africa and Asia to prevent and treat a variety of illnesses. The active stem and branches are green and pubescent with trichomes, whereas the bark of more mature stems is brown and dull. The foliage is evergreen, straightforward, and widely praised, measuring 5-21 cm long and 4-13 cm wide, and can be found whole or with up to seven large three-sided flaps. Fine stellate hairs cover the two surfaces, and prickles are scattered along the primary veins. The upper surface is cloudier than the lower. The peak intense up to sharpen is the explanation for the lamina and sideways shortening. Petioles are thickly stellate-pubescent, 1 to 5.5 cm long, with bended prickles up to 10 mm long. Thick and minimal inflorescences up to 6 cm long, 1-4 times stretched, with 50-100 blossoms, thickly pubescent with trichomes similar to that found on stems. Pentameric blossoms with 2-3 mm long thin and furry sepals framing a 4-6 mm long calyx. White to cream petals are about 1 cm long and form a 1.5-2 cm stellate corolla. Different arrangements in view of S. torvum organic products, seeds or vegetative parts are for sure answered to achieve success drugs against fever, hack, wounds, torment, liver inconveniences, tooth rot, regenerative issues, blood vessel hyper-strain and furthermore harming (use as remedy). Phytochemical studies demonstrate that S. torvum organic products have adequate convergences of different alkaloids, flavonoids, saponins, tannins, and glycosides for making sense of these pharmacological impacts. Nutrients, fundamental natural supplements which are essential for smooth digestion in thebody, canalsobefound in S. torvum. Solanum torvum organic product extricates were additionally used in the amalgamation of AgNPs after a straightforward and simple brooding of solanum torvum water separate with AgNO3 (Senizza *et al*., 2021; Thakur & Verma, 2021). The AgNPs from Solanum torvum were essentially circular and polygonal in good condition, with a normal center size of 8 to 10 nm (Rónavári *et al*., 2021). The different structure and size of the AgNPs suggested that more than one phytochemical was discovered to be associated with their reduction and possibly covering (Narchin *et al*., 2018). According to Kavitha *et al*., (2021) the covering tops in the concentrates' FTIR spectra and AgNPs upheld this case. While the water concentrate of Solanum torvum exhibited antibacterial action at groupings of the biogenic AgNPs can accumulate to concentrations of up to 50 mg/mL. Limited

bacterial advancement basically against S. epidermidis and P. aeruginosa.Little examination has been directed by certain analysts uncovers that, notwithstanding rich wellspring of metabolites Solanum torvum is less researched. Thusly in this survey attempt have been used this plant by consolidating AgNPs using new natural item concentrate of S. torvum, and contemplated curiously its bactericidal properties rather than the plant pathogenic microorganisms and moreover widened study with S. torvum watery leaf separate on the liver's status (antacid phosphatase, alanine transaminase, aspartate transaminase, plasma complete protein, plasma egg whites, plasma globulin, plasma all out bilirubin, plasma formed bilirubin), hematological profile, and liver, spleen, lung, and bone marrow histology (Naimon *et al*., 2015; Vanti *et al*., 2020).

4.8Alchornea cordifolia

Therapeutic plants are filling in fame because of their uncommon properties as a rich wellspring of helpful phytonutrients that might prompt the advancement of novel medications (Shedoeva *et al*., 2019). Therapeutic plants have additionally brought about the segregation of novel bioactive mixtures, which are then utilized as lead compounds found in amalgamation of patentable substances with further developed action and lower harmfulness (Annunziata *et al*., 2020). Many horticultural product have been discovered to contain antimicrobial, cancer prevention agent, and calming properties (Mousavi *et al*., 2021). Alchornea cordifolia of the Euphorbiaceae family, is a fundamental restorative plants in customary medication which is predominantly utilized in Africa (Chanchal *et al*., 2016). The Christmas tree is another name for *Alchornea cordifolia* which started at Senegal and is currently locate itself in Kenya, Tanzania, and West Africa and all through From Central Africa to Angola It includes sixty species, among which just six species happen in Tropical Africa. Terpenoids, steroids, glycosides, flavonoids, tannins, saponins, carbs, and alkaloids are found in the leaves, root, and stem bark (Mital & Jha, 2021). The root and stem bark are utilised to cure jaundice, and the powdered leaves of Wounds are treated with *Alchornea cordifolia* (Panda, 2018). Slurry of the organic product is directed for the fix of asthma and hack. The management of urinary and gastrointestinal confusion shapes part of its conventional utilization (Arora *et al*., 2021). The leaves, stem and root bark are remotely used to treat Leprosy and a cure to wind toxin. The organic product's sap is utilized to treat eye and skin ailments. Fever, intestinal sickness, and

rheumatic torments are treated with a decoction of verdant twigs. Cu2O/CuO nanoparticles (NPs), zinc oxide nanoparticles (NPs), and Cu2O/CuO–ZnO nanocomposites were created using *Alchornea cordifolia* leaf extract. The band hole is the distance between the various parts of the metal oxide, which include the leaves, stem, and root bark, and it varies depending on the metal oxide. In addition, the leaves have been shown to be less cytotoxic to some disease cell lines. The concept of nanoparticles acquired here is comparable to previous reports (Ponnar *et al.*, 2018). The uniform quantum size obtained for the nanocomposites, on the other hand, extremely intriguing and could be attributed to the copper's lower focus impact and the technique used in the nanocomposite combination.

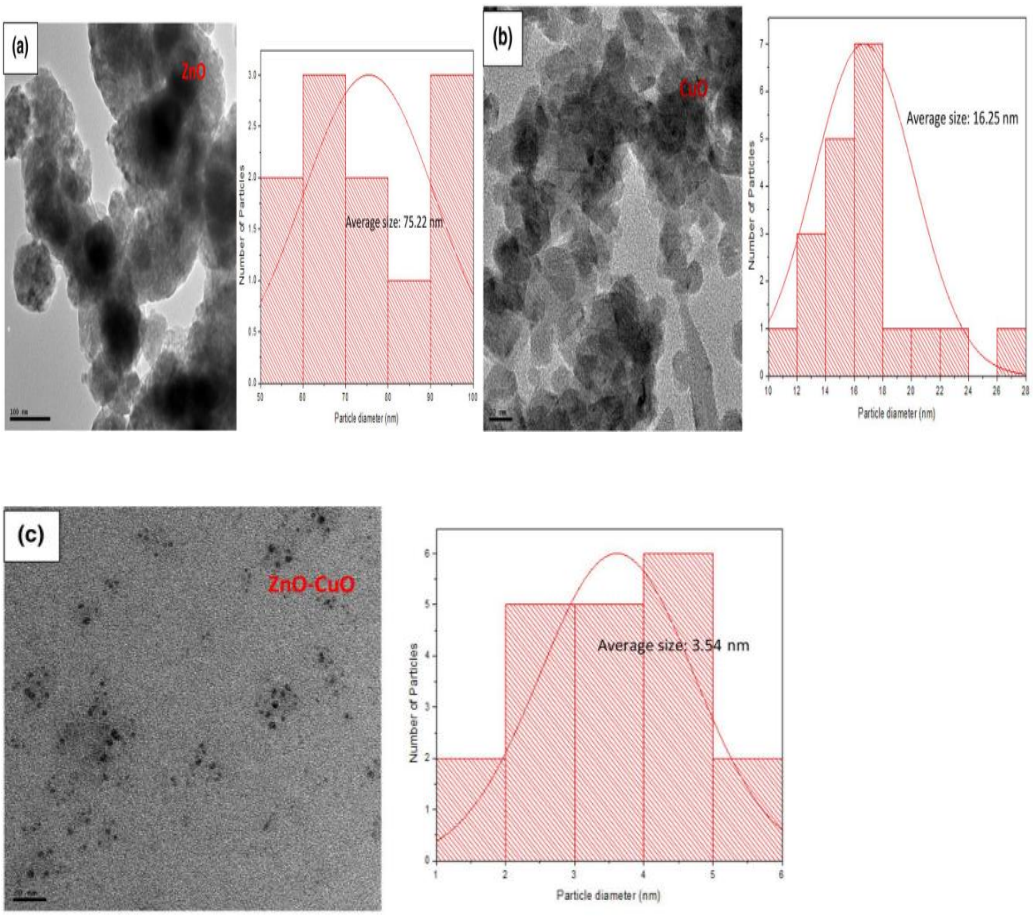


Figure 6: *TEM images of (a) ZnO NPs, (b) CuO NPs, and (c) ZnO-CuO nanoparticles, as well as the corresponding molecule size appropriation of Alchornea cordifolia leaf. Adapted from (Hasan et al., 2020; Kumar et al., 2021).*

4.9 Papaya leaves

Papaya is widely grown throughout the world's tropical and subtropical climates. Papaya, which contains beta-carotene, protein, starch, vitamins, and minerals, has long been regarded as a lucrative tropical organic product. The papaya plant is a small, sparsely developed plant with a single stem that can grow to a height of 5 to 10 metres.(García-villegas *et al*., 2022). The palmately lobed leaves are 0.5 to 0.7m wide and have seven projections. The natural product papaya has smooth skin, is green, and turns yellow when young. The typical Philippine papaya grows to be shaped like a pear and measures about 0.1-0.4 m long (Anjana *et al*., 2018). When the prepared papaya is opened, it has a sensitive orange yellowish tissue with various minimal dim seeds embedded at the vacant core interest. Carica papaya's bark, leaves, roots, latex, fruit, flowers, and seeds are all used in folk medicine to treat a variety of diseases. It additionally contains other important constituents, for example, nutrients, for example, A, E, and C, which are a rich wellspring of cell reinforcement and minerals, for example, magnesium and potassium, vitamin B pantothenic corrosive and folate, and fibre (Joy Ugo *et al*., 2019). The leaves have been read up for therapeutic purposes and reported in writing to be utilized by native people groups from everywhere the world for calming, antitumor, and hostile to diabetic impacts, in addition to other things. Carica papaya departs have as of late been demonstrated to have hemostatic properties and to be helpful in the treatment of dengue patients. The leaves additionally contain dynamic parts, for example, papin, chymopapin cystain, ascorbic destructive, flavornoids, and cynogenic glucosides, which increment the general specialist for disease anticipation power in blood and reduction the degree of lipid preoxidation.

4.10 Adansonia digitata

Adansonia digitata L. (Baobabis) species of deciduous tree belonging to the Malvaceae family. Baobab bark is utilized to treat fever in country of Ghana. The gum got from stem bark is utilized to purify wounds (Habibi, 2020). The bark appears to be utilized as an antidote to Strophanthus harming in East Africa. A bark decoction is utilized to wash ramshackle youngsters in Congo Brazzaville and for use as mouthwash for toothache in Tanzania. Inside Indian medicine, baobab bark is used as a refrigerant, antipyretic, and antiperiodic. (Donatien Kaboré *et al*., 2011).

The baobab natural product mash is presumably the main food item. It is easily degraded in water or different fluids and milk. The fluid is then utilized as a beverage, a sauce for food, a maturing specialist in neighborhood blending, or as an option to cream of tartar in baking.

Figure 7:*Readiness of baobab organic product mash porridge: (1-2-3) mash, seeds andfibres are weakened in water; (4) seeds and filaments are eliminated (4a) and broke up mash stays (4b); (5-6-7) simultaneously, water is added to for example maize flour, bubbled and thickened to a porridge which is blended in conjunction with broke down baobab mash* (Imoro *et al.*, 2013)

Baobab seeds can be eaten new, or they might to be dried and ground a flour which can either be added to soups and stews as a thickener, or broiled and ground up a glue, or bubbled for quite a while, aged and afterward dried for use (Egbadzor *et al*., 2022). Overall baobab mash is plentiful in L-ascorbic acid, the leaves are wealthy in great quality proteins (Keșa *et al*., 2021). Most central amino acids are found in the leaves and minerals, and the seeds in fat (Anaduaka *et al*., 2020; Calderón Bravo *et al*., 2021). Additionally, Jaiswal *et al*., (2022) reported that mash and leaves display cell reinforcement movement. An assortment of synthetic substances have been secluded and described from A. digitata. They own a spot with the classes of terpenoids, flavonoids, steroids, supplements, amino acids, carbs and lipids. Actually different kinds Plant materials, as in silver nanoparticles from Shorea tumbuggaia, were used to bio-organize nanoparticles. (Baran, 2019), Boswellia ovalifoliolata calcium nanoparticles (Bashir *et al*., 2022; Brinkman *et al*, 2005), Nanoparticles of zinc oxide from Catharanthus roseus (Vijai Anand *et al*., 2021), Avena sativa gold nanoparticles (Lu *et al*., 2022), Indium oxide nanoparticles from Aloe vera (Naikoo *et al*., 2021), Palladium Cinnamomum camphora nanoparticles (Fahmy *et al*., 2020),

Iron Medicago sativa oxide nanoparticles, Copper nanoparticles from Magnolia kobus and Achillea wilhelmsii Cadmium Oxide Nanoparticles (Khandel *et al*., 2018; Savithramma *et al.*, 2016). The application of ecologically harmless materials like plant extricate, microbes, organisms and green growth for the blend consisting of silver nanoparticles offers various advantages of eco-neighborliness and similarity for drug and other biomedical applications as they don't utilize poisonous synthetics for the amalgamation convention (Ansari *et al*., 2021; Baranwal *et al*., 2022; Di Mauro *et al*., 2021; Okafor *et al*., 2022)

4.11 UV-Vis Spectra Analysis

The aqueous concentrate of new leaves of P. biglobsa and A. cordifolia change their varieties when warmed. The P. biglobsa remove changes tone from lackluster to tanish yellow, while A. cordifolia becomes yellowish brown (Figure 8). This warm concentrate arrangement changed variety again later adding AgNO3 arrangement. Assortment changes are possible in light of the fact that a piece of the Ag particles begin to be diminished in view of the effects of force and creates Ag+ complex. This complex was answerable for changing variety from earthy yellow to grayish brown (P. biglobosa), while the (A. cordifolia) remove stayed an earthy yellow (Figure 8 (B and D)). This variety change shows the development of Ag nanoparticles (Marslin et al., 2018). The Ag nanoparticles orchestrated in each concentrate arrangement was dissected utilizing UV-Vis spectroscopy. This was done to decide the qualities of the pinnacle range of the Ag nanoparticle frequency arranged for each unique AgNO3 focuses (1mM-5mM) (Figure 3). The attributes of Ag nanoparticles typically show up at a frequency time period 600nm (Skandalis et al., 2017). UV-Vis spectra of Ag nanoparticles orchestrated utilizing the P. biglobosa watery concentrate reveal the blue shift of the retention band with expanding AgNO3 fixation. For 1mM, 2mM, 3mM, 4mM, and 5mM examples, the retention top is revolved around 450-420 nm. This data shows that the Ag nanoparticles have shaped in the concentrate, where the Ag+ has been decreased to Ag0. Proteins and all auxiliary metabolites of concentrate assume a basic part in both the diminishing and covering instrument for nanoparticle development (Marslin et al., 2018). The Ag nano-particles contained in the watery concentrate of the *A. cordifolia* likewise display comparative attributes, where the shift of the assimilation band with expanding AgNO3 focuses. Nonetheless, the shift

of the assimilation top was a little smaller than that of the Ag nanoparticles incorporated with the P. biglobosa fluid concentrate, where the ingestion top is fixated on 450-440 nm. The pinnacle frequency of silver nanoparticles in fluid new leaf concentrates should be visible in Table 2.

Figure 8: Aqueous extract from fresh leaves of (ab) *P. biglobosa* and (cd) *A. cordifolia*. Before (a and c) and after (b and d) the addition of AgNO3 solution.

