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Review Article

Nanoparticles and plant Biotechnology

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Among the advances in technology, nanotechnology has an important role. With increasing rate of population, traditional agriculture will not be accountable the population food needs. The use of plants to produce nanoparticles is a biological system, cost-effective and environmentally friendly. The aim from nanotechnology in agriculture and biotechnology is development new methods for rapid diagnosis of plant diseases and needs with the use of biosensors, improving agricultural products, reduce environmental pollution, reduce costs, producing new products and engineered according to the increasing population. This review article provides an overview of the nanoparticles production in plants and their applications in agriculture, biotechnology, improved crops, and hazards of nanoparticles.

The term nanotechnology was first proposed in 1974 by Norio Taniguchi, which briefly includes the study of manipulating matter at the atomic and molecular in the size range of 1 to 100 nm, and the development of materials and devices in this size. As the application of this technology in agriculture is considered and they help to reduce problems related to sustainable agriculture through improved utilization of agricultural inputs and food and water safety are used (Arivalagan et al., 2011; Gruère et al., 2011). Nanotechnology is a new initiative, interdisciplinary scientific approach to design, development and use of materials and devices at the nanoscale (Fakruddin et al., 2012). Nanotechnology is a growing area where the manufacturing of nanoparticles can be controlled with a size, shape and distribution (Nadagouda et al., 2009). The use of nanomaterials in the fields of biology, biotechnology and materials science are interrelated (Murray et al., 2000). Nanotechnology can increase yield crops, nutritional value and the value of the products and restore the environment (Misra et al., 2013). Nanoparticles are quite unique and different properties than larger particles. New properties of nanoparticles are to a variety of special features such as size, shape, and their distribution (Misra et al., 2009). The unique characteristics and benefits of nanoparticles, are created several aspects of the same size of nanoparticles and biomolecules such as proteins and nucleotides poly acid (Ferrari et al., 2005). Nanotechnology provided new ways to solve problems related to plants and food industries, as well as increasing the quality of food (Sharon et al., 2010). The use of nanoparticles is very different in agriculture, industry and medicine (Kim et al., 2004; Sperling et al., 2008). Because of their small size, nanoparticles have different surface to volume ratio so that their surface characteristics are more important and the properties of the nanoparticles have a unique and potentially toxic properties compared to bulk materials or separate molecules Among these features, increase the electrical conductivity, improve the strength and hardness is used for medicine, textile, defense, food, agriculture, cosmetic. In food and agricultural systems, nanotechnology covers many aspects of food safety, packaging, treatment and new tools for molecular and cellular biology (Kreuter.,1994). Nanoparticles produced via physical, chemical and biological methods (Chen et al., 2008). Physical and chemical methods are very expensive (Li et al., 1999). In chemical synthesis methods are used from toxic chemicals such as sodium borate particles that environmental hazards (Honary et al., 2011). Biological methods for nanoparticle synthesis eliminates processing conditions through the synthesis of physiological PH, temperature, pressure and doing.at the same time and low cost. Many microorganisms found that inorganic nanoparticles are synthesized inside or outside the cell. Due to the properties of nanoparticles are unacceptable, in recent years in many fields such as energy, health care, environment, agriculture and change the value obtained (Raveendran et al., 2003).

Synthesis of nanoparticles

Nanoparticles can be achieved by the use of chemical, physical and biological production. The chemical synthesis can be used in a short time a large amount of synthesized nanoparticles. The method of coating agents used to stabilize the nanoparticles (Vauthier et al., 1991; Alonso et al., 1996). In physiological synthesize metal nanoparticles by Evaporative Gas Condensates of different materials such as silver, Pbs and Fullerene generated by using density evaporation (Gurav et al., 1994; Schmidt et al.,1988). Fabrication of nanoparticles by using bacteria such as Bacillus species have been used to synthesize metal nanoparticles. Researchers showed the ability of bacteria to reduce silver, making the extracellular stability of nanoparticles spread ranging from 10-20 nm (Sunkar and Nachiyar., 2012). Extracellular biosynthesis of silver nanoparticles in *Aspergillus Nygra* (Gade et al., 2008), and *Aspergillus oryza* to produce silver nanoparticles have been reported (Ingle et al., 2009). Biological methods for the production of nanoparticles is currently for environmental sustainability and lack use of toxic chemicals are important in the synthesis of nanoparticles (Vigneshwaranm et al., 2007; Shankar et al., 2004). Plants and crops as cheap and renewable resources to produce nanoparticles are considered. Phytoremediation and use of biomass plants extracts such methods are used in the context of a plant for the production of nanoparticles. Interesting properties of nanoparticles has caused a variety of applications in industry, agriculture, medicine, pharmaceutical, chemical and electronic. Chemical methods for the preparation of nanoparticles, such as grinding off and vapor condensation, expensive, and produced dangerous by products. Therefore due to the safety of biological methods, production of nanoparticles is good alternative (Shankar et al., 2004; Mukherjee et al., 2001). Plant production nanoparticles advantages over other methods of biological, they are very reliable, safe and healthier than bacteria and fungi and yeast to produce nanoparticles (Karimi et al., 2011). Due to cheap and easily accessible of biological methods, especially of plant compared to other methods is important (Mohan et al., 2009). The use of different plant parts such as stems, leaves, flowers, fruit, seeds and bark for the synthesis of nanoparticles an entirely new way and green chemistry in compared to other physical and chemical methods, and it is cost-effective and environmentally-friendly(Benjamin and Bharathwaj.,2011; Shekhawat et al., 2012).

