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Green Synthesis of Plant Mediated Silver Nanoparticles and Their Anticancer Potentials: Review of Contemporary Literatures

Amina Aminu
Department of Chemistry, Federal College of Education, Yola, Nigeria

Abstract: *The recent advances in green synthesis of silver nanoparticles, their application as anticancer agents, and the mechanism of the antimicrobial mode of action have been developed and used for both human therapy and industrial applications. In recent years, ongoing research focused on the development of nano-scale objects as efficient anticancer therapies. Silver nanoparticles have gained much attention from various articles due to their unique properties. Silver nanoparticles are important because of their exceptional chemical, physical, and biological properties and applications. It also describes the comparison of efficient synthesis methods via green routes over physical and chemical methods, which provide strong evidence for selecting suitable methods of synthesizing silver nanoparticles (AgNPs). This review focuses on the green synthesis of AgNPs using plant sources. Green synthesis of nanoparticles is an eco-friendly approach, which should be further explored for the potential of different plants to synthesize nanoparticles. The sizes of AgNPs are in the range of 1to 100 nm. Characterization of synthesized nanoparticles is accomplished through UV spectroscopy, X-ray diffraction, Fourier transform infrared spectroscopy, transmission electron microscopy, and scanning electron microscopy. AgNPs have great potential to act as anticancer agents. The green synthesis of AgNPs can be efficiently applied for future engineering and medical concerns. Different types of cancer can be treated and/or controlled by phytonanotechnology. The present review provides a comprehensive survey of plant-mediated synthesis of AgNPs with a specific focus on their applications, in anticancer activities.*

Keywords: *Synthesis, Silver nanoparticle, Anticancer, Potentials.*

1.0 Introduction

Nanotechnology is the integration of science and technology involving the fabrication or synthesis, design, and analysis of materials at the nanometer scale [1] The control of atoms or molecules in the structure of materials at the nanometer scale allows us to adjust the properties of materials for more specific applications [2]. That is the reason why nanotechnology has received much attention from many researchers and scientists worldwide and has become more popular in both academic research and industry [3,4]. Nowadays, nanotechnology involving the green synthesis of nanoparticles has become an eye-catching idea and has gained much importance and significance in recent years due to its great facility, clean processing, non-toxic chemicals used, cost-effectiveness, and being environmentally and eco-friendly. There have been many research articles focusing on the use of many kinds of plant extracts as a reducing agent for synthesis of nanoparticles; especially silver nanoparticles (AgNPs).

Silver nanoparticles (AgNPs) constitute a class of materials with sizes in the range of 1-100 nm. The interest in the study of AgNPs concerning their various behaviors has recently increased because of their unique and attractive physical, chemical, and biological properties [5-7]. AgNPs are also known to have particular functions regarding toxicity, surface plasmon resonance, and electrical resistance. Based on these, intensive research works have been conducted to investigate their properties and potential applications for anticancer agents. Cancer is a group of diseases, that generate various pathological and metabolic changes in cellular environments. It is developed through diverse signaling mechanisms including cell proliferation, angiogenesis, and metastasis [8,9]. Cancer cells have abnormal metabolic activities in aerobic glycolysis, mitochondrial DNA depletion, and alterations in respiratory chains and genomic expressions. The physical and chemical treatments of cancer are limited at different stages. However, currently available therapies have an adverse effect and affect normal cell functions while giving excess drug and radiation exposures [10].

A marginal increase in cancer cases within the last few years ends mostly with death [11]. In several cancer types, we have to manipulate satisfactory medicine carriers similar to drug delivery to be applied as adequate chemotherapeutic agents [12,13]. Recently, AgNPs are reported to modulate the Pgp activity and enhance ic efficacy against multi-drug resistant cancer cells, thus, further emphasizing their excellent potential as combinational partners [14]. Moreover, the genotoxicity of AgNPs is supported by the generation of double-stranded DNA breaks along with chromosomal instability that drives the initiation of apoptotic execution [15]. This acting mechanism implies that AgNPs can be mutually associated with a great DNA-targeting anticancer drugs..

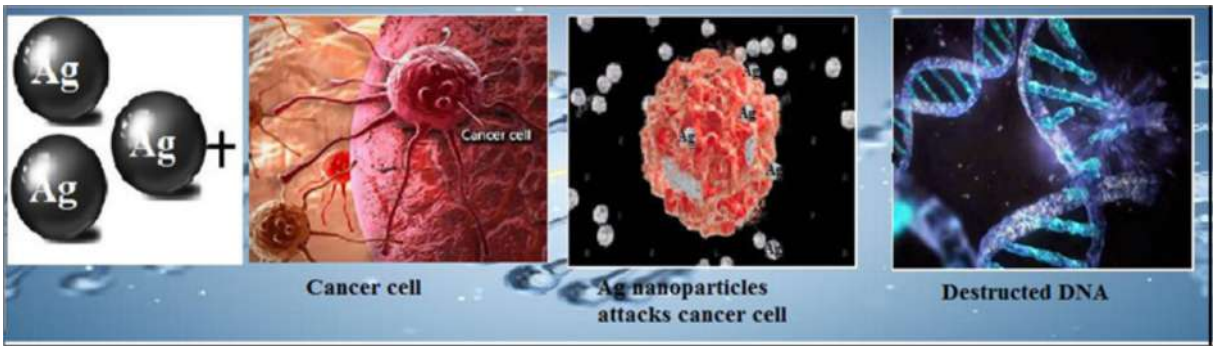

Figure 1: Mechanism of action of silver nanoparticles against cancer cells.