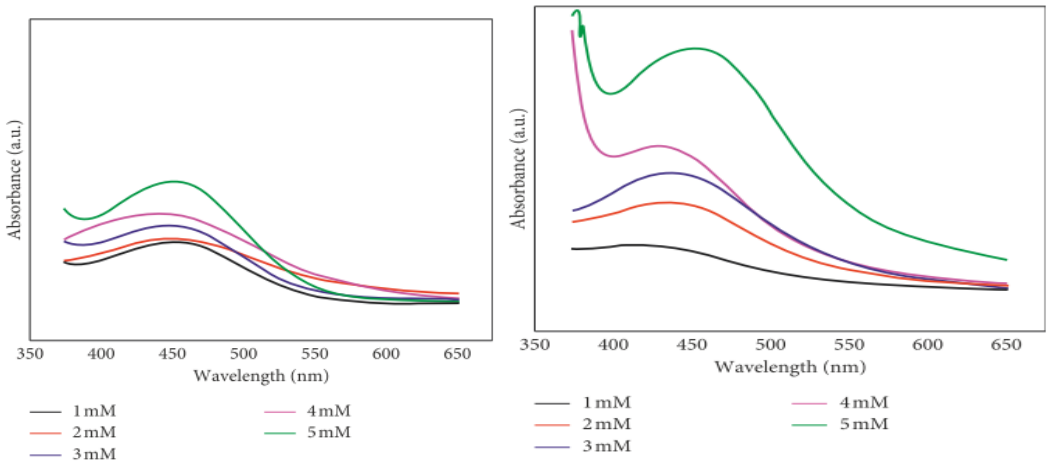


Figure 9: *UV-Vis absorbance spectrum of Ag nanoparticles as a function of AgNO3 concentration in aqueous extracts of fresh leaves of (a) P. biglobosa and (b) A. cordifolia, respectively*

4.12 Antibacterial Activity Studies

The current review uncovered that the tried leaf concentrates of P. biglobosa and A. cordifolia restorative plants showed powerful antibacterial movement against two bacterial strains: Gram-positive S. aureus and Gram-negative E. coli. Fluid concentrates of P. biglobosa and A. cordifolia containing Ag nanoparticles showed movement in all Ag focuses tried against all microorganisms (Figure 10). Antibacterial movement was shown by a restraint zone which was portrayed by an

unmistakable zone b*et*ween the wells (containing tests) and a specific distance. Development of hindrance zones around the wells shows bacterial aversion to antibacterial and anti-infection fixings (which are utilized as certain controls). The positive control utilized in the all-around was a ciprofloxacin 500mg arrangement and worked as a control of the test arrangement by looking at the breadth of the hindrance zone shaped. Running against the norm, refined water as regr*et*table control was utilized to decide the impact of solvents in the test arrangement on the advancement of S. aureus and E. coli microbes. Obviously it was the concentrates containing Ag nanoparticles that had the antibacterial movement, not the dissolvable. The breadth of restraint zones shaped for every grouping of the AgNO3 antecedent added to the fluid concentrates of new leaves of P. biglobosa and A. cordifolia therapeutic plants in integrating Ag nanoparticles is introduced in Table 3. Table 3 shows that the antibacterial action against S. aureus was expanded, which was demonstrated by an expansion in the hindrance zone breadth from 11.03mm to 13.8 mm, with the rising Ag focus in P. biglobosa extricate. In any case, the contrary outcome was shown by E. coli, which was from 10.2mm to 8.9 mm. The equivalent was valid for Ag nanoparticles in A. cordifolia watery concentrates which were from 13.9mm to 15.8mm and 17.7mm to 15.4mm for S. aureus and E. coli, separately

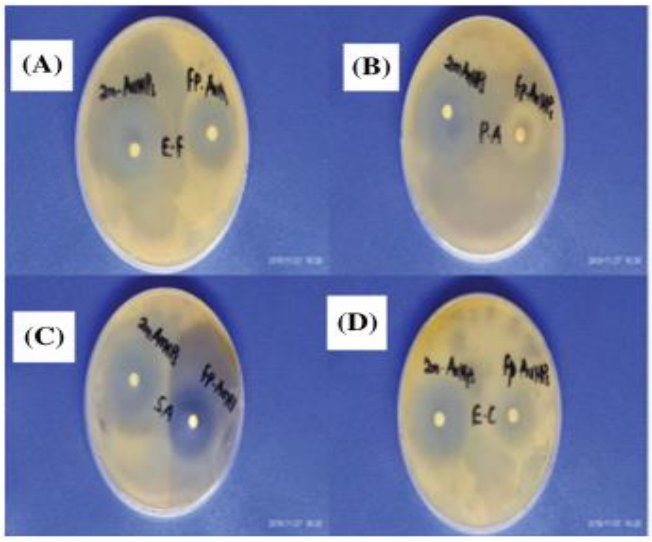


Figure 10: *Antibacterial activity of Ag nanoparticles synthesized using watery leaf concentrates of P. biglobosa (a) and A. cordifolia (b) against Gram-positive S. aureus (A and c) and Gram-negative E. coli bacteria (b and d).*

Table 4: Antibacterial activity of Ag nanoparticles synthesized using various concentrations ofAgNO3 precursors and aqueous extracts of new leaves of P. biglobosa and A. cordifolia.

Plants	AgNO3 (mM)/replication		Zone of inhibition S. aureus	Positive control	E. coli	Positive control
	3	1	11.3	18.2	14.3	17.8
		2	12.3	21.2	7.8	20.7
		3	9.5	*19.7*[b]	8.5	20
P. biglobosa	Average		*11.03*[a]	19.7	10.2	*19.5*[d]
	5	1	20	19.7	10.3	19.6
		2	10.5	19.8	7.3	19.4
		3	11	19.6	9	19.5
	Average		**13.8**	**19.7**	*8.9*[e]	*19.5*[f]
	3	1	12.8	18.1	20.5	18
		2	14.5	20.9	15.3	21
		3	14.5	20	17.3	19.8
A. cordifolia	Average		**13.9**	**19.7**	**17.7**	**19.6**
	5	1	13	19.6	15.3	19.4
		2	20	19.8	16.5	19.7
		3	14.3	19.8	14.5	19.8
	Average		**15.8**	**19.73**	**15.4**	**19.63**

Positive control = ciprofloxacin; values indicated with "a" are significantly different from values indicated with "b"; values indicated with "c" are significantly different from values indicated with "d"; values indicated with "e" are significantly different from values indicated with "f"

In any case, considering the aftereffects of measurable investigation, it was shown that main three medicines were fundamentally not the same as the positive controls. The factors were fluid concentrates of P. biglobosa leaves containing Ag nanoparticles (3mM) against S. aureus and E. coli microorganisms and fluid concentrates of P. biglobosa leaves containing Ag nanoparticles (5mM) against E.

coli microscopic organisms. This data was upheld by information that the normal size of Ag nanoparticles orchestrated utilizing A. cordifolia remove was generally more modest than that utilizing the concentrate of P. biglobosa. The aftereffects of this study were additionally upheld by past investigations that the little size of Ag nanoparticles makes these particles simpler to infiltrate the external mass of microbes, enter the body, annihilate the respiratory chain, and consequently restrain cell breath, causing bacterial demise [27, 28]. With respect to restraint zone, the antibacterial action of Ag nanoparticles blended in this study was classified into solid inhibitory action (hindrance zone of 10-19mm) as per Davis and Stout [29] particles delivered had an expanded size because of the expanded focus ofAgNO3 arrangement, however the normal size is still in nanom*et*er. Ag nanoparticles contained in the concentrate had the option to repress the development of S. aureus and E. coli microbes, and the best antibacterial movement was shown by the A. cordifolia separate containing Ag nanoparticles.

CHAPTER FIVE

5.0 CONCLUSION AND FUTURE SCOPE

It is self-evident from the first that, biogenic metallic nanoparticle definitions plainly have an expansive reach proclivity in contrast with a wide scope of extent of sicknesses; nonetheless, their fuse into standard drug has a few disadvantages, especially the exclusion of information in relation to their destiny in vivo. Different natural models joining Plants, unicellular organisms, microbes, fish, and warm-blooded animals have all been used in experiments to survey the harmfulness plant-mediated metallic nanoparticles; nonetheless, nobody has had the opportunity to satisfactorily spread out the particular part engaged with their noxiousness. Whatever the case may be, various pre-clinical/clinical examinations have obviously uncovered captivating antimicrobial, injury recovery, anticancer, antioxidative, quieting, these biogenic exercises have anticarcinogenic and cytotoxic affects metallic nanoparticles. It is consequently prescribed that critical endeavors be given to surveying the ampleness and security of these normal nanoparticles plans in clinical exploration. Besides, an exact portrayal of the methodologies for the mix, disinfecting, cautious combination of the metallic nanoparticles plans, and the portion ought to be given to consider its reproductivity. Accordingly, metallic nanoparticles plans made principally of natural material might fill in as better decisions than misleadingly joined nanostructures and their applications fuse into traditional medicine might be much speedier, with the advantage of defeating the various challenges related with current standard strategies for treatment.

REFERENCE

Aarthye, P., & Sureshkumar, M. (2021). Green synthesis of nanomaterials: An overview. *Materials Today: Proceedings*, *47*, 907–913. https://doi.org/10.1016/j.matpr.2021.04.564

Abdel-Khalek, H. H., & Mattar, Z. A. (2022). Biological activities of Egyptian grape and mulberry by-products and their potential use as natural sources of food additives and nutraceuticals foods. *Journal of Food Measurement and Characterization*, *2*(1), 1–13. https://doi.org/10.1007/s11694-022-01289-2

Abdellatif, A. A. H., Alturki, H. N. H., & Tawfeek, H. M. (2021). Different cellulosic polymers for synthesizing silver nanoparticles with antioxidant and antibacterial activities. *Scientific Reports*, *11*(1), 1–18. https://doi.org/10.1038/s41598-020-79834-6

Aboyewa, J. A., Sibuyi, N. R. S., Meyer, M., & Oguntibeju, O. O. (2021a). Green synthesis of metallic nanoparticles using some selected medicinal plants from southern africa and their biological applications. *Plants*, *10*(9), 1–24. https://doi.org/10.3390/plants10091929

Aboyewa, J. A., Sibuyi, N. R. S., Meyer, M., & Oguntibeju, O. O. (2021b). plants Green Synthesis of Metallic Nanoparticles Using Some Selected Medicinal Plants from Southern Africa and Their Biological Applications. *Plants*. https://doi.org/10.3390/plants10091929

Adak, T., Mishra, D., Kumar, K., & Singh, V. K. (2019). Analysis of soil and tree productivity under high density planting system in mango cv. Dashehari (Mangifera indica L.). *Tropical Plant Research*, *6*(1), 24–30. https://doi.org/10.22271/tpr.2019.v6.i1.005

Adeleye, O. A., Femi-Oyewo, M. N., Bamiro, O. A., Bakre, L. G., Alabi, A., Ashidi, J. S., Balogun-Agbaje, O. A., Hassan, O. M., & Fakoya, G. (2021). Ethnomedicinal herbs in African traditional medicine with potential activity for the prevention, treatment, and management of coronavirus disease 2019. *Future Journal of Pharmaceutical Sciences*, *7*(1), 1–14.

https://doi.org/10.1186/s43094-021-00223-5

Adeshina, G. O., Kunle, O. F., Onaolapo, J. A., Ehinmidu, J. O., & Odam, L. E. (2012). Phytochemical and Antibacterial Studies of the Hexane Extract of Alchornea cordifolia Leaf. *Phytochemicals as Nutraceuticals*, *7*(1), 90–96. https://doi.org/10.5772/26948

Agoglia, A. E., Tella, J., & Herman, M. A. (2020). Neuropharmacology Sex differences in corticotropin releasing factor peptide regulation of inhibitory control and excitability in central amygdala corticotropin releasing factor receptor 1-neurons. *Neuropharmacology*, *180*(April), 1–16. https://doi.org/10.1016/j.neuropharm.2020.108296

Ahamad, I., Aziz, M. N., & Fatma, T. (2021). Emerging Technologies for Nanoparticle Manufacturing. *Nature*, *July*, 460–472. https://doi.org/10.1007/978-3-030-50703-9

Ahmad, T., Bustam, M. A., Irfan, M., Moniruzzaman, M., Asghar, H. M. A., & Bhattacharjee, S. (2019). Mechanistic investigation of phytochemicals involved in green synthesis of gold nanoparticles using aqueous Elaeis guineensis leaves extract: Role of phenolic compounds and flavonoids. *Biotechnology and Applied Biochemistry*, *66*(4), 698–708. https://doi.org/10.1002/bab.1787

Ahmed, S. M., Nordeng, H., Sundby, J., Aragaw, Y. A., & de Boer, H. J. (2018). The use of medicinal plants by pregnant women in Africa: A systematic review. *Journal of Ethnopharmacology*, *224*, 297–313. https://doi.org/10.1016/j.jep.2018.05.032

Ahmed, S. R., Rabbee, M. F., Roy, A., Chowdhury, R., Banik, A., Kubra, K., Hassan Chowdhury, M. M., & Baek, K. H. (2021). Therapeutic promises of medicinal plants in bangladesh and their bioactive compounds against ulcers and inflammatory diseases. *Plants*, *10*(7), 1–30. https://doi.org/10.3390/plants10071348

Ajala, M. A., Abdulkareem, A. S., Tijani, J. O., & Kovo, A. S. (2022). Adsorptive behaviour of rutile phased titania nanoparticles supported on acid-modified kaolinite clay for the removal of selected heavy metal ions from mining

wastewater. *Applied Water Science*, *12*(2), 1–24. https://doi.org/10.1007/s13201-021-01561-8

Aken, B. Van, & Doty, S. L. (2009). Transgenic plants and associated bacteria for phytoremediation of chlorinated compounds. *Biotechnology and Genetic Engineering Reviews*, *26*(1), 43–64. https://doi.org/10.5661/bger-26-43

Al-Radadi, N. S. (2021). Facile one-step green synthesis of gold nanoparticles (AuNp) using licorice root extract: Antimicrobial and anticancer study against HepG2 cell line. *Arabian Journal of Chemistry*, *14*(2), 102956. https://doi.org/10.1016/j.arabjc.2020.102956

Al-Radadi, N. S. (2022). Biogenic proficient synthesis of (Au-NPs) via aqueous extract of Red Dragon Pulp and seed oil: Characterization, antioxidant, cytotoxic properties, anti-diabetic anti-inflammatory, anti-Alzheimer and their anti-proliferative potential against cancer cell . *Saudi Journal of Biological Sciences*. https://doi.org/10.1016/j.sjbs.2022.01.001

Al-Shabib, N. A., Husain, F. M., Qais, F. A., Ahmad, N., Khan, A., Alyousef, A. A., Arshad, M., Noor, S., Khan, J. M., Alam, P., Albalawi, T. H., & Shahzad, S. A. (2020). Phyto-Mediated Synthesis of Porous Titanium Dioxide Nanoparticles From Withania somnifera Root Extract: Broad-Spectrum Attenuation of Biofilm and Cytotoxic Properties Against HepG2 Cell Lines. *Frontiers in Microbiology*, *11*(July), 1–13. https://doi.org/10.3389/fmicb.2020.01680

Alabdallah, N. M., & Hasan, M. M. (2021). Plant-based green synthesis of silver nanoparticles and its effective role in abiotic stress tolerance in crop plants. *Saudi Journal of Biological Sciences*, *28*(10), 5631–5639. https://doi.org/10.1016/j.sjbs.2021.05.081

Alamgeer, Younis, W., Asif, H., Sharif, A., Riaz, H., Bukhari, I. A., & Assiri, A. M. (2018). Traditional medicinal plants used for respiratory disorders in Pakistan: A review of the ethno-medicinal and pharmacological evidence Milen Georgiev, Ruibing Wang. *Chinese Medicine*, *13*(1), 1–29. https://doi.org/10.1186/s13020-018-0204-y

Alegria, E. C. B. A., Ribeiro, A. P. C., Mendes, M., Ferraria, A. M., Botelho do

Rego, A. M., & Pombeiro, A. J. L. (2018). Effect of phenolic compounds on the synthesis of gold nanoparticles and its catalytic activity in the reduction of nitro compounds. *Nanomaterials*, *8*(5), 6–10. https://doi.org/10.3390/nano8050320

Ali, M. A., Ahmed, T., Wu, W., Hossain, A., Hafeez, R., Masum, M. M. I., Wang, Y., An, Q., Sun, G., & Li, B. (2020). Advancements in plant and microbe-based synthesis of metallic nanoparticles and their antimicrobial activity against plant pathogens. *Nanomaterials*, *10*(6), 1–24. https://doi.org/10.3390/nano10061146

Ali, N., & Setzer, W. (2013). Pharmacological Activities of Basil Oil. *Recent Progress in Medicinal Plants (RPMP)*, *May*, 286–307.

Alqethami, A., & Aldhebiani, A. Y. (2021). Medicinal plants used in Jeddah, Saudi Arabia: Phytochemical screening. *Saudi Journal of Biological Sciences*, *28*(1), 805–812. https://doi.org/10.1016/j.sjbs.2020.11.013

Amartey, N. A. (2018). BIOSYNTHESIS OF MAGNETIC IRON OXIDE NANOPARTICLES AND ITS POTENTIAL APPLICATION IN CANCER TREATMENT. *Computers and Industrial Engineering*, *2*(January), 6. http://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf%0Ahttp://wwwlib.murdoch.edu.au/find/citation/ieee.html%0Ahttps://doi.org/10.1016/j.cie.2019.07.022%0Ahttps://github.com/ethereum/wiki/wiki/White-Paper%0Ahttps://tore.tuhh.de/hand

Amina, S. J., & Guo, B. (2020). A Review on the Synthesis and Functionalization of Gold Nanoparticles as a Drug Delivery Vehicle. *International Journal of Nanomedicine*, *2020*(7), 9823–9857.

Amiri, S., Moghanjougi, Z. M., Bari, M. R., & Khaneghah, A. M. (2021). Natural protective agents and their applications as bio-preservatives in the food industry: An overview of current and future applications. *Italian Journal of Food Science*, *33*(SP1), 55–68. https://doi.org/10.15586/ijfs.v33iSP1.2045

Amuthavalli, P., Singh, S., Chandramohan, B., Paulpandi, M., Subramaniam, J., Murugan, K., Gandh, A. D., Vasanthakumaran, M., Anitha, J., Wang, L., Dahms, H., & Hwang, J. (2021). Zinc oxide nanoparticles using plant Lawsonia inermis and their anticancer applications showing moderate side effects.