Extraction of nanoparticles through phytoremediation

Plants are the basis of all ecosystems that play an important role in the fate, transport, engineered nanoparticle absorption and accumulation by the plant (Xingmao et al., 2010). Phytoremediation is a new method for water purification contaminated soils for the cleanup many pollutants such as pesticides, metals, petroleum hydrocarbons, the plant is used (McCutcheon and Jorgensen., 2008). More research on the production of gold and silver nanoparticles of different plants, which, depending on the nature of the nanoparticles, plant species or plant tissue in which they are stored Metallic nanoparticles of different shapes and sizes can be achieved when all of these processes are environmentally friendly and cost-effective (Gutiérrez et al., 2011). Scientists have found that plants can be used to extract the metals and the ability of plants to absorb precious metals commercial has attracted the attention of researchers (Gardea et al., 2005). The use of green plants to produce nanoparticles somewhat unknown (Sharma et al., 2007). The use of biomass for the production of nanoparticles is a simple and cost-effective (Narayanan and Sakthivel., 2011). Nanoparticles of gold and silver in the various forms in plant tissues are stored so that the aerial parts of alfalfa based on culture agar gold and silver as KAUCL and AgNO at concentrations exceeding 370 mg kg^{-1} Gold and 120 mg kg^{-1} silver is stored (Girling and Peterson., 1978).

Nanoparticles by plant extracts

Plants used in the synthesis of nanoparticles have many fans because it provides a one-step process of biosynthesis. Thin and delicate plants option for the synthesis of nanoparticles, such as protocols are pesticide free resources. The first report on the synthesis of silver nanoparticles using alfalfa in 2003 was a step towards green nanotechnology appeared (Gardea et al., 2009). Metallic nanoparticles synthesized by plants extract greater benefits from other biological processes such as the synthesis of complex microbial culture. Reports indicate that silver nanoparticles leaf extract *Camellia Sinensis* (Loo et al., 2012), *Lantana camara* (Thirumurugan et al., 2011), skin stem *ovalifoliolata Boswellia* (Ankanna et al., 2010), Euphorbia sap and root extracts *Glycyrrhize glabra*, is produced (De Matosa et al., 2011). In a study using the ethanol extract of the leaves of the tree *Terminalia Catappa* spherical gold nanoparticles in the range of 20 to 40 nm is obtained (Bindhani and Panigrahi., 2014). In addition the gold and silver nanoparticles are obtained by using Aloe Vera extract (Chandran et al., 2006). In a study of leaf and fruit extracts *Morindacoreia* Buck, Ham obtained the silver nanoparticles that have antimicrobial effect against Pathogenic bacteria (Kannan et al., 2014). Enzymes, proteins, and other reducing agents by plants play an important role in the preparation of nanoparticles and nanoparticle retrieval is costly and requires a wall of cellulosic degradation by the enzyme (Marshall et al., 2007). Leaves extract are rich from flavonoids that have a role in reduces the load in synthesis the gold and silver (Jang et al., 2010; Tavera et al., 2009). Pine and persimmon extract are used to produce silver nanoparticles in the size range 15-500 nm (Song and Kim, 2009). The report stated that the gold and silver nanoparticles have been synthesized by using alfalfa. That this biomass existing are, tetragonal, hexagonal, ten planar (Gardea et at., 1999; Gardea et al., 2003). Plants with a very rich genetic diversity and biological molecules of interest, in the form of coenzyme, vitamin intermediates and many other items can be useful in reducing metal ions to nanoparticles. Metabolites of plant material used as the reducing agent are including phenolic compounds, alkaloids and sterols. Another advantage is that the green synthesis and use of plant extracts, live plants can be used for the synthesis of nanoparticles. Synthesis of nanoparticles by using plant extracts, due to the need for high-energy, high-pressure, biological adaptation to the environment than other methods because of removal solid phase microbial growth can be beneficial (Castro-Longoria et al., 2011; Ashok et al., 2010). Many studies focused on the use of plant material for the manufacture of gold and silver nanoparticles (Park et al., 2011; Mubarak Ali et al., 2011). Production of nanoparticles by using Mirabilis Jalapa extracts have also been reported (Vankar and Bajpai., 2010). Herbal extract acts as a reducing agent nanoparticle stability. The natures of plant extract, type of nanoparticles are synthesized influences. And the most important factor affecting the morphology of the nanoparticles can be synthesized (Mukunthan and Balaji., 2012). And this is because of different plant extracts containing different concentrations of reducing agents biochemically (Li et al., 2011). New varieties of plants, have very good biomolecules in their genome through which reduces the biochemical For example, during the synthesis of silver nanoparticles of geranium extract particles formed quickly. And particle size of about 16-40 nm can be achieved (Shankar et al., 2003). Silver nanoparticles by using plants such as *Basella alba*, sunflower, sorghum, maize (Leela and Vivekanandan., 2008), pepper (Agarwal et al., 2014), cinnamon leaf (Huang et al., 2007), has been produced. Green synthesis of silver nanoparticles by using methanol extract of leaves of Eucalyptus hybrids have been reported (Dubey et al., 2009). In Table 1 Some of the plants used to produce nanoparticle are discussed.