There are several review papers published to address the issues associated with AgNPs regarding their toxicology properties during their use as antimicrobial agents for textiles, dental biomaterials, and bio-detectors, as well as during their syntheses [16]. For instance, toxicity properties including cytotoxicity and genotoxicity of capped or uncapped AgNPs have been reviewed in detail [17]. Their toxicity mechanisms after oral exposure were also thoroughly discussed [18]. Also, a recent review of AgNPs focused on their synthetic plant extracts for antimicrobial applications [19]. Most of the above studies concentrate chiefly on green synthesis. The synthesis of AgNPs through a green chemistry approach with several advantages like economical, efficient, eco-friendly process, energy efficient,cost-effective providing healthier workplaces and communities; protecting human health and environment leading to lesser waste and safer products. Green synthesis of silver nanoparticles has a vast potential for their use in biomedical applications.The recent advances in the field of nanoparticle synthesis

have a strong impact in many scientific areas and the synthesis of silver nanoparticles has also followed this tendency. These unique properties of nanomaterials have spurred numerous investigations and applications in electronics, nanomedicine, biomaterials, energy, and food. In fact, silver based compounds are much cheaper than gold-based one; moreover, silver nanoparticles are now considered as an important class of nanomaterials. They are presently mainly used as catalyst [20] or antibacterial/antifungal agents [21]. This trend has several origins, including the need for greener methods counteracting the higher costs and higher energy requirements of physical and chemical processes. For this reason, scientists search for cheaper methods of synthesis. The other reason is that conventional methods for nanoparticle synthesis usually require harmful reductants such as sodium borohydride or hydrazine and many steps in the synthesis procedure including heat treatments, often produce hazardous by-products to reduce the environmental impact of nanoparticle synthesis, greener routes have been investigated for over a decade. The principles of green chemistry were presented by Anastas and Warner who developed 12 principles that eloquently describe green chemistry [22]. Green chemistry should aim at converting waste, minimizing energy use, employing renewable materials, and applying methods that minimize risk. The three main concepts for the preparation of nanoparticles in a green synthesis approach are the choice of the solvent medium (preferably water), an environmentally friendly reducing agent, and a nontoxic material for the stabilization of the nanoparticles [23]

To be energy efficient, the synthesis processes should be carried out close to ambient temperature and pressure and under neutral pH. The biological systems then appear as the most suitable factory for reaching such natural chemistry conditions. It is well known that many microorganisms can provide inorganic materials either intra- or extracellularly [24] and it was found that some of these microorganisms can be used as ecofriendly nanofactories for the production of nanomaterials, more particularly for the production of silver metal nanoparticles (Ag NPs). More recently, the utilization of plants for the production of metal nanoparticles has spurred numerous investigations in the field of green synthesis. The aim of this review is to provide a brief overview of the contemporary literatures on the green synthesis of Plant Mediated silver nanoparticles and describe their Anticancer Potentials

1.1 Green synthesis of AgNPs,

Green synthesis is the biological method of synthesizing nanoparticles. Green synthesis of AgNPs, is the most accepted method as it provides various advantages over conventional techniques (chemical and physical methods). The technique is eco-friendly, easy, no sophisticated instruments and chemicals are required. No toxic chemicals are involved as reducing agents and stabilizing agents are derived from plants [25]. Plants provide free reducing, stabilizing, and capping agent and also cost of micro organisms and culture media is reduced. Ultimately reducing the overall cost of the formulation [26]. This method is a good alternative to conventional methods of nanoparticles synthesis. The product formed using this method is more stable with the desired shape and size [27].