Scientific Reports, 1–13. https://doi.org/10.1038/s41598-021-88164-0

Anaduaka, E. G., Uchendu, N. O., & Ezeanyika, L. U. S. (2020). Mineral, amino acid and fatty acid evaluations of Myristica fragrans seeds extracts. *Scientific African*, *10*, 1–5. https://doi.org/10.1016/j.sciaf.2020.e00567

Anjana, G. V., Priya, D., Srimathi, R., & Shantha Kumar, B. (2018). A review on medical advantages and chemical constituents of carica papaya linn. *Asian Journal of Pharmaceutical and Clinical Research*, *11*(9), 53–57. https://doi.org/10.22159/ajpcr.2018.v11i9.26992

Annunziata, F., Pinna, C., Dallavalle, S., Tamborini, L., & Pinto, A. (2020). An overview of coumarin as a versatile and readily accessible scaffold with broad-ranging biological activities. *International Journal of Molecular Sciences*, *21*(13), 1–83. https://doi.org/10.3390/ijms21134618

Ansari, S., Sami, N., Yasin, D., Ahmad, N., & Fatma, T. (2021). Biomedical applications of environmental friendly poly-hydroxyalkanoates. *International Journal of Biological Macromolecules*, *183*, 549–563. https://doi.org/10.1016/j.ijbiomac.2021.04.171

Aritonang, H. F., Koleangan, H., & Wuntu, A. D. (2019). Synthesis of silver nanoparticles using aqueous extract of medicinal plants' (impatiens balsamina and lantana camara) fresh leaves and analysis of antimicrobial activity. *International Journal of Microbiology*, *2019*, 1–9. https://doi.org/10.1155/2019/8642303

Arora, K., Kumar, P., Bose, D., Li, X., & Kulshrestha, S. (2021). Potential applications of algae in biochemical and bioenergy sector. *3 Biotech*, *11*(6), 1–24. https://doi.org/10.1007/s13205-021-02825-5

Artasensi, A., Mazzotta, S., & Fumagalli, L. (2021). Back to Basics : Choosing the Appropriate Surface Disinfectant. *Antibiotics*, 1–29.

Asadi, L., Mokhtari, J., & Abbasi, M. (2021). An alginate–PHMB–AgNPs based wound dressing polyamide nanocomposite with improved antibacterial and hemostatic properties. *Journal of Materials Science: Materials in Medicine*, *32*(1), 1–11. https://doi.org/10.1007/s10856-020-06484-5

Asare-Donkor, N. K., Boakye-Agyemang, D., & ... (2019). Assessment of formaldehyde levels and its health effects in some selected residential homes and offices in Ashanti region, Ghana. *Journal of Multidisciplinary Engineering Science Studies (JMESS)*, *5*(8), 2748–2755. http://www.jmess.org/wp-content/uploads/2019/08/JMESSP13420546.pdf

Asare, M. O., Afriyie, J. O., Hejcman, M., & Krbová, M. J. (2022). Can Wood Ashes of Commonly Planted Tree Species in Ghana be Applied as Fertilizers? *Waste and Biomass Valorization*, *13*(2), 1043–1058. https://doi.org/10.1007/s12649-021-01588-7

Ashokkumar, K., Pandian, A., Murugan, M., Dhanya, M. K., & Vellaikumar, S. (2021). Phytochemistry and pharmacological properties of Ocimum gratissimum (L .) extracts and essential oil - A critical review. *Journal of Current Opininion in Crop Science*, *2*(1), 138–148.

Badu, M., Boadi, N. O., & Mensah, J. K. (2012). International Journal of Pharma and Bio Sciences ISSN ANTIOXIDANT ACTIVITY OF METHANOL AND ETHANOL / WATER EXTRACTS OF TETRAPLEURA TETRAPTERA AND PARKIA BIGLOBOSA. *Int J Pharm Bio Sci*, *3*(3), 312–321.

Balunas, M. J., & Kinghorn, A. D. (2005). Drug discovery from medicinal plants. *Life Sciences*, *78*(5), 431–441. https://doi.org/10.1016/j.lfs.2005.09.012

Banat, I. M., Oliveira, R., Teixeira, J., & Rodrigues, L. (2006). Biosurfactants : potential applications in medicine. *Journal of Antimicrobial Chemotherapy*, *2*, 609–618. https://doi.org/10.1093/jac/dkl024

Banerjee, P., Deb, A., & Bhadra, P. (2021). An Anthology of Nutraceuticals. In *An Anthology of Nutraceuticals* (Issue August). https://doi.org/10.30954/anthnutraceuticals

Bao, Y., He, J., Song, K., Guo, J., Zhou, X., & Liu, S. (2021). Plant-Extract-Mediated Synthesis of Metal Nanoparticles. *Journal of Chemistry*, *2021*, 1–14. https://doi.org/10.1155/2021/6562687

Baranwal, J., Kumar, A., Delogu, G. L., Fais, A., & Barse, B. (2022). Biopolymer : A Sustainable Material for Food and Medical Applications. *Polymers Review*,

1(1), 1–22.

Barros-Rodríguez, A., Rangseekaew, P., Lasudee, K., Pathom-Aree, W., & Manzanera, M. (2021). Impacts of agriculture on the environment and soil microbial biodiversity. *Plants*, *10*(11), 1–10. https://doi.org/10.3390/plants10112325

Bashir, Mohammed, Ibrahim, A., Bilyaminu, M., Ali, R., Isa, H., Sambo, K., & Ishaq, I. (2021). Phytochemical Screening and Antibacterial Activity of Leaf and Stem Bark Extracts of Adansonia digitata on E. coli, S. aureus and S. typhi. *Microbes and Infectious Diseases*, *3*(1), 217–223. https://doi.org/10.21608/mid.2021.53939.1097

Bashir, Moneesa, Bahar, F. A., Bhat, M. A., Singh, L., Mahdi, S. S., & Palmo, T. (2022). Review : Nanotechnology in Agriculture : Prospects and Problems Review : Nanotechnology in Agriculture : Prospects and Problems. *Biological Forum – An International Journal*, *2*, 1–11.

Bekut, M., Boˇzin, B., Gavari´c, N., Dragovi´, G., Kladar, N., & Brki´, S. (2020). Potential of selected Lamiaceae plants in anti(retro) viral therapy. *Pharmacological Research J*, *1*, 301–314.

Benedec, D., Oniga, I., Cuibus, F., Sevastre, B., Stiufiuc, G., Duma, M., Hanganu, D., Iacovita, C., Stiufiuc, R., & Lucaciu, C. M. (2018). Origanum vulgare mediated green synthesis of biocompatible gold nanoparticles simultaneously possessing plasmonic, antioxidant and antimicrobial properties. *International Journal of Nanomedicine*, *13*(3), 1041–1058. https://doi.org/10.2147/IJN.S149819

Bere, A. W., Mulati, O., Kimotho, J., & Ng'Ong'A, F. (2021). Carica papaya leaf extract silver synthesized nanoparticles inhibit dengue type 2 viral replication in vitro. *Pharmaceuticals*, *14*(8), 1–13. https://doi.org/10.3390/ph14080718

Bhuiyan, M. R. A., & Mamur, H. (2021). A brief review on the synthesis of zno nanoparticles for biomedical applications. *Iranian Journal of Materials Science and Engineering*, *18*(3), 1–27. https://doi.org/10.22068/ijmse.1995

Boaventura, T. P., Souza, C. F., Ferreira, A. L., Favero, G. C., Baldissera, M. D.,

Heinzmann, B. M., Baldisserotto, B., & Luz, R. K. (2021). The use of Ocimum gratissimum L. essential oil during the transport of Lophiosilurus alexandri: Water quality, hematology, blood biochemistry and oxidative stress. *Aquaculture*, *531*(June 2020), 735964. https://doi.org/10.1016/j.aquaculture.2020.735964

Brown, S. D., Nativo, P., Smith, J., Stirling, D., Edwards, P. R., Venugopal, B., Flint, D. J., Plumb, J. A., Graham, D., & Wheate, N. J. (2010). Gold Nanoparticles for the Improved Anticancer Drug Delivery of the Active Component of Oxaliplatin. *JACS ARTICLES*, *8*, 4678–4684.

Bussmann, R. W., & Sharon, D. (2006). Traditional medicinal plant use in Northern Peru: Tracking two thousand years of healing culture. *Journal of Ethnobiology and Ethnomedicine*, *2*, 60–70. https://doi.org/10.1186/1746-4269-2-47

Cahill, J. F., & McNickle, G. G. (2011). Causes and consequences of root foraging behavior. *Annual Review of Ecology, Evolution, and Systematics*, *42*(November 2014), 1–27. https://doi.org/10.1146/annurev-ecolsys-102710-145006

Calderón Bravo, H., Vera Céspedes, N., Zura-Bravo, L., & Muñoz, L. A. (2021). Basil Seeds as a Novel Food, Source of Nutrients and Functional Ingredients with Beneficial Properties: A Review. *Foods*, *10*(7), 1–18. https://doi.org/10.3390/foods10071467

Calixto, J. B. (2005). Twenty-five years of research on medicinal plants in Latin America: A personal view. *Journal of Ethnopharmacology*, *100*(1–2), 131–134. https://doi.org/10.1016/j.jep.2005.06.004

Cao, H., Antonopoulos, A., Henderson, S., Wassall, H., Brewin, J., Masson, A., Shepherd, J., Konieczny, G., Patel, B., Williams, M., Davie, A., Forrester, M. A., Hall, L., Minter, B., Tampakis, D., Moss, M., Lennon, C., Pickford, W., Erwig, L., … Vickers, M. A. (2021). Red blood cell mannoses as phagocytic ligands mediating both sickle cell anaemia and malaria resistance. *Nature Communications*, 1–13. https://doi.org/10.1038/s41467-021-21814-z

Castellano, J. M., Perona, J. S., & Ramos-Romero, S. (1971). Biological Activity. *Aldosterone*, *1*(1), 1–29. https://doi.org/10.1016/b978-0-08-013368-3.50007-8

Castronovo, L. M., Vassallo, A., Mengoni, A., Miceli, E., Bogani, P., Firenzuoli, F., Fani, R., & Maggini, V. (2021). Medicinal plants and their bacterial microbiota: A review on antimicrobial compounds production for plant and human health. *Pathogens*, *10*(2), 1–17. https://doi.org/10.3390/pathogens10020106

Celebi, O., Cinisli, K. T., & Celebi, D. (2020). Antimicrobial activity of the combination (Nano-Bio) of Artemisia absinthium with copper nanoparticles. *Materials Today: Proceedings*, *45*, 3809–3813. https://doi.org/10.1016/j.matpr.2021.01.824

Cetkovi´, J., Cvijovi´c, J., Živkovi´, A., Vujadinovi´, R., Žarkovi´, M., Laki´, S., & Kneževi´, M. (2022). Financial and Economic Investment Evaluation of Wastewater Treatment Plant ´. *Water*, 1–23.

Chaachouay, N., Douira, A., & Zidane, L. (2022). Herbal Medicine Used in the Treatment of Human Diseases in the Rif, Northern Morocco. *Arabian Journal for Science and Engineering*, *47*(1), 131–153. https://doi.org/10.1007/s13369-021-05501-1

Chakraborty, N., Banerjee, J., Chakraborty, P., Banerjee, A., Chanda, S., Ray, K., Acharya, K., & Sarkar, J. (2022). Green synthesis of copper/copper oxide nanoparticles and their applications: a review. *Green Chemistry Letters and Reviews*, *15*(1), 185–213. https://doi.org/10.1080/17518253.2022.2025916

Chakravarty, M., & Vora, A. (2021). Nanotechnology-based antiviral therapeutics. *Drug Delivery and Translational Research*, *11*(3), 748–787. https://doi.org/10.1007/s13346-020-00818-0

Chanchal, D. K., Rashi, S., Niranjan, S., Alok, S., Rajput, R., Dilip, M., & Chanchal, K. (2016). Medicinal Plants Used in Hepatoprotective: a Review. *International Journal of Life Sciences and Review*, *2*(4), 1–17. https://doi.org/10.13040/IJPSR.0975-8232.IJLSR.2(4).61-77

Chandrasekaran, R., Rajiv, P., & Abd-Elsalam, K. A. (2019). Carbon nanotubes: Plant gene delivery and genome editing. In *Carbon Nanomaterials for Agri-food and Environmental Applications*. Elsevier Inc. https://doi.org/10.1016/B978-0-12-819786-8.00014-1

Chang, X., Zhao, Z., Zhang, W., Liu, D., Ma, C., Zhang, T., Meng, Q., Yan, P., Zou, L., & Zhang, M. (2021). Natural Antioxidants Improve the Vulnerability of Cardiomyocytes and Vascular Endothelial Cells under Stress Conditions: A Focus on Mitochondrial Quality Control. *Oxidative Medicine and Cellular Longevity*, *2021*, 1–27. https://doi.org/10.1155/2021/6620677

Chase, M. W., Dodsworth, S., & Christenhusz, M. J. M. (2021). 990. Nicotiana Ingulba. *Curtis's Botanical Magazine*, *38*(3), 309–318. https://doi.org/10.1111/curt.12397

Chaudhary, R., Nawaz, K., Khan, A. K., Hano, C., Abbasi, B. H., & Anjum, S. (2020). An overview of the algae-mediated biosynthesis of nanoparticles and their biomedical applications. *Biomolecules*, *10*(11), 1–35. https://doi.org/10.3390/biom10111498

Choudhury, K., Ghosh, R., & De, B. (2021). REVIEW ON FEW ANTI DIABETIC MEDICINAL PLANTS USED BY THE INDIGENOUS TRIBAL PEOPLE. *International Jornal of Multidiciplinary Education Research*, *816*(6), 228–230.

Chougle, S., Kumar, D., Khan, A., Zehra, S., & Ali, A. (2021). Treatment of Alzheimer's disease by natural products. *Journal of Experimental and Clinical Medicine (Turkey)*, *38*(4), 634–644. https://doi.org/10.52142/omujecm.38.4.42

Choungo Nguekeng, P. B., Hendre, P., Tchoundjeu, Z., Kalousová, M., Tchanou Tchapda, A. V., Kyereh, D., Masters, E., & Lojka, B. (2021). The current state of knowledge of shea butter tree (Vitellaria paradoxa c.f.gaertner.) for nutritional value and tree improvement in west and central africa. *Forests*, *12*(12), 1–26. https://doi.org/10.3390/f12121740

Cunningham, F. J., Goh, N. S., Demirer, G. S., Matos, J. L., & Landry, M. P. (2018). Nanoparticle-Mediated Delivery towards Advancing Plant Genetic Engineering. *Trends in Biotechnology*, *36*(9), 882–897. https://doi.org/10.1016/j.tibtech.2018.03.009

Dadfar, S. M., Roemhild, K., Drude, N. I., von Stillfried, S., Knüchel, R., Kiessling, F., & Lammers, T. (2019). Iron oxide nanoparticles: Diagnostic, therapeutic and theranostic applications. *Advanced Drug Delivery Reviews*, *138*(2019), 302–

325. https://doi.org/10.1016/j.addr.2019.01.005

Dafni, A., Blanché, C., Khatib, S. A., Petanidou, T., Aytaç, B., Pacini, E., Kohazurova, E., Geva-Kleinberger, A., Shahvar, S., Dajic, Z., Klug, H. W., & Benítez, G. (2021). In search of traces of the mandrake myth: the historical, and ethnobotanical roots of its vernacular names. *Journal of Ethnobiology and Ethnomedicine*, *17*(1), 1–35. https://doi.org/10.1186/s13002-021-00494-5

Dafni, A., Petanidou, T., Vallianatou, I., Kozhuharova, E., Blanché, C., Pacini, E., Peyman, M., Dajić Stevanovic, Z., Franchi, G. G., & Benítez, G. (2020). Myrtle, Basil, Rosemary, and Three-Lobed Sage as Ritual Plants in the Monotheistic Religions: an Historical–Ethnobotanical Comparison. *Economic Botany*, *74*(3), 330–355. https://doi.org/10.1007/s12231-019-09477-w

Danquah, L., Amegbor, P. M., & Ayele, D. G. (2021). Determinants of the type of health care sought for symptoms of Acute respiratory infection in children: analysis of Ghana demographic and health surveys. *BMC Pediatrics*, *21*(1), 1–14. https://doi.org/10.1186/s12887-021-02990-9

Dao, K. C., Yang, C. C., Chen, K. F., & Tsai, Y. P. (2020). Recent trends in removal pharmaceuticals and personal care products by electrochemical oxidation and combined systems. *Water (Switzerland)*, *12*(4), 1–30. https://doi.org/10.3390/W12041043

Darkwah, W. K., Koomson, D. A., Miwornunyuie, N., Nkoom, M., & Puplampu, J. B. (2020). Review: phytochemistry and medicinal properties of Solanum torvum fruits. *FRONTIERS IN LIFE SCIENCE*, *13*(1), 498–506. https://doi.org/10.1080/26895293.2020.1817799

Daruich De Souza, C., Ribeiro Nogueira, B., & Rostelato, M. E. C. M. (2019). Review of the methodologies used in the synthesis gold nanoparticles by chemical reduction. *Journal of Alloys and Compounds*, *798*(2), 714–740. https://doi.org/10.1016/j.jallcom.2019.05.153

Das, R. K., Pachapur, V. L., Lonappan, L., Naghdi, M., Pulicharla, R., Maiti, S., Cledon, M., Dalila, L. M. A., Sarma, S. J., & Brar, S. K. (2017). Biological synthesis of metallic nanoparticles: plants, animals and microbial aspects.

Nanotechnology for Environmental Engineering, *2*(1), 1–21. https://doi.org/10.1007/s41204-017-0029-4

Dawadi, S., Katuwal, S., Gupta, A., Lamichhane, U., Thapa, R., Jaisi, S., Lamichhane, G., & Bhattarai, D. P. (2021). Review Article Current Research on Silver Nanoparticles : Synthesis , Characterization , and Applications. *Journal of Nanomaterials*, *2021*, 1–23.

De Vitis, M., Hay, F. R., Dickie, J. B., Trivedi, C., Choi, J., & Fiegener, R. (2020). Seed storage: maintaining seed viability and vigor for restoration use. *Restoration Ecology*, *28*(S3), 1–7. https://doi.org/10.1111/rec.13174

Del Pino, M., Bienvenido, C., Wong, M. E., Rodríguez, M. D. C., Boyero, J. R., & Vela, J. M. (2021). Influence of pre-harvest bagging on the incidence of aulacaspis tubercularis newstead (Hemiptera: Diaspididae) and fruit quality in mango. *Insects*, *12*(6), 1–12. https://doi.org/10.3390/insects12060500

Denizkara, A., Atik, İ., & Atik, A. (2021). Biological Activities of Medlar (Mespilus germanica) Extracts Obtained Using Different Solvents and Gökhan Akarca. *Records of Agricultural and Food Chemistry*, *2*(December), 19–26.

Dey, A., Pandey, G., & Rawtani, D. (2022). Functionalized nanomaterials driven antimicrobial food packaging : A technological advancement in food science. *Food Control*, *131*(2021), 1–19. https://doi.org/10.1016/j.foodcont.2021.108469

Di Mauro, E., Rho, D., & Santato, C. (2021). Biodegradation of bio-sourced and synthetic organic electronic materials towards green organic electronics. *Nature Communications*, *12*(1), 1–10. https://doi.org/10.1038/s41467-021-23227-4

Ding, X., Li, D., & Jiang, J. (2020). *Theranostics Gold-based Inorganic Nanohybrids for Nanomedicine Applications*. *10*(18), 8061–8079. https://doi.org/10.7150/thno.42284

Diop, A. L., Malan, D. F., & Kougbo, M. D. (2022). Perception of malaria and cultural diversity of antimalarial plants in three sympatric communities : Agni , Akyé and Gwa in the District of Alépé , Côte d ' Ivoire. *Asain Journal of Technology*, *5*(1), 1–11. https://doi.org/10.13057/asianjethnobiol/y050201

Donatien Kaboré, Diawara, B., Mogens JakobsenDicko, M. H., & Clarisse S. CompaoréSawadogo-Lingani, H. (2011). A review of baobab (Adansonia digitata) products: Effect of processing techniques, medicinal properties and uses. *African Journal of Food Science*, *5*(16), 833–844. https://doi.org/10.5897/ajfsx11.004

Donga, S., Bhadu, G. R., & Chanda, S. (2020). Antimicrobial, antioxidant and anticancer activities of gold nanoparticles green synthesized using Mangifera indica seed aqueous extract. *Artificial Cells, Nanomedicine and Biotechnology*, *48*(1), 1315–1325. https://doi.org/10.1080/21691401.2020.1843470

Dorothy, V., Lucy, H., Sunday, O. O., & Mary, O. U. (2022). The anti-inflammatory activities of twelve Nigerian medicinal plants: Inhibition of NfkB, activation of Nrf2, and antioxidant content. *African Journal of Biochemistry Research*, *16*(1), 1–10. https://doi.org/10.5897/ajbr2021.1134

Dowlath, M. J. H., Karuppannan, S. K., Sinha, P., Dowlath, N. S., Arunachalam, K. D., Ravindran, B., Chang, S. W., Nguyen-Tri, P., & Nguyen, D. D. (2021). Effects of radiation and role of plants in radioprotection: A critical review. *Science of the Total Environment*, *779*, 146431. https://doi.org/10.1016/j.scitotenv.2021.146431

Dreaden, E. C., El-Sayed, M. A., Mackey, M. A., A, L., & Austin. (2012). Size matters : gold nanoparticles in targeted cancer drug delivery. *Future Science Group*, 457–478.

Duta, L., Dorcioman, G., & Grumezescu, V. (2021). A review on biphasic calcium phosphate materials derived from fish discards. *Nanomaterials*, *11*(11), 1–37. https://doi.org/10.3390/nano11112856

Dykas, K., Felkle, D., Karnas, K., Khachatryan, G., Duli, J., & Karewicz, A. (2022). Hyaluronic Acid-Silver Nanocomposites and Their Biomedical Applications: A Review. *Materials Review*, 1–16.

Egbadzor, K. F., & Akuaku, J. (2022). Prospects of raising baobab (Adansonia digitata L.) to fruiting in two years. *Trees, Forests and People*, *8*, 1–4. https://doi.org/10.1016/j.tfp.2022.100232

Eid, A. M., & Hawash, M. (2021). Biological evaluation of Safrole oil and Safrole oil Nanoemulgel as antioxidant , antidiabetic , antibacterial , antifungal and anticancer. *BMC Complementary Medicine and Therapies*, 1–12.

Elkhoury, K., Russell, C. S., Sanchez-gonzalez, L., Mostafavi, A., Williams, T. J., Kahn, C., Peppas, N. A., Arab-tehrany, E., & Tamayol, A. (2019). Soft-Nanoparticle Functionalization of Natural Hydrogels for Tissue Engineering Applications. *Dvanced Healthcare Material*, *1*(1), 1–14. https://doi.org/10.1002/adhm.201900506

Elmusa, F., Aygun, A., Gulbagca, F., Seyrankaya, A., Göl, F., Yenikaya, C., & Sen, F. (2021). Investigation of the antibacterial properties of silver nanoparticles synthesized using Abelmoschus esculentus extract and their ceramic applications. *International Journal of Environmental Science and Technology*, *18*(4), 849–860. https://doi.org/10.1007/s13762-020-02883-x

Eren, A., & Baran, M. F. (2019). Green synthesis, characterization and antimicrobial activity of silver nanoparticles (AgNPs) from maize (Zea Mays L.). *Applied Ecology and Environmental Research*, *17*(2), 4097–4105. https://doi.org/10.15666/aeer/1702_40974105

Espinosa, J. C. M., Cerritos, R. C., Morales, M. A. R., Guerrero, K. P. S., Contreras, R. A. S., & Macías, J. H. (2020). Characterization of silver nanoparticles obtained by a green route and their evaluation in the bacterium of pseudomonas aeruginosa. *Crystals*, *10*(5), 1–13. https://doi.org/10.3390/cryst10050395

Fadil, Y., Thickett, S. C., Agarwal, V., & Zetterlund, P. B. (2022). Synthesis of graphene-based polymeric nanocomposites using emulsion techniques. *Progress in Polymer Science*, *125*, 1–35. https://doi.org/10.1016/j.progpolymsci.2021.101476

Fahmy, S. A., Azzazy, H. M. E.-S., Bakowsky, U., & Preis, E. (2020). Palladium Nanoparticles Fabricated by Green. *Materials Review*, 1–22.

Fernandes, H. R., Rebelo, A., Stan, G. E., Gaddam, A., & Brazete, D. (2018). Bioactive Glasses and Glass-Ceramics for Healthcare Applications in Bone Regeneration and Tissue Engineering. *Materials Review*, *1*(1), 1–54.

https://doi.org/10.3390/ma11122530

Fernandez, V. E., & Ruiz, M. A. (2021). Polyphenol content, antioxidant capacity and toxicity of Solanum ferrugineum (Solanaceae) with medicinal potential. *Acta Biológica Colombiana*, *26*(3), 414–422. https://doi.org/10.15446/abc.v26n3.87032

Friedrich, R. P., Cicha, I., & Alexiou, C. (2021). Iron Oxide Nanoparticles in Regenerative Medicine and Tissue Engineering. *Nanomaterials*, 1–72.

Fürstner, A. (2021). Lessons from Natural Product Total Synthesis: Macrocyclization and Postcyclization Strategies. *Accounts of Chemical Research*, *54*(4), 861–874. https://doi.org/10.1021/acs.accounts.0c00759

Gao, W., Elnabawy, A. O., Hood, Z. D., Shi, Y., Wang, X., Roling, L. T., Pan, X., Mavrikakis, M., Xia, Y., & Chi, M. (2021). Atomistic insights into the nucleation and growth of platinum on palladium nanocrystals. *Nature Communications*, *12*(1), 1–10. https://doi.org/10.1038/s41467-021-23290-x

García-villegas, A., Rojas-garcía, A., Villegas-aguilar, M. D. C., Fernández-moreno, P., Fernández-ochoa, Á., Cádiz-gurrea, M. de la L., Arráez-román, D., & Segura-carretero, A. (2022). Cosmeceutical Potential of Major Tropical and Subtropical Fruit By-Products for a Sustainable Revalorization. *Antioxidants*, *11*(2), 1–37. https://doi.org/10.3390/antiox11020203

Gebresilassie, A. B., & Engida, A. M. (2021). Synthesis, characterization and functional evaluation of gold nanoparticles prepared using Dovyalis abyssinica leaf extracts as reducing and surface capping agent Abera. *Ethiop. J. Sci. Technol*, *14*(June), 171–190.

Gentile, C., Di Gregorio, E., Di Stefano, V., Mannino, G., Perrone, A., Avellone, G., Sortino, G., Inglese, P., & Farina, V. (2019). Food quality and nutraceutical value of nine cultivars of mango (Mangifera indica L.) fruits grown in Mediterranean subtropical environment. *Food Chemistry*, *277*(October 2018), 471–479. https://doi.org/10.1016/j.foodchem.2018.10.109

Gharpure, S., Yadwade, R., & Ankamwar, B. (2022). Non-antimicrobial and Non-anticancer Properties of ZnO Nanoparticles Biosynthesized Using Different

Plant Parts of Bixa orellana. *ACS Omega*, *7*(2), 1914–1933. https://doi.org/10.1021/acsomega.1c05324

Ghazi, I., Zefzoufi, M., Siniti, M., Fdil, R., & Elattari, H. (2022). Corrosion Inhibition of Carob Pod Pulp (Ceratonia siliqua L.) on Carbon Steel Surface C38 in Hydrochloric Acid. *Journal of Bio- and Tribo-Corrosion*, *8*(1), 1–23. https://doi.org/10.1007/s40735-022-00630-y

Gianguzzi, G., Farina, V., Inglese, P., & Rodrigo, M. G. L. (2021). Effect of harvest date on mango (Mangifera indica l. cultivar osteen) fruit's qualitative development, shelf life and consumer acceptance. *Agronomy*, *11*(4), 1–11. https://doi.org/10.3390/AGRONOMY11040811

Govindaraju, S., & Yun, K. (2018). Synthesis of gold nanomaterials and their cancer - related biomedical applications : an update. *3 Biotech*, 1–13. https://doi.org/10.1007/s13205-018-1137-y

Grover, J. K., & Yadav, S. P. (2004). Pharmacological actions and potential uses of Momordica charantia: A review. *Journal of Ethnopharmacology*, *93*(1), 123–132. https://doi.org/10.1016/j.jep.2004.03.035

Gurkov, I., & Morley, M. J. (2021). Looking in the rear-view mirror—A 35 year retrospective on the Russian automotive industry. *Thunderbird International Business Review*, *63*(6), 699–712. https://doi.org/10.1002/tie.22197

Gurtu, M. G., & Sharma, M. (2021). Major Applications Of Green Nanotechnology In Sustainable Development And Its Impact On Global Environment : A Revi ew. *Natural Volatiles and Essentials Oils*, *8*(4), 12823–12851.

Gutiérrez-Del-río, I., López-Ibáñez, S., Magadán-Corpas, P., Fernández-Calleja, L., Pérez-Valero, Á., Tuñón-Granda, M., Miguélez, E. M., Villar, C. J., & Lombó, F. (2021). Terpenoids and polyphenols as natural antioxidant agents in food preservation. *Antioxidants*, *10*(8), 1–33. https://doi.org/10.3390/antiox10081264

H Madkour, L. (2017). Ecofriendly green biosynthesized of metallic nanoparticles: Bio-reduction mechanism, characterization and pharmaceutical applications in biotechnology industry. *Global Drugs and Therapeutics*, *3*(1), 1–11. https://doi.org/10.15761/gdt.1000144

Habibi, K. (2020). International Journal of Current Medical and Pharmaceutical Research. *International Journal Of Current Medical And Pharmaceutical Research*, *5*(09), 4521–4524. https://doi.org/10.24327/23956429.ijcmpr202001830

Hamouda, R. A., Hussein, M. H., Abo-elmagd, R. A., & Bawazir, S. S. (2019). Synthesis and biological characterization of silver nanoparticles derived from the cyanobacterium Oscillatoria limnetica. *Scientific Reports*, *9*(1), 1–17. https://doi.org/10.1038/s41598-019-49444-y

Hasan, I., Shekhar, C., Bin Sharfan, I. I., Khan, R. A., & Alsalme, A. (2020). Ecofriendly Green Synthesis of the ZnO-Doped CuO@Alg Bionanocomposite for Efficient Oxidative Degradation of p-Nitrophenol. *ACS Omega*, *5*(49), 32011–32022. https://doi.org/10.1021/acsomega.0c04917

Hasan, M. K., Ara, I., Mondal, M. S. A., & Kabir, Y. (2021). Phytochemistry, pharmacological activity, and potential health benefits of Glycyrrhiza glabra. *Heliyon*, *7*(6), 1–10. https://doi.org/10.1016/j.heliyon.2021.e07240

Hashim, M., Ahmad, B., Drouet, S., Hano, C., Abbasi, B. H., & Anjum, S. (2021). Comparative effects of different light sources on the production of key secondary metabolites in plants in vitro cultures. *Plants*, *10*(8), 1–18. https://doi.org/10.3390/plants10081521

Hassan, S. S. M., Azab, W. I. M. El, Ali, H. R., & Mansour, M. S. M. (2015). Green synthesis and characterization of ZnO nanoparticles for photocatalytic degradation of anthracene. *Advances in Natural Sciences*, 1–12.

Heads, M. (2019). Biogeography and ecology in a pantropical family, the Meliaceae. *Gardens' Bulletin Singapore*, *71*(suppl.2), 335–461. https://doi.org/10.26492/gbs71(suppl.2).2019-22

Hernández, A. A., Gabriel, H., Álvarez, A., Cariño, R., & Mendoza-Huizar, L. H. (2020). Iron oxide nanoparticles : synthesis , functionalization , and applications in diagnosis and treatment of cancer. *Chemical Papers*, *2*, 1–16. https://doi.org/10.1007/s11696-020-01229-8

Hosny, M., Fawzy, M., El-Badry, Y. A., Hussein, E. E., & Eltaweil, A. S. (2022).

Plant-assisted synthesis of gold nanoparticles for photocatalytic, anticancer, and antioxidant applications. *Journal of Saudi Chemical Society*, *26*(2), 1–14. https://doi.org/10.1016/j.jscs.2022.101419

Huang, L., Lin, H., Chen, Q., Yu, L., & Bai, D. (2019). MPPa-PDT suppresses breast tumor migration/invasion by inhibiting Akt-NF-κB-dependent MMP-9 expression via ROS. *BMC Cancer*, *19*(1), 1–11. https://doi.org/10.1186/s12885-019-6374-x

Hussein, H. A., & Abdullah, M. A. (2021). Novel drug delivery systems based on silver nanoparticles , hyaluronic acid , lipid nanoparticles and liposomes for cancer treatment. *Applied Nanoscience*, 1–26. https://doi.org/10.1007/s13204-021-02018-9

I.Ln, I., A.K, D., S.Y, M., F.H, B., Y.B, P., S.H, M., M.Z, D., & M, M. (1967). COMPARATIVE PROXIMATE EVALUATION OF PEARL MILLET (PENNISETUMTYPHOIDES), MAIZE (ZEA MAYS), GARLIC (ALLIUM SATIVUM), GINGER(ZINGEBEROFFICINALE) AND GREAT MILLET (SORGHUM BICOLOR). *Gastronomía Ecuatoriana y Turismo Local.*, *1*(69), 28–40.

Ibisanmi, T. A. (2022). Nanotechnology Strategy as Antibacterial : a Primer for the Notice . *Research Square*, *20*, 1–17.