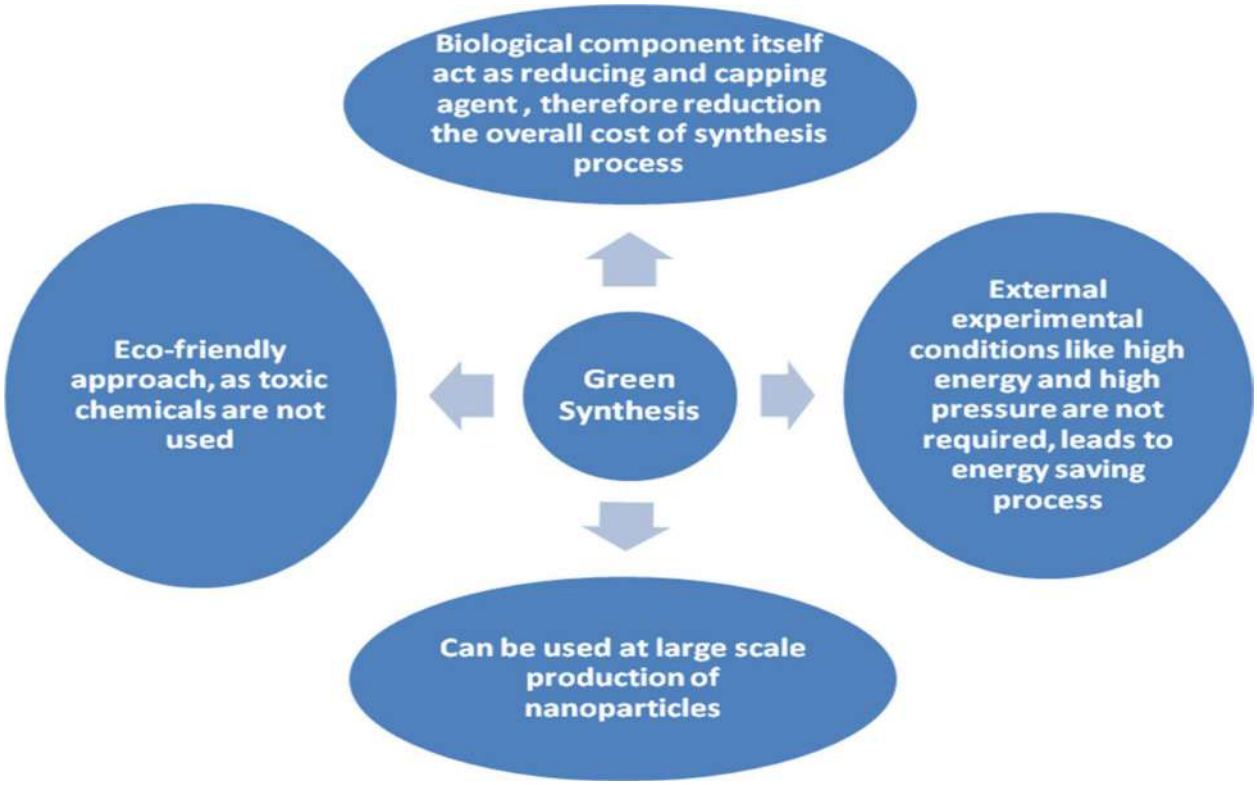

Fig. 2 Key merits of green synthesis methods

1.2 Anticancer activity of silver nanoparticles

The Metallo-pharmaceuticals were included within the research field that was previously dominated by organic compounds and natural products. Many platinum and platinum-based compounds including carboplatin and oxaliplatin were approved as antitumor agents [38]. However, numerous drawbacks of platinum-based pharmaceuticals were reported proving, therefore, their curative effects. Many cancer types are not susceptible to platinum drugs, and there are many toxic side effects, including gastrointestinal and haematological toxicity [28]. Moreover, several cancer cells have either intrinsic or acquired resistance to other platinating agents and cisplatin [29]. Consequently, current anticancer research has been devoted to the discovery of novel transition metal compounds. While silver was initially investigated because of its advantageous antimicrobial activity, there has been a recent interest in its anticancer functions.

2.0 Green Synthesis Methods:

2.1 Green Synthesis Using Bacteria as a Medium.

Bacteria are known to produce inorganic materials either intra- or extracellular. This makes them potential biofactories for the synthesis of nanoparticles like gold and silver. Silver is well known for its biocidal properties; however, some bacteria are known to be silver resistant [30] and can accumulate silver on the cell wall to as much as 25% of their dry weight biomass, thus suggesting their use in industrial recovery of silver from ore materials. Therefore, the use of prokaryotic bacteria as nanofactories was first studied. First noble metal nanoparticle synthesis, using bacteria, was done using silver resistant bacterial strains *Pseudomonas stutzeri*AG259, which were cultured in high concentrations of silver nitrates. It was demonstrated that the cells accumulate silver in large quantities and the majority of the silver was deposited in the form of particles of 200 nanometers of diameter [31]. Significant results were observed when bacteria

Proteus mirabilis PTCC 1710 were used for producing silver nanoparticles. It was found that depending on the type of "broth" used during the incubation of bacteria, extracellular or intracellular synthesis can be promoted. This kind of selection makes bacteria-based green synthesis flexible, inexpensive, and a suitable method for large-scale production [32]. It is important to point out that bacteria continued to grow after the synthesis of silver nanoparticles. However, the main drawback of using bacteria as nanofactories is the slow synthesis rate and the limited number of sizes and shapes available compared to the conventional chemical methods of synthesis. For this reason, fungi-based nano factories and chemical reactions involving plant based materials were investigated [33].

2.2 Green Synthesis Using Fungi as Medium.

Like bacteria, due to their tolerance and metal bioaccumulation ability, high binding capacity, and intracellular uptake, fungi have been interested in biological production of nanoparticles [34]. Compared to bacteria, fungi are simpler to handle in a laboratory process. The mechanism of nanoparticle production using fungi is different; fungi secrete large amounts of enzymes which are used to reduce silver ions that induce the formation of the metal nanoparticles [35]. The first synthesis involving fungus-mediated approaches for the metal nanoparticle synthesis was performed in the beginning of the 20th century, and Ag NPs with diameter of 25±12nmwere synthesized using fungus *Verticillium*[36, 37]. In previous studies involving bacteria, bacteria *Pseudomonas stutzeri* AG259 isolated from silver mines were able to produce AgNP so well-defined size and distinct morphology within the periplasmic space of the bacteria [38]. Synthesis using *Verticillium* takes the green approach even further. During the exposure of the fungus to AgNO3 solution, the reduction of ions and the formation of AgNPs take place. Nanoparticles were approximately 25nm in diameter presenting a rather good monodispersity and spherical morphology. Contrary to bacteria, AgNPs were formed below the surface of the fungal cells.