Imoro, A. Z., Khan, A. T., & Eledi, J. D. A. (2013). Exploitation and use of medicinal plants, Northern Region, Ghana. *Journal of Medicinal Plants Research*, *7*(27), 1984–1993. https://doi.org/10.5897/jmpr12.489

Imran, M., Irfan, A., Khalid, M., Khalid, N., Uddin, J., Hussain, R., Ali, B., Hussien, M., Assiri, M. A., & Al-Sehemi, A. G. (2021). In-vitro and in-silico antioxidant, α-glucosidase inhibitory potentials of abutilins C and D, new flavonoide glycosides from Abutilon pakistanicum. *Arabian Journal of Chemistry*, *14*(4), 1–12. https://doi.org/10.1016/j.arabjc.2021.103021

Iqbal, A., Saeed, A., & Ul-Hamid, A. (2021). A review featuring the fundamentals and advancements of polymer/CNT nanocomposite application in aerospace industry. *Polymer Bulletin*, *78*(1), 539–557. https://doi.org/10.1007/s00289-019-

03096-0

Iqbal, J., Abbasi, B. A., Yaseen, T., Zahra, S. A., Shahbaz, A., Shah, S. A., Uddin, S., Ma, X., Raouf, B., Kanwal, S., Amin, W., Mahmood, T., El-Serehy, H. A., & Ahmad, P. (2021). Green synthesis of zinc oxide nanoparticles using Elaeagnus angustifolia L. leaf extracts and their multiple in vitro biological applications. *Scientific Reports*, *11*(1), 1–13. https://doi.org/10.1038/s41598-021-99839-z

Irshad, M. A., Nawaz, R., Rehman, M. Z. ur, Adrees, M., Rizwan, M., Ali, S., Ahmad, S., & Tasleem, S. (2021). Synthesis, characterization and advanced sustainable applications of titanium dioxide nanoparticles: A review. *Ecotoxicology and Environmental Safety*, *212*, 1–14. https://doi.org/10.1016/j.ecoenv.2021.111978

Ishaque, M., Nisa, S., Masood, S., Bibi, Y., & Ayoubi, S. Al. (2021). Antibiotic for Gastrointestinal Tract Infections. *Antibiotics*, 1–14.

Ishaque, S., Arshad, A., Haider, M., & Fatima, F. (2021). Therapeutic Activities of Garlic Constituent Phytochemicals. *Biological and Clinical Sciences Research Journal*, 1–9.

Islam, R., Sun, L., & Zhang, L. (2021). Biomedical applications of chinese herb-synthesized silver nanoparticles by phytonanotechnology. *Nanomaterials*, *11*(10), 1–27. https://doi.org/10.3390/nano11102757

Izzaty, R. E., Astuti, B., & Cholimah, N. (2021). Documentation of Medicinal Plants used bt the Tradional Healers, Mayannur Forest, Thrissur District, Kerala , India. *Angewandte Chemie International Edition*, *8*(2), 1–26.

Jabbar, A. H., A-kadhim, M. M., Maseer, R. M., & Oudah, S. (2021). Eco-Friendly Synthesis of Silver Nanoparticles AGNPS and Antibacterial Actitivty. *Turkish Journal of Physiotherapy and Rehabilitation*, *32*(3), 11225–11231.

Jadhav, A. S., Urkude, R. P., & Jangam, S. S. (2021). CURRENT REVIEW ON NANOPARTICLES : PROPERTIES ,. *SJIF Impact Factor*, *10*(3), 804–829. https://doi.org/10.20959/wjpr20213-19897

Jadoun, S., Arif, R., Jangid, N. K., & Meena, R. K. (2021). Green synthesis of nanoparticles using plant extracts: a review. *Environmental Chemistry Letters*, *19*(1), 355–374. https://doi.org/10.1007/s10311-020-01074-x

Jain, N., Jain, P., Rajput, D., & Patil, U. K. (2021). Green synthesized plant-based silver nanoparticles: therapeutic prospective for anticancer and antiviral activity. *Micro and Nano Systems Letters*, *9*(1). https://doi.org/10.1186/s40486-021-00131-6

Jaiswal, D., Devnani, G. L., Rajeshkumar, G., Sanjay, M. R., & Siengchin, S. (2022). Review on extraction, characterization, surface treatment and thermal degradation analysis of new cellulosic fibers as sustainable reinforcement in polymer composites. *Current Research in Green and Sustainable Chemistry*, *5*(November 2021), 1–17. https://doi.org/10.1016/j.crgsc.2022.100271

Joy Ugo, N., Raymond Ade, A., & Tochi Joy, A. (2019). Nutrient Composition of Carica Papaya Leaves Extracts. *Journal of Food Science and Nutrition Research*, *02*(03), 274–282. https://doi.org/10.26502/jfsnr.2642-11000026

Jubair, N., Rajagopal, M., Chinnappan, S., Abdullah, N. B., & Fatima, A. (2021). Review on the Antibacterial Mechanism of Plant-Derived Compounds against Multidrug-Resistant Bacteria (MDR). *Evidence-Based Complementary and Alternative Medicine*, *2021*, 1–30. https://doi.org/10.1155/2021/3663315

Kakudidi, E., Anywar, G., Kiguli, J., Katuura, E., & Kirimuhuzya, C. (2016). Medicinal plants - recent advances in research and development. *Medicinal Plants - Recent Advances in Research and Development*, *July 2017*, 1–491. https://doi.org/10.1007/978-981-10-1085-9

Kalpana, V. N., & Devi Rajeswari, V. (2018). A Review on Green Synthesis, Biomedical Applications, and Toxicity Studies of ZnO NPs. *Bioinorganic Chemistry and Applications*, *2018*(1), 1–12. https://doi.org/10.1155/2018/3569758

Kanti, A., Rahman, M. M., Biswas, B., & Naidu, R. (2021). Mechanistic insights of hexavalent chromium remediation by halloysite- supported copper nanoclusters Mechanistic insights of hexavalent chromium remediation by halloysite-

supported copper nanoclusters. *Journal of Hazardous Materials*, *421*(8), 1–14. https://doi.org/10.1016/j.jhazmat.2021.126812

Kavitha, S., Sadishkumar, S. T., & Prabhu, N. (2021). Biomedical Applications of Wo 3 , Zno and Graphene Nanoparticles. *International Journal of Mechanical Engineering*, *6*(3), 972–982.

Kebede, T., Gadisa, E., & Tufa, A. (2021). Antimicrobial activities evaluation and phytochemical screening of some selected medicinal plants: A possible alternative in the treatment of multidrug-resistant microbes. *PLoS ONE*, *16*(3 March), 1–16. https://doi.org/10.1371/journal.pone.0249253

Keith, J. A., Vassilev-Galindo, V., Cheng, B., Chmiela, S., Gastegger, M., Müller, K. R., & Tkatchenko, A. (2021). Combining Machine Learning and Computational Chemistry for Predictive Insights into Chemical Systems. *Chemical Reviews*, *121*(16), 9816–9872. https://doi.org/10.1021/acs.chemrev.1c00107

Kemegne, G. A., Nyegue, M. A., Kamdem, S. L. S., Etoa, F. X., & Menut, C. (2018). Mangifera indica bark essential oil: Chemical composition and biological activities in comparison with aqueous and ethanol extracts. *Natural Product Communications*, *13*(7), 903–906. https://doi.org/10.1177/1934578x1801300730

Keșa, A. L., Pop, C. R., Mudura, E., Salanță, L. C., Pasqualone, A., Dărab, C., Burja-Udrea, C., Zhao, H., & Coldea, T. E. (2021). Strategies to improve the potential functionality of fruit-based fermented beverages. *Plants*, *10*(11), 1–27. https://doi.org/10.3390/plants10112263

Ketan, D., & Dhatariya, K. (2004). *Assessing the Effects of Dehydroepiandrosterone (DHEA) Replacement on Insulin Sensitivity, Body Composition, and Skeletal Muscle Physiology in Hypoadrenal Women In Partial Fulfilment of the Requirements for the MD*. *February*.

Khan, F., Shariq, M., Asif, M., Siddiqui, M. A., Malan, P., & Ahmad, F. (2022). Green Nanotechnology: Plant-Mediated Nanoparticle Synthesis and Application. *Nanomaterials*, *12*(4), 1–22. https://doi.org/10.3390/nano12040673

Khandel, P., Yadaw, R. K., Soni, D. K., Kanwar, L., & Shahi, S. K. (2018).

Biogenesis of metal nanoparticles and their pharmacological applications: present status and application prospects. In *Journal of Nanostructure in Chemistry* (Vol. 8, Issue 3). Springer Berlin Heidelberg. https://doi.org/10.1007/s40097-018-0267-4

Khazaei, H., Pesce, M., Patruno, A., Aneva, I. Y., & Farzaei, M. H. (2021). Medicinal plants for diabetes associated neurodegenerative diseases: A systematic review of preclinical studies. *Phytotherapy Research*, *35*(4), 1697–1718. https://doi.org/10.1002/ptr.6903

Kishor, R., Purchase, D., Saratale, G. D., Saratale, R. G., Ferreira, L. F. R., Bilal, M., Chandra, R., & Bharagava, R. N. (2021). Ecotoxicological and health concerns of persistent coloring pollutants of textile industry wastewater and treatment approaches for environmental safety. *Journal of Environmental Chemical Engineering*, *9*(2), 1–18. https://doi.org/10.1016/j.jece.2020.105012

Komlaga, G., Agyare, C., Dickson, R. A., Mensah, M. L. K., Annan, K., Loiseau, P. M., & Champy, P. (2015). Medicinal plants and finished marketed herbal products used in the treatment of malaria in the Ashanti region, Ghana. *Journal of Ethnopharmacology*, *172*, 333–346. https://doi.org/10.1016/j.jep.2015.06.041

Kumar, Anil, Liang, X.-J., Zou, G., Cao, W., Wei, T., Liu, J., Jin, S., Huang, K., Zhang, X., & Ma, H. (2012). Gold nanoparticles functionalized with therapeutic and targeted peptides for cancer treatment. *Biomaterials*, *33*, 1180–1189. https://doi.org/10.1016/j.biomaterials.2011.10.058

Kumar, Arun, & Rao, S. (2021). Review — Carbon Electrodes in Magnesium Sulphur Batteries : Performance Comparison of Electrodes and Future Directions Manuscript version : Accepted Manuscript. *The Electrochemical Society*, *1*(3), 1–57.

Kumar Bachheti, R., Fikadu, A., Bachheti, A., & Husen, A. (2020). Biogenic fabrication of nanomaterials from flower-based chemical compounds, characterization and their various applications: A review. *Saudi Journal of Biological Sciences*, *27*(10), 2551–2562. https://doi.org/10.1016/j.sjbs.2020.05.012

Kumar, H., Bhardwaj, K., Cruz-Martins, N., Nepovimova, E., Oleksak, P., Dhanjal, D. S., Bhardwaj, S., Singh, R., Chopra, C., Verma, R., Chauhan, P. P., Kumar, D., & Kuča, K. (2021). Applications of fruit polyphenols and their functionalized nanoparticles against foodborne bacteria: A mini review. *Molecules*, *26*(11), 1–19. https://doi.org/10.3390/molecules26113447

Kumar, M., Saurabh, V., Tomar, M., Hasan, M., Changan, S., Sasi, M., Maheshwari, C., Prajapati, U., Singh, S., Prajapat, R. K., Dhumal, S., Punia, S., Amarowicz, R., & Mekhemar, M. (2021). Mango (Mangifera indica l.) leaves: Nutritional composition, phytochemical profile, and health-promoting bioactivities. *Antioxidants*, *10*(2), 1–23. https://doi.org/10.3390/antiox10020299

Kumar, P., Inwati, G. K., Mathpal, M. C., Ghosh, S., Roos, W. D., & Swart, H. C. (2021). Defects induced enhancement of antifungal activities of Zn doped CuO nanostructures. *Applied Surface Science*, *560*(2), 1–18. https://doi.org/10.1016/j.apsusc.2021.150026

Kumar, Santosh, Gerth, K., Mukherji, A., & Zhi, K. (2020). Repurposing Antiviral Protease Inhibitors Using. *Viruses*, *12*(486), 15.

Kumar, Sunil, Joseph, L., & George, M. (2015). Herbal approaches of leaves of the plant maytenus emarginata as anti-inflammatory and anti-nociceptive. *World Journal of Pharmaceutical Sciences*, *10*(02), 216–231.

Kumari, I., Kaurav, H., & Chaudhary, G. (2021). Ethnobotanical Significance of Picrorhiza Kurroa (Kutki), a Threatened Species. *International Journal of Research and Review*, *8*(4), 363–375. https://doi.org/10.52403/ijrr.20210443

Kumari, Y., Porwal, O., Dua, K., Singh, P. K., Kapoor, B., Yadav, A. K., Kumar, R., Awasthi, A., Ghosh, D., Mahalingam, R., Narayana, V. V. S., Karri, R., Khursheed, R., Gowthamarajan, K., Clarisse, A., Gulati, M., Singh, S. K., Kumar, R., & Kaur, G. (2019). Gold Nanoparticles: New Routes Across Old Boundaries. *Advances in Colloid and Interface Science*, 1–113. https://doi.org/10.1016/j.cis.2019.102037

Kurniawan, Y. S., Priyangga, K. T. A., Krisbiantoro, P. A., & Imawan, A. C. (2021). Green Chemistry Influences in Organic Synthesis: A Review. *Journal of*

Multidisciplinary Applied Natural Science, *2*(1), 56–61.

Kwame, A. (2021). Integrating Traditional Medicine and Healing into the Ghanaian Mainstream Health System: Voices From Within. *Qualitative Health Research*, *31*(10), 1847–1860. https://doi.org/10.1177/10497323211008849

Liang, X., Luo, D., & Luesch, H. (2019). Advances in exploring the therapeutic potential of marine natural products. *Pharmacological Research*, *147*, 104373. https://doi.org/10.1016/j.phrs.2019.104373

Liu, J., Ge, X., Liu, L., Xu, W., & Shao, R. (2022). Challenges and Opportunities of Silk Protein Hydrogels in Biomedical Applications. *Materials Advances*, 1–15. https://doi.org/10.1039/d1ma00960e

Liu, P., Li, Y., Wang, R., Ren, F., & Wang, X. (2022). Oxidative Stress and Antioxidant Nanotherapeutic Approaches for Inflammatory Bowel Disease. *Biomedicines*, *10*(1), 1–16. https://doi.org/10.3390/biomedicines10010085

Lowe, H., Steele, B., Bryant, J., Fouad, E., Toyang, N., & Ngwa, W. (2021). Antiviral activity of jamaican medicinal plants and isolated bioactiv compounds. *Molecules*, *26*(3), 1–30. https://doi.org/10.3390/molecules26030607

Lu, Z., Giles, L. W., Teo, B. M., & Tabor, R. F. (2022). Carbon dots as a 'green' reagent to produce shape and size controlled gold nanoparticles for application in pollutant degradation. *Colloids and Interface Science Communications*, *46*(December 2021), 1–6. https://doi.org/10.1016/j.colcom.2021.100571

Luyckx, V. A., Al-Aly, Z., Bello, A. K., Bellorin-Font, E., Carlini, R. G., Fabian, J., Garcia-Garcia, G., Iyengar, A., Sekkarie, M., van Biesen, W., Ulasi, I., Yeates, K., & Stanifer, J. (2021). Sustainable Development Goals relevant to kidney health: an update on progress. *Nature Reviews Nephrology*, *17*(1), 15–32. https://doi.org/10.1038/s41581-020-00363-6

Mafara, S. M., & Bakura, T. L. (2021). MULTIPLE POTENTIALS OF NEEM TREE (AZADIRACHTA INDICA); A REVIEW. *Bakolori Journal of General Studies*, *11*(1), 3110–3128.

Mahana, A., Guliy, O. I., & Mehta, S. K. (2021). Accumulation and cellular toxicity of engineered metallic nanoparticle in freshwater microalgae: Current status and future challenges. *Ecotoxicology and Environmental Safety*, *208*(1), 1–14. https://doi.org/10.1016/j.ecoenv.2020.111662

Mahato, K., Nagpal, S., Ayesha, M., Ananya, S., Pawan, S., & Maurya, K. (2019). Gold nanoparticle surface engineering strategies and their applications in biomedicine and diagnostics. *3 Biotech*, *3*(2019), 1–19. https://doi.org/10.1007/s13205-019-1577-z

Mahomoodally, M. F. (2013). Traditional Medicines in Africa : An Appraisal of Ten Potent African Medicinal Plants. *Evidence-Based Complementary and Alternative Medicine*, *2013*(2), 1–15.

Malik, P., Shankar, R., Malik, V., Sharma, N., & Mukherjee, T. K. (2014). Green Chemistry Based Benign Routes for Nanoparticle Synthesis. *Journal of Nanoparticles*, *2014*, 1–14. https://doi.org/10.1155/2014/302429

Manisha, D. R., Alwala, J., Kudle, K. R., & Rudra, M. P. P. (2014). Biosynthesis of Silver nanoparticles using flower extracts of Catharanthus roseus and evaluation of its antibacterial efficacy. *World Journal of Pharmacy and Pharmaceutical Sciences*, *3*(5), 669–677.

Mansuriya, B. D., & Altintas, Z. (2021). Carbon dots: Classification, properties, synthesis, characterization, and applications in health care-an updated review (2018–2021). *Nanomaterials*, *11*(10), 1–25. https://doi.org/10.3390/nano11102525

Mante, R. Y. A. (2019). University of Ghana Evaluation of Some Nutraceutical Properties of Lesser Known Functional Foods in Ghana [Univerity of Ghana-Legon]. In *University of Ghana* (Issue July). http://ugspace.ug.edu.gh/handle/123456789/34746

Marslin, G., Siram, K., Maqbool, Q., Selvakesavan, R. K., Kruszka, D., Kachlicki, P., & Franklin, G. (2018). Secondary metabolites in the green synthesis of metallic nanoparticles. *Materials*, *11*(6), 1–25. https://doi.org/10.3390/ma11060940

Mehta, S., & Macgillivray, M. (2022). Aromatherapy in Textiles : A Systematic Review of Studies Examining Textiles as a Potential Carrier for the Therapeutic Effects of Essential Oils †. *Texiles*, 29–49.