2.3 Green Synthesis Using Plants and Plant Extract as a Medium.

One of the first approaches of using plants as a source for the synthesis of metallic nanoparticles was with alfalfa sprouts [40], which was the first report on the formation of AgNPs using a living plant system. Alfalfa roots have the capability of absorbing Ag from agar medium and transferring them into the shoots of the plant in the same oxidation state. In the shoots, these Ag atoms arranged themselves to form nanoparticles by joining themselves and forming larger arrangements. In comparison to bacteria and fungi, green synthesis using plants appears to be faster and the first investigations demonstrate that synthesis procedures are able to produce quite rapidly AgNPs. Shankar et al. showed that using *Geranium* leaf takes around nine hours to reach 90% reaction compared to the 24 to 124 hours necessary for other reactions reported earlier [41]. Therefore, the use of plant extracts in green synthesis has spurred numerous investigations and studies up till now. It was demonstrated that the production of metal nanoparticles using plant extracts could be completed in the metal salt solution within minutes at room temperature, depending on the nature of the plant extract. After the choice of the plant extract, the main affecting parameters are the concentration of the extract, the metal salt, the temperature, the pH, and the contact time [42]. In addition to the synthesis parameters, the main issue is the choice of the plant from which the extract could be used. The advantages of using plants for the synthesis of nanoparticles are that the plants are easily available and safe to handle and possess a large variety of active agents that can promote the reduction of silver ions. Most of the plant parts like leaves, roots, latex, bark, stem, and seeds are being used for nanoparticle synthesis [43].

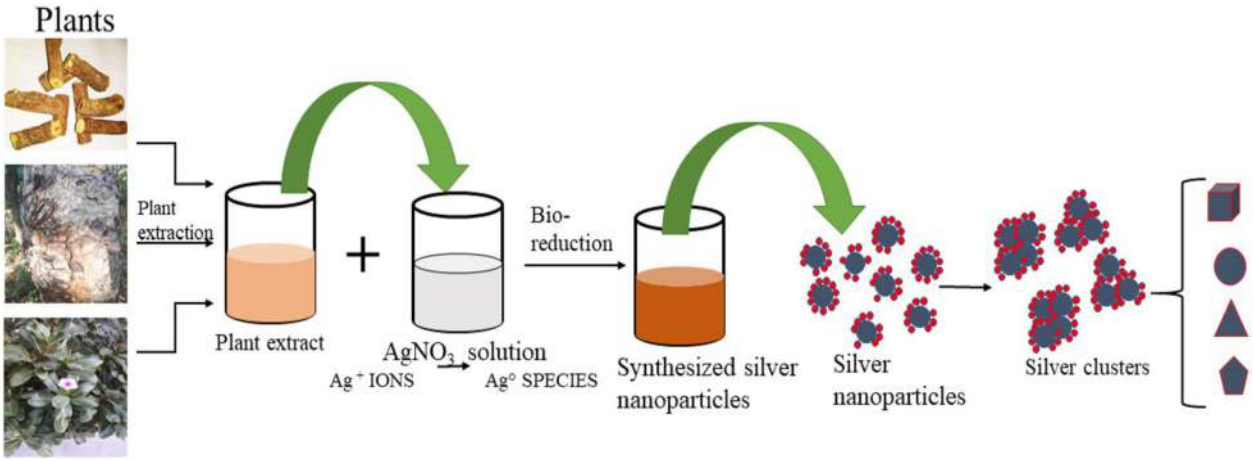

Figure 3: Green Synthesis Using Plants and Plant Extract as a Medium.

The use of plants for nanoparticle synthesis offers a wide range of benefits over other biological synthesis methods because it does not require the maintenance of cell cultures and incorporates support for the large-scale synthesis of nanoparticles [44]. Extracellular nanoparticle synthesis, which utilizes extracts from individual leafs rather than entire plants, may prove to be more inexpensive due to easier downstream processing. Sastry and his group are responsible for pioneering nanoparticle synthesis using plant extracts [45–46]. Green synthesis of AgNPs using plant extracts containing phytochemical agents has attracted considerable interest. This environmentally friendly approach is more biocompatible and cost-efficient and includes
the capability of supporting larger synthesis [47,48]. The synthesis of AgNPs via different "green" chemico-physical conditions, as well as by numerous microorganisms, has been heavily investigated. When AgNPs are chemically synthesized, three main components are required: (1) silver salt (such as., AgNO3), (2) a reducing agent (such as, NaBH4), and (3) a stabilizing or capping agent (such as., polyvinyl alcohol) for controlling the size of nanoparticles and preventing their aggregation [49]. AgNPs have applications in wound-healing, eye disease therapy, DNA processing, and pharmaceuticals in addition to other relevant mainstream applications: electronics, optics, catalysis, and Raman scattering [50]. The advantages of using plants for the synthesis of nanoparticles include their availability, safety in handling, and the presence variability of different types of metabolites that may aid in reducing silver. The time required to reduce 90 % of silver ions is approximately 2 to 4 h [51]. Gericke and Pinches [52] reported that the size of particles that form intracellularly could be controlled by altering key factors such as pH, temperature, substrate concentration, and time of exposure to the substrate. The biochemical and molecular mechanisms of AgNP biosynthesis remain poorly characterized and should be investigated to further optimize the process. For instance, the characterization of biochemical mechanismsunderscored the importance of phytochemicals, which may mediate biosynthesis. Improvements in chemical composition, size, shape, and dispersity of nanoparticles would permit the use of nanobiotechnology in a variety of other applications [53]. Plant crude extracts contain novel secondary metabolites such as phenolic acid, flavonoids, alkaloids, and terpenoids, which are mainly responsible for the reduction of ionic metal into bulk metallic nanoparticles [54]. Primary and secondary metabolites are constantly involved in redox reactions required to synthesize eco-friendly nanoparticles.
Biosynthesis reactions can be modulated to transform the shape and size of nanoparticles by using different metal concentrations and amounts of plant extract the reaction medium [54, 59]