Mejía-Giraldo, J. C., Gallardo, C., & Puertas-Mejía, M. A. (2022). Selected Extracts from High Mountain Plants as Potential Sunscreens with Antioxidant Capacity. *Photochemistry and Photobiology*, *98*(1), 211–219. https://doi.org/10.1111/php.13490

Mital, P., & Jha, C. (2021). Qualitative and Quantitative Phytochemical Screening of Three Plants Stem Bark and. *International Journal of Multidiciplinary Education Research*, *816*(6), 1–6.

Mitchell, M. J., Billingsley, M. M., Haley, R. M., Langer, R., Wechsler, M. E., & Peppas, N. A. (2021). Engineering precision nanoparticles. *Nature Reviews Drug Discovery*, *20*(2), 101–123. https://doi.org/10.1038/s41573-020-0090-8

Modi, S., Prajapati, R., Inwati, G. K., Deepa, N., Tirth, V., Yadav, V. K., Yadav, K. K., Islam, S., Gupta, P., & Kim, D. (2022). Recent Trends in Fascinating Applications of Nanotechnology in Allied Health Sciences. *Crystals Review*, *1*(1), 1–16.

Mohajeri, M. (2018). Biomedical applications of carbon nanomaterials : Drug and gene delivery potentials. *Journal of Cellular Physiology*, *1*(3), 1–22. https://doi.org/10.1002/jcp.26899

Mohammadi, S., Cao, Y., & Abyaneh, M. H. (2022). Nanosized Products for Agriculture. *Nanosized Products for Agriculture Reported*, *January*, 1–37.

Mohd Taib, S. H., Shameli, K., Moozarm Nia, P., Etesami, M., Miyake, M., Rasit Ali, R., Abouzari-Lotf, E., & Izadiyan, Z. (2019). Electrooxidation of nitrite based on green synthesis of gold nanoparticles using Hibiscus sabdariffa leaves. *Journal of the Taiwan Institute of Chemical Engineers*, *95*, 616–626. https://doi.org/10.1016/j.jtice.2018.09.021

Monowar, T., Rahman, M. S., Bhore, S. J., & Sathasivam, K. V. (2021). Endophytic bacteria enterobacter hormaechei fabricated silver nanoparticles and their antimicrobial activity. *Pharmaceutics*, *13*(4), 1–15.

https://doi.org/10.3390/pharmaceutics13040511

More, G. K., Makola, R. T., & Prinsloo, G. (2021). In Vitro Evaluation of Anti-Rift Valley Fever Virus , Antioxidant Plant Extracts. *Viruses*, *13*, 1–18.

Morgan, E. D. (2009). Azadirachtin, a scientific gold mine. *Bioorganic and Medicinal Chemistry*, *17*(12), 4096–4105. https://doi.org/10.1016/j.bmc.2008.11.081

Mousavi, S. M., Hashemi, S. A., Behbudi, G., Mazraedoost, S., Omidifar, N., Gholami, A., Chiang, W. H., Babapoor, A., & Pynadathu Rumjit, N. (2021). A Review on Health Benefits of Malva sylvestris L. Nutritional Compounds for Metabolites, Antioxidants, and Anti-Inflammatory, Anticancer, and Antimicrobial Applications. *Evidence-Based Complementary and Alternative Medicine*, *2021*, 1–13. https://doi.org/10.1155/2021/5548404

Muhammed, D., Odey, B. O., Agboola, A. R., Adegbola, G. A., Alawode, A. R., & Yusuf, A. A. (2021). A systematic review of domestication, ethnopharmacological use, phytochemistry, nutritional composition, and biological activities of Parkia biglobosa (Jacq.) R.Br. ex G.Don. *BIOMED Natural and Applied Science*, *01*(01), 20–31.

Mukhtar, M., Ameyaw, B., Yimen, N., Quixin, Z., Bamisile, O., Adun, H., & Dagbasi, M. (2021). Building retrofit and energy conservation/efficiency review: A techno-environ-economic assessment of heat pump system retrofit in housing stock. *Sustainability (Switzerland)*, *13*(2), 1–23. https://doi.org/10.3390/su13020983

Muntala, A., Kwadwo Gyasi, S., Mawuenyegan Norshie, P., Larbi-Koranteng, S., Kwekucher Ackah, F., Afreh Ntiamoah, D., & Atef Mohamed, M. (2021). Diseases and Insect Pests associated with Cashew (Anacardium occidentale L.) Orchards in Ghana. *European Journal of Agriculture and Food Sciences*, *3*(5), 23–32. https://doi.org/10.24018/ejfood.2021.3.5.357

Mustapha, T., Misni, N., Ithnin, N. R., Daskum, A. M., & Unyah, N. Z. (2022). A Review on Plants and Microorganisms Mediated Synthesis of Silver Nanoparticles , Role of Plants Metabolites and Applications. *International*

Journal of Environmental Research and Public Health, 1–17.

Nadeem, M., Khan, R., Shah, N., Bangash, I. R., Abbasi, B. H., Hano, C., Liu, C., Ullah, S., Hashmi, S. S., Nadhman, A., & Celli, J. (2022). A Review of Microbial Mediated Iron Nanoparticles (IONPs) and Its Biomedical Applications. *Nanomaterials Review*, *12*, 1–12.

Naegeli, H., Mevissen, M., Walkenhorst, M., Ayrle, H., & Kupper, J. (2017). Recent challenges in veterinary pharmacotherapy – could medicinal plants be an option? *Thieme*, *4*(September), 1–202. https://doi.org/10.1055/s-0037-1608012

Naganthran, A., Verasoundarapandian, G., Khalid, F. E., Masarudin, M. J., Zulkharnain, A., Nawawi, N. M., Karim, M., Abdullah, C. A. C., & Ahmad, S. A. (2022). Synthesis, Characterization and Biomedical Application of Silver Nanoparticles. *Materials*, *15*(2), 1–43. https://doi.org/10.3390/ma15020427

Naikoo, G. A., Mustaqeem, M., Hassan, I. U., Awan, T., Arshad, F., Salim, H., & Qurashi, A. (2021). Bioinspired and green synthesis of nanoparticles from plant extracts with antiviral and antimicrobial properties: A critical review. *Journal of Saudi Chemical Society*, *25*(9), 1–17. https://doi.org/10.1016/j.jscs.2021.101304

Naimon, N., Pongchairerk, U., & Suebkhampet, A. (2015). Phytochemical analysis and antibacterial activity of ethanolic leaf extract of solanum torvum sw. against pathogenic bacteria. *Kasetsart Journal - Natural Science*, *49*(4), 516–523.

Nangare, S. N., & Patil, P. O. (2020). Green synthesis of silver nanoparticles: An eco-friendly approach. *Nano Biomedicine and Engineering*, *12*(4), 281–296. https://doi.org/10.5101/nbe.v12i4.p281-296

Narchin, F., Larijani, K., Rustaiyan, A., Ebrahimi, S. N., & Tafvizi, F. (2018). Phytochemical synthesis of silver nanoparticles by two techniques using Saturaja rechengri Jamzad extract: Identifying and comparing in vitro anti-proliferative activities. *Advanced Pharmaceutical Bulletin*, *8*(2), 235–244. https://doi.org/10.15171/apb.2018.028

National, G., & Pillars, H. (2021). Effectiveness of Azadirachta indica (neem tree) on Prevention and Treatment of Clinical Human. *East African Health Research Commission, Research for Health and Prosperity*, *2*(1), 34–43.

Naveed Ul Haq, A., Nadhman, A., Ullah, I., Mustafa, G., Yasinzai, M., & Khan, I. (2017). Synthesis Approaches of Zinc Oxide Nanoparticles: The Dilemma of Ecotoxicity. *Journal of Nanomaterials*, *2017*(1), 1–14. https://doi.org/10.1155/2017/8510342

Nayak, V., Singh, K. R., Singh, A. K., & Singh, R. P. (2021). Potentialities of selenium nanoparticles in biomedical science. *New Journal of Chemistry*, *45*(6), 2849–2878. https://doi.org/10.1039/d0nj05884j

Nerkar, A. G., & Chakraborthy, G. S. (2021). Review of azadirachta indica. *Current Trends in Pharmacy and Pharmaceutical Chemistry*, *3*(3), 11–14. https://doi.org/10.18231/j.ctppc.2021.004

Newaz, A. I., Sikder, A. K., Rahman, M. A., & Uluagac, A. S. (2021). A Survey on Security and Privacy Issues in Modern Healthcare Systems. *ACM Transactions on Computing for Healthcare*, *2*(3), 1–44. https://doi.org/10.1145/3453176

Newman, D. J., & Cragg, G. M. (2012). Natural products as sources of new drugs over the 30 years from 1981 to 2010. *Journal of Natural Products*, *75*(3), 311–335. https://doi.org/10.1021/np200906s

Ng'uni, T., Klaasen, J. A., & Fielding, B. C. (2018). Acute toxicity studies of the South African medicinal plant Galenia africana. *Toxicology Reports*, *5*(July 2017), 813–818. https://doi.org/10.1016/j.toxrep.2018.08.008

Nikiema, J., & Asiedu, Z. (2022). A review of the cost and effectiveness of solutions to address plastic pollution. *Environmental Science and Pollution Research*, *2022*, 1–27. https://doi.org/10.1007/s11356-021-18038-5

Njoga, U. J., Oguejiofor, C. F., & Ochiogu, I. S. (2021). Azadirachta indica seed extract caused detrimental pregnancy outcomes and haematological effects in adult female albino rats. *Animal Research International*, *18*(1), 3927–3937.

Nxumalo, K. A., Aremu, A. O., & Fawole, O. A. (2021). Potentials of medicinal plant extracts as an alternative to synthetic chemicals in postharvest protection and preservation of horticultural crops: A review. *Sustainability (Switzerland)*, *13*(11), 1–33. https://doi.org/10.3390/su13115897

Odounharo, O. G. R., Gnansounou, S. C., Salako, K. V., Idohou, R., Mensah, G. A., Glèlè Kakaï, R., & Assogbadjo, A. E. (2021). Medicinal use patterns of Parkia biglobosa (Jacq.) Benth. and Vitellaria paradoxa (Gaertn. F), two important traditional agroforestry species in Benin, West-Africa. *Advances in Traditional Medicine*, *June*, 1–16. https://doi.org/10.1007/s13596-021-00583-6

Ofori, D. A., Darko, O. B., Gyimah, A., Adam, K. A., Jimoh, S. O., & Jamnadass, R. (2012). Ethnobotany, propagation and conservation of medicinal plants in Ghana. *Ghana J. Forestry*, 29–38.

Oguntibeju, O. O. (2018). Medicinal plants with anti-inflammatory activities from selected countries and regions of africa. *Journal of Inflammation Research*, *11*, 307–317. https://doi.org/10.2147/JIR.S167789

Ojewumi, M. E., Obanla, O. M., Ajayi, A. A., & Omoleye, J. A. (2021). Molecular Compositions and Morphological Structures of Fermented African Locust Bean Seed (Parkia biglobosa). *Letters in Applied NanoBioScience*, *11*(1), 3111–3119. https://doi.org/10.33263/lianbs111.31113119

Okafor, C. E., Kebodi, L. C., Ihueze, C. C., Rangappa, S. M., Siengchin, S., & Okonkwo, U. C. (2022). Development of Dioscorea alata stem fibers as eco-friendly reinforcement for composite materials. *Journal of King Saud University - Engineering Sciences*, *6*(4), 1–10. https://doi.org/10.1016/j.jksues.2022.02.003

Okigbo, R. N., & Frances, E. C. (2021). UNDERUTILIZED PLANTS OF AFRICA. *Journal of Biology and Nature*, *13*(2), 1–17.

Okwunodulu, F. U., Friday, C., Okwunodulu, I. N., & Chukwudi, V. I. (2021). Comparative Study on the Phytochemicals, Prox imates, Vitamins and Mineral Elements Compositions of Unfermented and Fermented Seeds of Parkia biglobosa. *Bioscience and Biotechnology Journal*, *2*(1), 7–10.

Oladzadabbasabadi, N., Nafchi, A. M., Ariffin, F., Wijekoon, M. M. J. O., Dheyab, M. A., & Ghasemlou, M. (2022). Recent advances in extraction, modification, and application of chitosan in packaging industry. *Carbohydrate Polymers*, *2021*, 1–95. https://doi.org/10.1016/j.carbpol.2021.118876

Onani, M. O., Meyer, M., M, A. M., Skepu, A., Drah, M., Meyer, M. D., Gabuza, K.

B., Thovhogi, N., & Sibuyi, N. R. S. (2017). Peptide-functionalized nanoparticles for the selective induction of apoptosis in target cells. *Nanomedicine*, 1–15.

Ondua, M., Njoya, E. M., Abdalla, M. A., & McGaw, L. J. (2019). Anti-inflammatory and antioxidant properties of leaf extracts of eleven South African medicinal plants used traditionally to treat inflammation. *Journal of Ethnopharmacology*, *234*, 27–35. https://doi.org/10.1016/j.jep.2018.12.030

Onochie, A. U., Oli, A. H., Oli, A. N., Ezeigwe, O. C., Nwaka, A. C., Okani, C. O., Okam, P. C., Ihekwereme, C. P., & Okoyeh, J. N. (2020). The pharmacobiochemical effects of ethanol extract of justicia secunda vahl leaves in rattus norvegicus. *Journal of Experimental Pharmacology*, *12*, 423–437. https://doi.org/10.2147/JEP.S267443

Onyszko, M., Mijowska, E., Wenelska, K., Gorgon-Kuza, A., Szczupak, A. M., Rakoczy, R., Paszkiewicz, O., & Janusz, J. (2022). The cellulose fibers functionalized with star - like zinc oxide nanoparticles with boosted antibacterial performance for hygienic products. *Scientific Reports*, 1–13. https://doi.org/10.1038/s41598-022-05458-7

Ospina-Alvarez, A., de Juan, S., Pita, P., Ainsworth, G. B., Matos, F. L., Pita, C., & Villasante, S. (2022). A network analysis of global cephalopod trade. *Scientific Reports*, *12*(1), 1–14. https://doi.org/10.1038/s41598-021-03777-9

Ovais, M., Khalil, A. T., Ayaz, M., Ahmad, I., Nethi, S. K., & Mukherjee, S. (2018). Biosynthesis of metal nanoparticles via microbial enzymes: A mechanistic approach. *International Journal of Molecular Sciences*, *19*(12), 1–20. https://doi.org/10.3390/ijms19124100

Panda, D. (2018). Ethnobotanical study of medicinal plants in Jajpur district of Odisha , India. *Journal of Pharmacognosy and Phytochemistry*, *7*(4), 1508–1512.

Panneerselvi, V., Shankar, K., Muthukrishnan, P., & Prabhu, A. (2022). Mangifera indica Resin Assisted Synthesis of Nano Silver: Assessing their Photocatalytic Degradation of Methylene Blue, Anticorrosive and Antioxidant Activity.

Journal of Cluster Science, *33*(1), 1–12. https://doi.org/10.1007/s10876-020-01965-7

Passos, M. L. C., & Saraiva, M. L. M. F. S. (2018). Detection in UV-visible spectrophotometry : Detectors , detection systems , and detection strategies Name : Marieta L . C . Passos. *Measurement*, *1*(1). https://doi.org/10.1016/j.measurement.2018.12.045

Patil, A. P., & Kapadnis, K. H. (2021). Antibacterial Applications of Biosynthesized AgNPs: A Short Review (2015-2020). *Material Science Research India*, *18*(2), 143–153. https://doi.org/10.13005/msri/180203

Patra, J. K., & Baek, K. (2014). Green Nanobiotechnology : Factors Affecting Synthesis and Characterization Techniques. *Journal of Nanomaterials*, *2014*, 1–12.

Patra, J. K., Das, G., Fraceto, L. F., Campos, E. V. R., Rodriguez-Torres, M. D. P., Acosta-Torres, L. S., Diaz-Torres, L. A., Grillo, R., Swamy, M. K., Sharma, S., Habtemariam, S., & Shin, H. S. (2018). Nano based drug delivery systems: Recent developments and future prospects 10 Technology 1007 Nanotechnology 03 Chemical Sciences 0306 Physical Chemistry (incl. Structural) 03 Chemical Sciences 0303 Macromolecular and Materials Chemistry 11 Medical and He. *Journal of Nanobiotechnology*, *16*(1), 1–33. https://doi.org/10.1186/s12951-018-0392-8

Pedrosa, R., P Gaudêncio, S., & Vasconcelos, V. (2020). XVI International Symposium on Marine Natural Products|XI European Conference on Marine Natural Products. *Marine Drugs*, *18*(1), 10–15. https://doi.org/10.3390/md18010040

Peprah, P., Agyemang-Duah, W., Arthur-Holmes, F., Budu, H. I., Abalo, E. M., Okwei, R., & Nyonyo, J. (2019). "We are nothing without herbs": A story of herbal remedies use during pregnancy in rural Ghana. *BMC Complementary and Alternative Medicine*, *19*(1), 1–12. https://doi.org/10.1186/s12906-019-2476-x

Perera, W. P. T. D., Pahalagedara, L. R., Dissanayake, D. M. R. K., Unagolla, J. M., Silva, R. T. De, & Bathige, D. N. K. (2022). Albumin grafted coaxial

electrosparyed polycaprolactone-zinc oxide nanoparticle for sustained release and activity enhanced. *Royal Society of Chmiestry*, 1718–1727. https://doi.org/10.1039/d1ra07847j

Perme, N., Choudhury, R., De, B., Natung, T., & Choudhury, S. N. (2013). Medicinal Plants in Traditional Use at Arunachal Pradesh, India. *International Journal of Phytopharmacy*, *3*(2), 56–62. https://doi.org/10.7439/ijpp

Philip, D. (2010). Rapid green synthesis of spherical gold nanoparticles using Mangifera indica leaf. *Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy*, *77*(4), 807–810. https://doi.org/10.1016/j.saa.2010.08.008

Pizon, J. R. L., Senarath, W. T. P. S. K., Uy, M. M., & Nuñeza, O. M. (2018). IN-VITRO ALPHA- AMYLASE INHIBITORY ACTIVITY, ANTIOXIDANT POTENTIAL, AND GC-MS ANALYSIS OF CREPE GINGER (COSTUS SPECIOSUS (J. KOENIG.) SM) LEAVES. *Angewandte Chemie International Edition, 6(11), 951–952.*, *9*(11), 10–27. https://doi.org/10.13040/IJPSR.0975-8232.9(11).4741-49

Ponnar, M., Thangamani, C., Monisha, P., Gomathi, S. S., & Pushpanathan, K. (2018). Influence of Ce doping on CuO nanoparticles synthesized by microwave irradiation method. *Applied Surface Science*, *449*(3), 132–143. https://doi.org/10.1016/j.apsusc.2018.01.126

Pouresmaieli, M., Ekrami, E., Akbari, A., Noorbakhsh, N., Moghadam, N. B., & Mamoudifard, M. (2021). A comprehensive review on efficient approaches for combating coronaviruses. *Biomedicine and Pharmacotherapy*, *144*(August), 1–27. https://doi.org/10.1016/j.biopha.2021.112353

Povydysh, M. N., Titova, M. V., Ivanov, I. M., Klushin, A. G., Kochkin, D. V., Galishev, B. A., Popova, E. V., Ivkin, D. Y., Luzhanin, V. G., Krasnova, M. V., Demakova, N. V., & Nosov, A. M. (2021). Effect of phytopreparations based on bioreactor-grown cell biomass of dioscorea deltoidea, tribulus terrestris and panax japonicus on carbohydrate and lipid metabolism in type 2 diabetes mellitus. *Nutrients*, *13*(11), 1–21. https://doi.org/10.3390/nu13113811

Prabhu, K. S., Lobo, R., Shirwaikar, A. A., & Shirwaikar, A. (2009). Ocimum gratissimum: A Review of its Chemical, Pharmacological and Ethnomedicinal Properties. *The Open Complementary Medicine Journal*, *1*(1), 1–15. https://doi.org/10.2174/1876391x00901010001

Prabhu, S., & Poulose, E. K. (2012). Silver nanoparticles: mechanism of antimicrobial. *International Nano Letters*, *2*, 32–41.

Prado, H. M., Murrieta, R. S. S., Shepard, G. H., de Lima Souza, T., & Schlindwein, M. N. (2022). Sympathetic science: analogism in Brazilian ethnobiological repertoires among quilombolas of the Atlantic forest and Amazonian ribeirinhos. *Journal of Ethnobiology and Ethnomedicine*, *18*(1), 1–16. https://doi.org/10.1186/s13002-021-00499-0

Prasad, S. R., Teli, S. B., Ghosh, J., Prasad, N. R., Shaikh, V. S., Nazeruddin, G. M., Al-Sehemi, A. G., Patel, I., & Shaikh, Y. I. (2021). A Review on Bio-inspired Synthesis of Silver Nanoparticles: Their Antimicrobial Efficacy and Toxicity. *Engineered Science*, *16*, 90–128. https://doi.org/10.30919/es8d479

Pregitzer, C., Sonti, N. F., & Hallett, R. A. (2016). The Influence of New York City Urban Soils on Native Tree Seedling Growth, Health and Survival. *Ecological Restoration*, *1*(6), 107–115.

Probe, S. F. S., Agrawal, N., Saha, C., Member, S., Kumar, C., & Member, S. (2020). Development of Uric Acid Sensor Using Copper Oxide and Silver Nanoparticles Immobilized. *Future Issue of This Journal*, *9456*, 1–8. https://doi.org/10.1109/TIM.2020.2998876

Probst, B., Westermann, L., Anadón, L. D., & Kontoleon, A. (2021). Leveraging private investment to expand renewable power generation: Evidence on financial additionality and productivity gains from Uganda. *World Development*, *140*, 1–14. https://doi.org/10.1016/j.worlddev.2020.105347

Rafeeq, H., Hussain, A., Ambreen, A., Zill-e-Huma, Waqas, M., Bilal, M., & Iqbal, H. M. N. (2022). Functionalized nanoparticles and their environmental remediation potential: a review. *Journal of Nanostructure in Chemistry*, *1*, 1–26. https://doi.org/10.1007/s40097-021-00468-9

Rahman, A., Kumar, S., & Nawaz, T. (2019). Biosynthesis of nanomaterials using algae. *Microalgae Cultivation for Biofuels Production*, 265–279. https://doi.org/10.1016/B978-0-12-817536-1.00017-5

Raja, M. E., Kumar, S. C. A., & Raju, S. Y. (2005). Boron deficiency in Mango (Mangifera indica L.): A cause delineation study in acidic soils of Maharashtra, India. *Soil Science and Plant Nutrition*, *51*(5), 751–754. https://doi.org/10.1111/j.1747-0765.2005.tb00106.x

Romano, B., Lucariello, G., & Capasso, R. (2021). Topical collection "pharmacology of medicinal plants." *Biomolecules*, *11*(1), 1–6. https://doi.org/10.3390/biom11010101

Rónavári, A., Igaz, N., Adamecz, D. I., Szerencsés, B., Molnar, C., Kónya, Z., Pfeiffer, I., & Kiricsi, M. (2021). Green silver and gold nanoparticles: Biological synthesis approaches and potentials for biomedical applications. *Molecules*, *26*(4), 1–39. https://doi.org/10.3390/molecules26040844

Ryu, U., Jee, S., Chandra, P., Shin, J., Ko, C., Yoon, M., Sung, K., & Min, K. (2021). Recent advances in process engineering and upcoming applications of metal – organic frameworks. *Coordination Chemistry Reviews*, *426*, 1–73. https://doi.org/10.1016/j.ccr.2020.213544

Saarnio, V. (2021). *Fluorescent Probes, Noble Metal Nanoparticles and their Nanocomposites* (T. Lahtinen (ed.)). University of Jyväskylä. http://urn.fi/URN:ISBN:978-951-39-8559-2

Sabatini, M. T., Boulton, L. T., Sneddon, H. F., & Sheppard, T. D. (2019). A green chemistry perspective on catalytic amide bond formation. *Nature Catalysis*, *2*(1), 10–17. https://doi.org/10.1038/s41929-018-0211-5

Sabu, C., Mufeedha, P., & Pramod, K. (2019). Yeast-inspired drug delivery: biotechnology meets bioengineering and synthetic biology. In *Expert Opinion on Drug Delivery* (Vol. 16, Issue 1). Taylor & Francis. https://doi.org/10.1080/17425247.2019.1551874

Sah, J. N., Singh, U. K., & Sah, R. K. (2021). Potential of non-timber forest products in contribution on rural livelihood. *Journal of Medicinal Plants Studies*, *9*(2),

141–145. https://doi.org/10.22271/plants.2021.v9.i2b.1265

Sahoo, G., Swamy, S., Rout, S., Mishra, A., & Wani, A. (2021). View of Exploitation of Wild Leafy Vegetables and Under-utilized Fruits: Consequences for Food and Nutritional Security. *Annals of R.S.C.B*, *25*(6), 5656–5668. https://annalsofrscb.ro/index.php/journal/article/view/6583/4960

Salazar-camacho, N. A., Sanchez-echeverri, L. A., Fonseca, F. J., Falguera, V., Castro-bocanegra, D., & Tovar-perilla, N. J. (2022). Mango (Mangifera indica L .) Dehydration as a Women Entrepreneurship Alternative in Vulnerable Communities. *Sustainability*, *2*(2), 1–13.

Salehi, B., Azzini, E., Zucca, P., Varoni, E. M., Kumar, N. V. A., Dini, L., Panzarini, E., Rajkovic, J., Fokou, P. V. T., Peluso, I., Mishra, A. P., Nigam, M., Rayess, Y. El, Beyrouthy, M. El, Setzer, W. N., Polito, L., Iriti, M., Sureda, A., Quetglas-Llabrés, M. M., … Sharifi-Rad, J. (2020). Plant-derived bioactives and oxidative stress-related disorders: A key trend towards healthy aging and longevity promotion. *Applied Sciences (Switzerland)*, *10*(3), 1–73. https://doi.org/10.3390/app10030947

Samuel J. Offor, Victor U. Anah, Romanus Umoh, Uduak P. Iseh, Idara I. Ebong, & Herbert O.C. Mbagwu. (2021). Antimicrobial activities of biosynthesized silver nano particles from leaves extract of some medicinal plants. *GSC Biological and Pharmaceutical Sciences*, *14*(2), 197–203. https://doi.org/10.30574/gscbps.2021.14.2.0057

Samuggam, S., Chinni, S. V., Mutusamy, P., Gopinath, S. C. B., Anbu, P., Venugopal, V., Reddy, L. V., & Enugutti, B. (2021). Green synthesis and characterization of silver nanoparticles using spondias mombin extract and their antimicrobial activity against biofilm-producing bacteria. *Molecules*, *26*(9), 1–13. https://doi.org/10.3390/molecules26092681

Sant, D. G., Woods, L. C., Barr, J. J., & McDonald, M. J. (2021). Host diversity slows bacteriophage adaptation by selecting generalists over specialists. *Nature Ecology and Evolution*, *5*(3), 350–359. https://doi.org/10.1038/s41559-020-01364-1

Santos-aberturas, J., & Vior, N. M. (2022). Beyond Soil-Dwelling Actinobacteria : Fantastic Antibiotics and Where to Find Them. *Antibiotics*, *95*(11), 1–59.

Saran, M., Vyas, S., Mathur, M., & Bagaria, A. (2018). Green synthesis and characterisation of CuNPs: Insights into their potential bioactivity. *IET Nanobiotechnology*, *12*(3), 357–364. https://doi.org/10.1049/iet-nbt.2017.0138

Schneider, M., Otarola, J., Vakarelska, E., Simeonov, V., & Nedyalkova, M. (2022). Biomedical Applications of Iron Oxide Nanoparticles : Current Insights Progress and Perspectives. *Pharmaceutics Review*, *9*, 1–25.

Seepe, H. A., Nxumalo, W., & Amoo, S. O. (2021). Natural products from medicinal plants against phytopathogenic fusarium species: Current research endeavours, challenges and prospects. In *Molecules* (Vol. 26, Issue 21). https://doi.org/10.3390/molecules26216539

Senizza, B., Rocchetti, G., Sinan, K. I., Zengin, G., Mahomoodally, M. F., Glamocilja, J., Sokovic, M., Lobine, D., Etienne, O. K., & Lucini, L. (2021). The phenolic and alkaloid profiles of Solanum erianthum and Solanum torvum modulated their biological properties. *Food Bioscience*, *41*(February), 100974. https://doi.org/10.1016/j.fbio.2021.100974

Shabanzadeh, P., Yusof, R., & Shameli, K. (2015). Modeling of biosynthesized silver nanoparticles in Vitex negundo L. extract by artificial neural network. *RSC Advances*, *5*(106), 87277–87285. https://doi.org/10.1039/c5ra11940e

Shafey, A. M. El. (2020). Green synthesis of metal and metal oxide nanoparticles from plant leaf extracts and their applications: A review. *Green Processing and Synthesis*, *9*(1), 304–339. https://doi.org/10.1515/gps-2020-0031

Shafiee, P., Ahmadi, E., Nafchi, M. R., Eskandarinezhad, S., & Mahmoudi, S. (2021). Synthesis and Sintering Sol-gel zinc oxide nanoparticles : advances in synthesis and applications. *Syntesis Ns Sintering*, *1*(December), 242–254.

Shahbaz, K., Asif, J. A., Liszen, T., Nurul, A. A., & Alam, M. K. (2022). Cytotoxic and Antioxidant Effects of Phoenix dactylifera L . (Ajwa Date Extract) on Oral Squamous Cell Carcinoma Cell Line. *BioMed Research International*, *2022*, 1–16.

Sharma, Shilpi, & Malik, P. (2012). INTERNATIONAL JOURNAL OF ADVANCES IN PHARMACY , BIOLOGY AND CHEMISTRY Review Article Biopestcides : Types and Applications. *International Journal of Advances in Pharmacy*, *1*(4), 508–515. www.ijapbc.com

Sharma, Sudripet, Das, J., Braje, W. M., Dash, A. K., & Handa, S. (2020). A Glimpse into Green Chemistry Practices in the Pharmaceutical Industry. *ChemSusChem*, *3*(1), 1–16. https://doi.org/10.1002/cssc.202000317

Shashanka, R., Uzun, O., Bülbül, A. S., Taş, R., Ceylan, Y., & Kamac, Y. (2019). Antimicrobial Investigation of CuO and ZnO Nanoparticles Prepared by a Rapid. *Article PHYSICAL CHEMISTRY RESEARCH*, *7*(4), 799–812. https://doi.org/10.22036/pcr.2019.199338.1669

Shedoeva, A., Leavesley, D., Upton, Z., & Fan, C. (2019). Wound healing and the use of medicinal plants. *Evidence-Based Complementary and Alternative Medicine*, *2019*, 1–31. https://doi.org/10.1155/2019/2684108

Sheldon, R. A. (2018). Metrics of Green Chemistry and Sustainability: Past, Present, and Future. *ACS Sustainable Chemistry and Engineering*, *6*(1), 32–48. https://doi.org/10.1021/acssuschemeng.7b03505

Shine, D. J., Shasha, S., Kingdom, A., Emmanuel, O., Fometu, S. S., & Guohua, W. (2020). Biosynthesizing Gold Nanoparticles with Parkia biglobosa Leaf Extract for Antibacterial Efficacy In Vitro and Photocatalytic Degradation Activities of Rhodamine B Dye. *Advanced Science, Engineering and Medicine*, *12*(7), 1–12. https://doi.org/10.1166/asem.2020.2661

Shubham, S., Mishra, R., Gautam, N., Nepal, M., Kashyap, N., & Dutta, K. (2019). Phytochemical Analysis of Papaya Leaf Extract: Screening Test. *EC Dental Science*, *3*(March), 485–490.

Shukur, I. (2021). Nanoparticles and their Potential affect as Antimicrobials in dentistry. *International Journal of Medical, Pharmacy and Drug Research (IJMPD)*, *5*(3), 37–46.

Siddique, S., & Chow, J. C. L. (2020). applied sciences Gold Nanoparticles for Drug Delivery and Cancer Therapy. *Applied Sciences*, 1–22.

Simbine, E. O., Rodrigues, L. da C., Lapa-Guimarães, J., Kamimura, E. S., Corassin, C. H., & de OLIVEIRA, C. A. F. (2019). Application of silver nanoparticles in food packages: A review. *Food Science and Technology*, *39*(4), 793–802. https://doi.org/10.1590/fst.36318

Singh, A., Gautam, P. K., Verma, A., Singh, V., Shivapriya, P. M., Shivalkar, S., Sahoo, A. K., & Samanta, S. K. (2020). Green synthesis of metallic nanoparticles as effective alternatives to treat antibiotics resistant bacterial infections: A review. *Biotechnology Reports*, *25*, 1–11. https://doi.org/10.1016/j.btre.2020.e00427

Singh, B. R., Sinha, D. K., & Agrawal, R. K. (2021). *Alternative Approaches to Mitigate Antimicrobial Drug Resistance* (D. B. R. Singh, D. V. Singh, D. R. K. Agrawal, & D. D. K. Sinha (eds.); Issue October).

Singh, S., Numan, A., & Cinti, S. (2022). Point-of-Care for Evaluating Antimicrobial Resistance through the Adoption of Functional Materials. *Analytical Chemistry*, *94*(2022), 26–40. https://doi.org/10.1021/acs.analchem.1c03856

Sivakumar, S., Selvaraj, A., Ramasamy, A. K., & Balasubramanian, V. (2013). Enhanced photocatalytic degradation of reactive dyes over FeTiO 3/TiO2 heterojunction in the presence of H 2O2. *Water, Air, and Soil Pollution*, *224*(5). https://doi.org/10.1007/s11270-013-1529-x

Skandalis, N., Dimopoulou, A., Georgopoulou, A., Gallios, N., Papadopoulos, D., Tsipas, D., Theologidis, I., Michailidis, N., & Chatzinikolaidou, M. (2017). The effect of silver nanoparticles size, produced using plant extract from Arbutus unedo, on their antibacterial efficacy. *Nanomaterials*, *7*(7), 1–14. https://doi.org/10.3390/nano7070178

Soltys, L., Naushad, M., Olkhovyy, O., & Tatarchuk, T. (2021). Green Synthesis of Metal and Metal Oxide Nanoparticles : Principles of Green Chemistry and Raw Materials. *Magnetochemistry*, 1–34.