Physical Requisites for the Synthesis of AgNPs easier, more reliable, and environmentally friendly methods to synthesize nanoparticles accelerate the widespread adoption, which would benefit humans and the environment [60]. Silver disassembles into particles following the addition of plant extract, which may lead to a color change. Solutions of AgNPs appear dark, yellow-brown in color because of the surface plasmon resonance phenomenon [61]. Two extracts from the same host plant may have a different pH, thus highlighting the need for better synthesis method for nanoparticles. Large nanoparticles are most often formed only at lower pH values, instead of highevalueses, as has been previously reported [62, 68, 69], utilizing extracts of Chenopodium album observed trivial variations in zeta potential nanoparticles pH conditions ranging from 2 to 10 and determined that nanoparticles were more stable when exposedosed higher pH conditions [70] demonstrated that mangosteen extracts induced the nucleation of cluster of AgNPs at pH values over 4. Furthermore, nanoparticles grew rapidly, with their values ranging from basic to neutral. These results demonstrate the significant impact of pH on parameters of nanoparticles. The formation and growth of nanoparticlessretarded by acidic conditions, whereas basic conditions promote nanoparticle assembly. Larger nanoparticles are formed in lower pH conditions (pH 4), whereas significantly smaller nanoparticles are formed in higher pH conditions (pH 8). Our results indicate that the size of nanoparticles decreases when pH increases pH values in the range of 2–14 play an important role in the synthesis of AgNPs. In plants, AgNP synthesis occurs at various pH values depending on the plant species [71]. However, previous studies have indicated that neutral is optimal for AgNP synthesis. At this pH, little or no assembly of AgNPs into particles of suitable size and shape occurs [72].

3.0 AgNPs in Cancer Control

AgNPs perform well as cancer therapeutics because they can disrupt the mitochondrial respiratory chain, which induces the generation of reactive oxygen species (ROS),and ATP synthesis, which can induce DNA damage [73,74]. AgNPs synthesized with Sesbania grandifloraleaf extracts were demonstrated to be cytotoxic to MCF-7cancer cells. Morphological characteristics, including the disruption of membrane integrity, decreased cell growth, cytoplasmic condensation, and cell clumping, were observed in MCF-7 cells treated with AgNPs, whereas control cells remained active. In addition, apoptotic features, such as cell shrinkage and nuclear condensationndfragmentationon, were also observed in MCF-7 tumor cells 48 h after treatment with 20 μg/mL of AgNPs. AgNP synthesized with S. Grandiflora extracts induced the generation of free radicals, which resulted in oxidative damage and caspase-mediated apoptosis [75].AgNPs synthesized with Guignardia mangiferaextracts exhibited potent antifungal activity against plant pathogenic fungi. IC50 values of AgNPs were 63.37, 27.54, and 23.84 μg/mL against normal African monkey kidney (Vero), HeLa (cervical), and MCF-7 (breast) cells , respectively, after a 24-h incubation period. Thus, AgNPs synthesized with G. mangiferae extracts are highly biocompatible, have potentially wider applicability, and should be explored as promising candidates for a variety of biomedical/pharmaceutical and agricultural applications [76]. AgNPs were synthesized using extracts from different plant origins: Cucurbita maxima (petals),Moringa oleifera (leaves), and Acorus calamus (rhizome).Among the three synthesized nanoparticles, AgNPs synthesized with A. calamus rhizome extracts had enhanced antimicrobial and anticancer activity, which were evaluated through MTT assays against epidermoid A431 carcinoma cells AgNPs synthesized with A.calamus rhizome extracts were superior to AgNPgenerated with petal and leaf extracts in their antimicrobial and anticancer activities [77]. Both treated (synthesized) and untreated AgNPs induced DNA fragmentation at all concentrations [78]. Compared to untreated cells,treated

AgNPs synthesized using Phytolacca decandra,Hydrastis canadensis, Gelsemium sempervirens, andThuja occidentalis extracts exhibited DNA laddering,confirming the apoptotic effects of nanoparticles. Specifically,AgNPs synthesized using P. decandra and G. sempervirensextracts effectively induced DNA ladderingcompared to AgNPs synthesized using H. Canadensis and T. occidentalis extracts [79].

AgNPs synthesized with Coleusamboinicus extracts were cytotoxic to EAC cell lines. AgNPs induced 50 and 70 % cytotoxicity at 30 and50 µg/mL, respectively, indicating concentration-dependent cytotoxicity [99]. AgNPs synthesized with alcoholic flower extracts of Nyctanthes arbor-tristis be used for molecular imaging and drug delivery. Even at the highest concentration tested (250 µg/mL), AgNPswere only marginally toxic to L929 cells [80]. The anticancer activity of AgNPs synthesized with unripe fruits of Solanum trilobatum against a human breast cancer celline (MCF-7) was evaluated in vitro using MTT assays, nuclear morphological characteristics, and RPCR and western blot analyses. MCF-7 cells treated with either AgNPs or cisplatin exhibited decreased Bcl-expression and increased Bax expression, indicating involvement of mitochondria in the mechanism of ddeath induced by AgNPs [81].