Soni, V., Raizada, P., Singh, P., Cuong, H. N., S, R., Saini, A., Saini, R. V., Le, Q. Van, Nadda, A. K., Le, T. T., & Nguyen, V. H. (2021). Sustainable and green trends in using plant extracts for the synthesis of biogenic metal nanoparticles

toward environmental and pharmaceutical advances: A review. *Environmental Research*, *202*(1), 1–16. https://doi.org/10.1016/j.envres.2021.111622

Spirescu, V. A., Chircov, C., Grumezescu, A. M., Vasile, B. Ștefan, & Andronescu, E. (2021). Inorganic nanoparticles and composite films for antimicrobial therapies. *International Journal of Molecular Sciences*, *22*(9), 1–25. https://doi.org/10.3390/ijms22094595

Stolker, A. A. M., & Brinkman, U. A. T. (2005). Analytical strategies for residue analysis of veterinary drugs and growth-promoting agents in food-producing animals - A review. *Journal of Chromatography A*, *1067*(1–2), 15–53. https://doi.org/10.1016/j.chroma.2005.02.037

Su, R., Yu, W., Sun, K., Yang, J., Chen, C., Lian, W., Liu, S., & Yang, H. (2019). The Ion Source of Nitrogen Direct Analysis in Real-Time Mass Spectrometry as a Highly Efficient Reactor : Generation of Reactive Oxygen Species. *American Society for Mass Spectrometry*, 581–587. https://doi.org/10.1007/s13361-019-02132-7

Sulaiman, G. M., Tawfeeq, A. T., & Naji, A. S. (2018). Biosynthesis, characterization of magnetic iron oxide nanoparticles and evaluations of the cytotoxicity and DNA damage of human breast carcinoma cell lines. *Artificial Cells, Nanomedicine and Biotechnology*, *46*(6), 1215–1229. https://doi.org/10.1080/21691401.2017.1366335

Sun, W., Dou, F., Li, C., Ma, X., & Ma, L. Q. (2021). Impacts of metallic nanoparticles and transformed products on soil health. *Critical Reviews in Environmental Science and Technology*, *51*(10), 973–1002. https://doi.org/10.1080/10643389.2020.1740546

Sutoyo, S., Sanjaya, A. I. G. M., Hidayah, R., Puspita, D., & Nurrulhidayah, S. (2021). Phytochemical Screening , Total Flavonoid Content , and Total Phenolic Content of Ethanol Extract of the Indonesian Fern Selaginella Plana. *Advances in Engineering Research*, *209*(Ijcse), 357–362.

Tadele, K. T., Feyisa, T. Y., & Abire, T. O. (2021). Green Synthesized Silver Nanoparticles using Plant Extracts as Promising Prospect for Cancer Therapy:

A Review of Recent Findings. *Journal of Nanomedicine*, *July*, 1–13. https://www.researchgate.net/profile/Kirubel-Tadele/publication/353389052_Green_Synthesized_Silver_Nanoparticles_using_Plant_Extracts_as_Promising_Prospect_for_Cancer_Therapy_A_Review_of_Recent_Findings/links/60fa83501e95fe241a8129c1/Green-Synthesized-Sil

Tanzila Sultana, Kazi M Maraz, Arwah Ahmed, Shamima Shultana, & Ruhul A Khan. (2021). Effect of Irradiation process on mango. *GSC Advanced Research and Reviews*, *9*(2), 108–118. https://doi.org/10.30574/gscarr.2021.9.2.0267

Tashi, T., Vishal Gupta, N., & Mbuya, V. B. (2016). Silver nanoparticles: Synthesis, mechanism of antimicrobial action, characterization, medical applications, and toxicity effects. *Journal of Chemical and Pharmaceutical Research*, *8*(2), 526–537.

Thakare, M., Sarma, H., Datar, S., Roy, A., Pawar, P., Gupta, K., Pandit, S., & Prasad, R. (2021). Understanding the holistic approach to plant-microbe remediation technologies for removing heavy metals and radionuclides from soil. *Current Research in Biotechnology*, *3*(November 2020), 84–98. https://doi.org/10.1016/j.crbiot.2021.02.004

Thakkar, K. N., Mhatre, S. S., & Parikh, R. Y. (2010). Biological synthesis of metallic nanoparticles. *Nanomedicine: Nanotechnology, Biology, and Medicine*, *6*(2), 257–262. https://doi.org/10.1016/j.nano.2009.07.002

Thakur, P. K., & Verma, V. (2021). A Review on Green Synthesis, Characterization and Anticancer Application of Metallic Nanoparticles. *Applied Biochemistry and Biotechnology*, *193*(7), 2357–2378. https://doi.org/10.1007/s12010-021-03598-6

Thangadurai, D., Naik, J., Sangeetha, J., Shettar, A. K., & Adetunji, J. B. (2020). Handbook of Nanomaterials and Nanocomposites for Energy and Environmental Applications. *Handbook of Nanomaterials and Nanocomposites for Energy and Environmental Applications*, 1–18. https://doi.org/10.1007/978-3-030-11155-7

Thiripuranthagan, S., & Rupa, V. (2019). Detoxification of Carcinogenic Dyes by

Noble Metal (Ag, Au, Pt) Impregnated Titania Photocatalysts. *Gold Nanoparticles - Reaching New Heights*, *1*(1), 1–26. https://doi.org/10.5772/intechopen.80467

Tilahun Bekele, E., Gonfa, B. A., & Sabir, F. K. (2021). Use of Different Natural Products to Control Growth of Titanium Oxide Nanoparticles in Green Solvent Emulsion, Characterization, and Their Photocatalytic Application. *Bioinorganic Chemistry and Applications*, *2021*, 1–17. https://doi.org/10.1155/2021/6626313

Tran, T. Van, Nguyen, D. T. C., Kumar, P. S., Din, A. T. M., Jalil, A. A., & Vo, D. V. N. (2022). Green synthesis of ZrO2 nanoparticles and nanocomposites for biomedical and environmental applications: a review. *Environmental Chemistry Letters*, 1–23. https://doi.org/10.1007/s10311-021-01367-9

Tripathi, D. K., Singh, S., Gaur, S., Singh, S., Yadav, V., Liu, S., Singh, V. P., Sharma, S., Srivastava, P., Prasad, S. M., Dubey, N. K., Chauhan, D. K., & Sahi, S. (2018). Acquisition and homeostasis of Iron in higher plants and their probable role in abiotic stress tolerance. *Frontiers in Environmental Science*, *5*(2), 1–15. https://doi.org/10.3389/fenvs.2017.00086

Tsekhmistrenko, S., Bityutskyy, V., Tsekhmistrenko, O., Merzlo, S., Tymoshok, N., Melnichenko, A., Polishcuk, S., Demchenko, A., & Yakymenko, I. (2021). Bionanotechnologies: Synthesis of metals' nanoparticles with using plants and their applications in the food industry: A review. *Journal of Microbiology, Biotechnology and Food Sciences*, *10*(6), 1–9. https://doi.org/10.15414/jmbfs.1513

Tyavambiza, C., Dube, P., Goboza, M., Meyer, S., Madiehe, A. M., & Meyer, M. (2021). Wound healing activities and potential of selected african medicinal plants and their synthesized biogenic nanoparticles. *Plants*, *10*(12), 1–14. https://doi.org/10.3390/plants10122635

Tyavambiza, C., Elbagory, A. M., Madiehe, A. M., Meyer, M., & Meyer, S. (2021). The antimicrobial and anti-inflammatory effects of silver nanoparticles synthesised from cotyledon orbiculata aqueous extract. *Nanomaterials*, *11*(5), 1–19. https://doi.org/10.3390/nano11051343

Uba, B., Umar, M., & Ht, A. (2021). Extraction , Compositional Analysis and Therapeutic Studies of Essential Oils Obtained From The Leaves of Ocimum gratissimum And Leucas martinicensis . *Scholars International Journal of Chemistry and Material Sciences*, *8669*, 283–294. https://doi.org/10.36348/sijcms.2021.v04i11.001

Umme Ruman, & Poonah Kia. (2021). Biosynthesis and Characterization of Silver Nanoparticles from Bitter Melon (Momordica charantia) Fruit and Seed Extract and their Antimicrobial Activity. *Journal of Research in Nanoscience and Nanotechnology*, *2*(1), 1–11. https://doi.org/10.37934/jrnn.2.1.111

Vanti, G. L., Kurjogi, M., Basavesha, K. N., Teradal, N. L., Masaphy, S., & Nargund, V. B. (2020). Synthesis and antibacterial activity of solanum torvum mediated silver nanoparticle against Xxanthomonas axonopodis pv.punicae and Ralstonia solanacearum. *Journal of Biotechnology*, *309*, 20–28. https://doi.org/10.1016/j.jbiotec.2019.12.009

Veeresham, C. (2012). Natural products derived from plants as a source of drugs. *Journal of Advanced Pharmaceutical Technology and Research*, *3*(4), 200–201. https://doi.org/10.4103/2231-4040.104709

Verma, M. (2021). Nanotechnology and its application on drug delivery. *Annals of the Romanian Society for Cell Biology*, *25*(1), 3683–3690. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85101627050&partnerID=40&md5=561ea95e969cdd02fd5fd017de454fc3

Vijai Anand, K., Reshma, M., Kannan, M., Muthamil Selvan, S., Chaturvedi, S., Shalan, A. E., & Govindaraju, K. (2021). Preparation and characterization of calcium oxide nanoparticles from marine molluscan shell waste as nutrient source for plant growth. *Journal of Nanostructure in Chemistry*, *11*(3), 409–422. https://doi.org/10.1007/s40097-020-00376-4

Villa, A., Dimitratos, N., Chan-Thaw, C. E., Hammond, C., Veith, G. M., Wang, D., Manzoli, M., Prati, L., & Hutchings, G. J. (2016). Characterisation of gold catalysts. *Chemical Society Reviews*, *45*(18), 4953–4994. https://doi.org/10.1039/c5cs00350d

Wagner, S., Gondikas, A., Neubauer, E., Hofmann, T., & Kammer, F. Von Der. (2014). Spot the Difference : Engineered and Natural Nanoparticles in the Environment — Release , Behavior , and Fate Angewandte. *Environmental Chemistry*, *2*(3), 12398–12419. https://doi.org/10.1002/anie.201405050

Walusansa, A., Asiimwe, S., Nakavuma, J. L., Ssenku, J. E., Katuura, E., Kafeero, H. M., Aruhomukama, D., Nabatanzi, A., Anywar, G., Tugume, A. K., & Kakudidi, E. K. (2022). Antibiotic-resistance in medically important bacteria isolated from commercial herbal medicines in Africa from 2000 to 2021: a systematic review and meta-analysis. *Antimicrobial Resistance & Infection Control*, *11*(1), 1–20. https://doi.org/10.1186/s13756-022-01054-6

Wang, L., Xu, J., Yan, Y., Liu, H., & Li, F. (2019). Synthesis of gold nanoparticles from leaf Panax notoginseng and its anticancer activity in pancreatic cancer PANC-1 cell lines activity in pancreatic cancer PANC-1 cell lines. *Artificial Cells, Nanomedicine, and Biotechnology*, *47*(1), 1216–1223. https://doi.org/10.1080/21691401.2019.1593852

Waris, A., Din, M., Ali, A., Ali, M., Afridi, S., Baset, A., & Ullah Khan, A. (2021). A comprehensive review of green synthesis of copper oxide nanoparticles and their diverse biomedical applications. *Inorganic Chemistry Communications*, *123*, 44–63. https://doi.org/10.1016/j.inoche.2020.108369

Wilde, T. J. J. De, Ben, I. O., Woode, E., & Abotsi, W. K. M. (2013). Preliminary Phytochemical Screening and In vitro Antioxidant Prop-erties of Trichilia monadelpha (Thonn.) J. J. de Wilde (Meliaceae). *Journal of Medical and Biomedical Sciences*, *2*(2), 6–15.

Yakubu, C. M., Sharma, R., & Sharma, S. (2022). Fermentation of locust bean (Parkia biglobosa): modulation in the anti-nutrient composition, bioactive profile, in vitro nutrient digestibility, functional and morphological characteristics. *International Journal of Food Science and Technology*, *57*(2), 753–762. https://doi.org/10.1111/ijfs.15288

Yan, J. K., Yu, Y. B., Wang, C., Cai, W. D., Wu, L. X., Yang, Y., & Zhang, H. N. (2021). Production, physicochemical characteristics, and in vitro biological activities of polysaccharides obtained from fresh bitter gourd (Momordica

charantia L.) via room temperature extraction techniques. *Food Chemistry*, *337*(July 2020), 1–10. https://doi.org/10.1016/j.foodchem.2020.127798

Yang, D., Zhang, W., Zhang, H., Zhang, F., Chen, L., Ma, L., Larcher, L. M., Chen, S., Liu, N., Zhao, Q., Tran, P. H. L., Chen, C., Veedu, R. N., & Wang, T. (2020). Progress, opportunity, and perspective on exosome isolation - Efforts for efficient exosome-based theranostics. *Theranostics*, *10*(8), 3684–3707. https://doi.org/10.7150/thno.41580

Yaragalla, S., Bhavitha, K. B., & Athanassiou, A. (2021). A Review on Graphene Based Materials and Their. *Coatings Review*, 1–18.

Yin, X., & Xu, Y. (2022). Nanoparticles: Excellent Materials Yet Dangerous When They Become Airborne. *Toxics*, *8*, 1–22.

Yılmaz, Ş., Yıldız, Y. Ş., & Yılmaz, D. D. (2022). Green synthesis of iron oxide nanoparticles using Ceratonia siliqua L . aqueous extract : Optimization , characterization , stabilization and evaluation of its antibacterial activity against gram-positive and gram-negative bacteria. *Research Square*, *1*(1), 1–19.

Yu, J., Wu, X., Liu, C., Newmaster, S., Ragupathy, S., & Kress, W. J. (2021). Progress in the use of DNA barcodes in the identification and classification of medicinal plants. *Ecotoxicology and Environmental Safety*, *208*, 1–7. https://doi.org/10.1016/j.ecoenv.2020.111691

Yu, X., Trase, I., Ren, M., Duval, K., Guo, X., & Chen, Z. (2016). Design of Nanoparticle-Based Carriers for Targeted Drug Delivery. *Hindawi Publishing Corporation*, *2016*, 1–15.

Yudhani, R. D., Nugrahaningsih, D. A. A., Sholikhah, E. N., & Mustofa, M. (2021). The molecular mechanisms of hypoglycemic properties and safety profiles of swietenia macrophylla seeds extract: A review. *Open Access Macedonian Journal of Medical Sciences*, *9*, 370–388. https://doi.org/10.3889/oamjms.2021.6972

Yugandhar, P., & Savithramma, N. (2016). Biosynthesis, characterization and antimicrobial studies of green synthesized silver nanoparticles from fruit extract of Syzygium alternifolium (Wt.) Walp. an endemic, endangered medicinal tree

taxon. *Applied Nanoscience (Switzerland)*, *6*(2), 223–233. https://doi.org/10.1007/s13204-015-0428-4

ZANNOU, O., KOCA, I., & CHABI, I. B. (2018). S Ome T Raditional F Ermented F Ood From a Frican L Ocust B Eans (P Arkia Biglobosa): P Roduction and. *Global Scientific Journal*, *6*(9), 673–701.

Zeb, S., Jiang, X., Cui, Y., Xu, H., Nie, Y., & Sun, G. (2021). Materials Advances Advanced developments in nonstoichiometric tungsten oxides for electrochromic applications. *Materials Advances*, 6839–6884. https://doi.org/10.1039/d1ma00418b

Zhang, J., Ahmadi, M., Fargas, G., Perinka, N., Reguera, J., Lanceros-m, S., Llanes, L., & Jim, E. (2022). Silver Nanoparticles for Conductive Inks : From Synthesis and Ink Formulation to Their Use in Printing Technologies. *Metals*, 1–26.

Zhang, L., Godil, D. I., Bibi, M., Khan, M. K., Sarwat, S., & Anser, M. K. (2021). Caring for the environment: How human capital, natural resources, and economic growth interact with environmental degradation in Pakistan? A dynamic ARDL approach. *Science of the Total Environment*, *774*(14), 1–12. https://doi.org/10.1016/j.scitotenv.2021.145553

Zhang, W., Zhang, X., Cai, L., Chen, R., Zhang, Q., & Wang, X. (2015). Determination of levan from Bacillus licheniformis by ultraviolet spectrophotometry. *Tropical Journal of Pharmaceutical Research*, *14*(4), 679–685. https://doi.org/10.4314/tjpr.v14i4.17

Zolfaghari, M. R., & Noghabi, K. A. (2022). sp. EAZ03 cell extract as a novel natural source for the biosynthesis of zinc oxide nanoparticles: its antibacterial, anticancer, and antibiofilm characteristics. *Journal of Applied Microbiology.*, *2022*, 1–40. https://doi.org/10.1111/jam.15177