3.1 Different Field Applications of AgNPs

Nanotechnology applications are highly suited for biologicalmolecules because of their unique properties.Nanotechnology is a growing area of research in thefields of material science and biological science [82].Silver nanoparticles have attracted the attention of researchersbecause of their broad applications in diverseareas, such as integrated circuits [83], sensors [84],bio labeling, filters, antimicrobial deodorant fibers [85],cell electrodes [86], low-cost paper batteries (silvernano-wires) [87], and antimicrobials [88]. AgNPs havebeen used extensively as antimicrobial agents in thehealth industry, food storage, textile coatings, and anumber of environmental applications [89], few ofwhich are shown in Fig. 4. Antimicrobial properties of AgNPs are beneficial for different fields of medicine,various industries, animal husbandry, packaging, accessories,cosmetics, health, and the military. In general,therapeutic effects of silver particles (in suspension) dependon different parameters, including particle size(surface area and energy), particle shape (catalytic activity),particle concentration (therapeutic index), and particlecharge (oligodynamic quality) [90].The viability of A549 cells treated for 6 h with 10 and50 µg/mL of AgNPs synthesized with Albizia adianthifolialeaf extracts was 21 and 73 %, respectively, andthat of normal peripheral lymphocytes was 117 and109 %, respectively, indicating that AgNPs are nontoxicto normal PLs cells [91]. AgNPs synthesized with Indigoferaaspalathoides extracts were tested in wound-

Plant	plant part	size of nm	characterization	reference
Pedalium murex	Leaves	43	UV, X R, XR D	71
Artemisia turcomanica	Leaves	22	SEM, FTIR, EDX and UV/Vis	72
Caesalpinia pulcherrima	Flower	12	SEM, FTIR, and UV	73
Coriandrum sativum	Leaves	37	*XRD, TEM, UV-Vis*	74
Elephantopus scaber	Leaves	37.86	UV, FTIR, XRD, FESEM-EDAX and TEM	75
Erigeron bonariensis	Leaves	13	FTIR, XRD and EDX	76
Indigofera tinctoria	Leaves	36	UV, XR D	77

Vitex negundo L	Leaves	18	SEM, FTIR, and XRD	78
nepeta leucophylla	Root	41	SEM, FTIR, and UV	79
Anogeissus acuminate	Root	40	*XRD, TEM, UV-Vis*	87
Lepidium draba	Root	28-80	UV, FTIR, XRD, FESEM-EDAX and TEM	89
Holarrhena antidysenterica (L.)	Bark	42	FTIR, XRD and EDX	
Cnidoscolus chayamansa	Leaves	2-20	UV, XR D	90
Nervalia zeylanica	Leaves	34.2	SEM, FTIR, and XRD	91
Lippia citriodora (Lemon Verbena)	Leaves	15-30	XRD	92
Gloriosa superba L	Leaves	18.1	UV, X R, XR D	94
Fatsia japonica	Leaves	2	SEM, FTIR, EDX and UV/Vis	95
Dendropanax morbifera	Leaves	10-20	SEM, FTIR, and UV	99
Pistacia Atlantica	Fruit	15	*XRD, TEM, UV-Vis*	101
Zataria Multiflora	Leaves	30	UV, FTIR, XRD, FESEM-EDAX and TEM	102
Clinacanthus Nutans	Leaves	10-80	FTIR, XRD and EDX	103
Centella asiatica	Leaves	19.17	UV, XR D	104
mangifera indica	Leaves	26-28	SEM, FTIR, and XRD	110
Andean blackberry	Flower	12-50	XRD	111
Adansonia digitata L	Flower	7-57	SEM, FTIR, EDX and UV/Vis	113
Solanum nigrum	Flower	20-30	SEM, FTIR, and UV	112
Artemisia turcomanica	Leaves	22	*XRD, TEM, UV-Vis*	116
Sygyzium cumini	Seeds	43.03	UV, FTIR, XRD, FESEM-EDAX and TEM	118
maderaspatana (Cucurbitaceae)	Leaves	64	FTIR, XRD and EDX	117
Madhuca longifolia	Flower	30-50	UV, XR D	121
green and black tea	Leaves	18	SEM, FTIR, and XRD	122
Bergenia ciliate	Leaves	35	SEM, FTIR, and UV	123
annona muricata	Leaves	4.54-16.48	*XRD, TEM, UV-Vis*	125
Cleome viscosa L	Flower	20-50	UV, FTIR, XRD, FESEM-EDAX and TEM	126
Matricaria chamomilla	Leaves	45.12	FTIR, XRD and EDX	127
Phoenix dactylifera	root hair	15-40	UV, XR D	128
Ocimum sanctum	Leaves	18	SEM, FTIR, and XRD	129
Pimpinella anisum	Seeds	3.2	XRD	130
Punica granatum	Peel	65	SEM, FTIR, EDX, XRD and UV/Vis	131
Moringa oleifera	Leaves	8	*XRD,, FTIR , TEM,*	132

Asafoetida	Gum	5-28	*XRD, TEM, UV-Vis*	133
abutilon indicum	Leaves	26	UV, FTIR, XRD, FESEM-EDAX and TEM	135
Calotropis gigantean	Leaves	17-42	FTIR, XRD and EDX	137
Jasminum officinal l.	Leaves	13	UV, XR D	138
Diospyros Montana	stem bark	36	SEM, FTIR, and XRD	139
Cordia dichotoma	Flower	18	XRD	140
Jasmine	Flower	50	UV, X R, XR D	141
Rhanterium epapposum	Flower	43	SEM, FTIR, EDX and UV/Vis	142
Abelmoschus esculentus (L.) pulp	Pulp	22	SEM, FTIR, and UV	
Zephyranthes Rosea	Flower	41	*XRD, TEM, UV-Vis*	143
Clitoria ternatea	Flower	40	UV, FTIR, XRD, FESEM-EDAX and TEM	144
Mangifera indica	Leaves	28-80	FTIR, XRD and EDX	151
Pomegranate	Leaves	42	UV, XR D	147
Premna integrifolia (L.)	Leaves	2-20	SEM, FTIR, and XRD	146
Eruca sativa	Leaves	32	XRD	147
Spinacia oleracea	Leaves	16	UV, X R, XR D	147
Tectona grandis	Leaves	4-18	SEM, FTIR, EDX and UV/Vis	148
Oscillatoria limnetica	Leaves	36	SEM, FTIR, and UV	149
Centella asiatica (L.)	Leaves	18	*XRD, TEM, UV-Vis*	150
Murraya koenigii (L.)	Leaves	50	UV, FTIR, XRD, FESEM-EDAX and TEM	151
Eriobotrya japonica	Leaves	43	FTIR, XRD and EDX	152
Carica papaya	Leaves	22	UV, XR D	153
Ginkgo biloba	Leaves	41	SEM, FTIR, and XRD	154
annona muricata	Leaves	40	XRD	155
Catharanthus roseus (*Vinca rosea*)	Leaves	43	SEM, FTIR, EDX and UV/Vis	156
Prunus serrulate	Leaves	22	SEM, FTIR, and UV	157
Artemisia turcomanica leaf	Leaves	12	*XRD, TEM, UV-Vis*	
Clitoria ternatea	Leaves	37	UV, FTIR, XRD, FESEM-EDAX and TEM	158
Solanum nigrum	Leaves	86	FTIR, XRD and EDX	158
Salvia spinosa	Plant	13	UV, XR D	159
Azadirachta indica	Leaves	36	SEM, FTIR, and XRD	160
Catharanthus roseus	Seed	18	SEM, FTIR, and UV	161
Urtica dioica Linn	Leaves	50	*XRD, TEM, UV-Vis*	162
Pedalium murex	Leaves	43	UV, FTIR, XRD, FESEM-EDAX and TEM	163
Tectona grandis	Leaves	22	FTIR, XRD and EDX	164

Glycyrrhiza glabra	Root	41	UV, XR D	165
Malachra capitata	Leaves	40	SEM, FTIR, and XRD	167
Lysiloma acapulcensis	Leaves	80	XRD	168
Salvia miltiorrhiza	Leaves	42	SEM, FTIR, EDX, XRD and UV/Vis	169
Nigella sativa	Seeds	20	*XRD, FTIR , TEM, and UV-Vis*	170
Gloriosa superba (L.)	Leaves	34	*XRD, TEM, UV-Vis*	171
Cynara scolymus	Leaves	30	UV, FTIR, XRD, FESEM-EDAX and TEM	172
Phyla dulcis	Plant	18	FTIR, XRD and EDX	173
Pinus roxburghii	Leaves	2	UV, XR D	174
Phyllanthus emblica	Leaves	20	SEM, FTIR, and XRD	175
Tropaeolum majus L	Leaves	15	XRD	176
Punica granatum	Leaves	30	UV, X R, XR D	177
Teucrium polium	Leaves	10	SEM, FTIR, EDX and UV/Vis	178
Scutellaria barbata	Leaves	17	SEM, FTIR, and UV	179
Commelina nudiflora L	Leaves	28	*XRD, TEM, UV-Vis*	180
Coptis chinensis	Leaves	50	UV, FTIR, XRD, FESEM-EDAX and TEM	181
Annona squamosal	Leaves	57	FTIR, XRD and EDX	183
Melia dubia	Leaves	30	UV, XR D	184
Alternanthera sessilis	Leaves	22	SEM, FTIR, and XRD	185
Bauhinia Tomentosa linn	Leaves	43	XRD	186
Capparis zeylanica L	Leaves	64	UV, X R, XR D	187
Indigofera tinctoria	Leaves	32	SEM, FTIR, EDX and UV/Vis	188
Zanthoxylum rhetsa	Leaves	82	SEM, FTIR, and UV	189
Myrtus communis L	Leaves	41	*XRD, TEM, UV-Vis*	190
Taraxacum officinale	Leaves	12	UV, FTIR, XRD, FESEM-EDAX and TEM	191
Phytolacca decandr	Leaves	20	FTIR, XRD and EDX	192
Iresine herbstii	Leaves	3-28	SEM, FTIR, EDX and UV/Vis	193
Nepeta deflersiana	Leaves	41	SEM, FTIR, and UV	194
Prunus domestica	Leaves	50	*XRD, TEM, UV-Vis*	196
Vitex negundo L	Leaves	60-20	UV, FTIR, XRD, FESEM-EDAX and TEM	197
Cucumis prophetarum	Leaves	25	FTIR, XRD and EDX	198
Momordica cymbalaria	Leaves	30	UV, XR D	200
Nigella arvensis	Seed	10-80	SEM, FTIR, and XRD	201
Pueraria tuberose	Leaves	19.17	SEM, FTIR, and UV	202
Carpesium cernuum	Leaves	26-28	*XRD, TEM, UV-Vis*	203
Panax ginseng root	Leaves	12-50	UV, FTIR, XRD, FESEM-EDAX and TEM	204

Artemisia turcomanica	Leaves	7-57	FTIR, XRD and EDX	
Abelmoschus esculentus (L	Leaves	20-30	UV, XR D	205
Salvia spinosa	Lant	22	SEM, FTIR, and XRD	206
Azadirachta indica	Leaves	43.03	XRD	207
Glycyrrhiza glabra	Root	64	SEM, FTIR, EDX, XRD and UV/Vis	209
Salvia miltiorrhiza	Leaves	30-50	*XRD, FTIR , TEM, UV-Vis and EDS*	210
Nigella sativa	Seeds	18	*XRD, TEM, UV-Vis*	211
Gloriosa superba (L	Leaves	35	UV, FTIR, XRD, FESEM-EDAX and TEM	212
Cynara scolymus	Leaves	4.54-16.48	FTIR, XRD and EDX	213
Phyla dulcis plant	Leaves	20-50	UV, XR D	214
Phyllanthus emblica	Leaves	45.12	SEM, FTIR, and XRD	215
Punica granatum	Leaves	15-40	XRD	217
Teucrium polium	Leaves	18	UV, X R, XR D	218
Commelina nudiflora	Leaves	16	SEM, FTIR, EDX and UV/Vis	219
Coptis chinensis	Leaves	55	SEM, FTIR, and UV	220
Annona squamosal	Leaves	4.54	*XRD, TEM, UV-Vis*	221
Glycyrrhiza uralensis	Leaves	20-50	UV, FTIR, XRD, FESEM-EDAX and TEM	222
Bauhinia Tomentosa linn	Leaves	45.12	FTIR, XRD and EDX	223
Capparis zeylanica L	Leaves	15-40	UV, XR D	224
Indigofera tinctoria	Leaves	18	SEM, FTIR, and XRD	
Taraxacum officinale	Leaves	3.2 -16	XRD	225
Nepeta deflersiana	Leaves	65	UV, X R, XR D	226
Nothapodytes nimmonian	Flower	8	SEM, FTIR, EDX and UV/Vis	227
Prunus domestica gum	Leaves	5-28	SEM, FTIR, and UV	228
Vitex negundo L	Leaves	26	*XRD, TEM, UV-Vis*	229
Cucumis prophetarum	Leaves	17-42	UV, FTIR, XRD, FESEM-EDAX and TEM	230
Clerodendrum phlomidis	Leaves	13	FTIR, XRD and EDX	231
Momordica cymbalaria	Tuber	36	UV, XR D	232
Nigella arvensis	Leaves	18	SEM, FTIR, and XRD	233
Pueraria tuberose	Leaves	50	XRD	234
Carpesium cernuum	Leaves	43	SEM, FTIR, EDX and UV/Vis	235
Prosopis cineraria	Leaves	22	SEM, FTIR, and UV	236
Coriandrum sativum	Leaves	41	*XRD, TEM, UV-Vis*	237
(Styrax benzoin benzoin	Gum	40	UV, FTIR, XRD, EDAX and TEM	238
Andrographis echioides	Leaves	40	FTIR, XRD and EDX	239
Plumeria alba	Flower	17	UV, XRD	240

Note: DLS—Dynamic light scattering, EDAX/EDS Energy Dispersive X-ray Analysis/Energy Dispersive Spectroscopy; FTIR—Fourier transform infrared spectroscopy, HRTEM—High Resolution Transmission Electron Microscopy; SEM—Scanning Electron Microscopy, TGA—Thermogravimetric analysis, UV-Vis—Ultra violet-visible spectroscopy; XRD—X Ray Diffraction, DEC—decahedral, sph—spherical, Tri—Triangular, R— Rod, Hex—Hexagonal, PD—Polydispersed, MD—monodispersed, WD—Well Dispersed, Cryst—Crystalline.

4.0 Conclusion

This review looks at the prospective of green synthesized AgNPs in the treatment of cancer. An overview of the green synthesis of AgNPs, then reviewed the applications of AgNPs in the treatment of cancer and their possible mechanism for cytotoxic activities. Various plants species has been widely used in comparison with other sources. Several characterizations methods and techniques have been used for AgNPs synthesis and confirmation. The AgNPs synthesized using biological reducing and capping agents have shown wide variation in size. Among applications, the anti-cancer action of AgNPs has been widely studied. Various methods used to carry out antibacterial study and mechanisms of anti-cancer have been developed. This makes the AgNPs as a promising candidate for future cancer treatment. Although various studies on size, shape, capping agenting, reducing agents of AgNPs have been performed, nevertheless there is still no clear optimum condition indicated for proper synthesis and development of targetdrug delivery system for cancer; thus, Several published literatures is available on the synthesis of AgNPs through green chemistry. Extensive studies are required in this field. In addition to this, long-termstudies of AgNPs in vivo are necessary to evaluate the toxicity and performance. The potential of AgNPs for their use as drug carriers in cancer therapy, as biosensors for metabolites and pollutants, as catalyst etc. is quite high and requires intensive and integrated research activity for harnessing it.

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