Table1: Plants used for the synthesis of nanoparticles

Plant	Tissue	Produced nanoparticles	size of nanoparticles	shape nanoparticles	References
Camellia Sinensis	Leaves	Ag	2-10 nm	spherical	Loo et al., 2012
Lantana Camara	Leaves	Ag	40 nm	-	Thirumurugan et al., 2011
Ovalifoliolata Boswellia	Bark	Ag	30-40 nm	spherical	Ankanna et al., 2010
Euphorbia Milli	Latex Extract	Ag	10-50 nm	-	De Matosa et al., 2011
Glycyrrhiza Glabra	Roots Extract	Ag	20-30 nm	spherical	De Matosa et al., 2011
Terminalia Catappa	Leaves	Au	20-40 nm	spherical	Bindhani and Panigrahi., 2014
Aloevera	Leaves	Ag and Au	50-350nm	spherical triangular	Chandran et al., 2006
MorindaCoreia Buk. Ham	Leaves Fruit	Ag	-	-	Kannan et al., 2014
Pin	Leaves	Ag	15-500 nm	-	(Song and Kim, 2009)
Persimmon	Leaves	Ag	15-500 nm	-	(Song and Kim, 2009)
Medicago Sativa	Leaves	Ag and Au	20-40 nm	hexagonal	(Gardea et at., 1999; 2003)
Mirabilis Jalapa	Flowers	Au	60-70 nm	spherical	(Vankar and Bajpai., 2010)
Geranium leaf	Leaves	Au	16-40 nm	spherical triangular	Shankar et al., 2003
Capsicum Annuuml	Callus Extract	Ag	15 nm	hexagonal, cubical	Agarwal et al., 2014
Cinnamomum Caphora	Leaves	Ag and Au	55- 80 nm	Spherical, hexagonal, cubical	Huang et al., 2007
Eucalyptus Hybrida	Leaves	Ag	-	cubica	Dubey et al., 2009

Application of nanoparticle

Nanoparticles have widely used in pharmaceuticals, cosmetics, food and beverages, agriculture, polymers. And newly are used for developed inside the body imaging techniques to diagnose medical disorders. Silver nanoparticles have antibacterial activity and are used in production textiles, medical devices (Tolaymat et al., 2010). Morphology and Surface properties of colloidal nanoparticle are important. So that smaller nanoparticles than larger nanoparticles have further antimicrobial activity (Chwalibog et al., 2010). Because the drug delivery system in the body, smaller nanoparticles remain more in the circulatory system and more chances have for distribution among target site (Gaumet et al., 2008). The size and shape of the nanoparticles plays an important role in commercial applications. So that the advantages and limitations depending on the type and use of nanoparticles. For example the selective optical filters and biosensors, including many of the applications that are used on the optical properties of nanoparticles. The optical properties of surface plasmon resonance, which is strongly dependent on the particle, the larger Shapes is caused losses of more plasmons (Borkovskaya et al., 1997). In recent years much attention has been nanoparticles. And because of their small size compared to their bulk materials are used in the chemical industry, biotechnology, medical, analytical (Martin and Mitchell., 1988; McConnel et al., 2002). Nanoparticles of about 25 nm has antibacterial properties, if the size of nanoparticles smaller than 10 nm leads to interference in the process of cell division and destroys the respiratory chain and electrical effects are created. The antibacterial effect of silver nanoparticles is entirely dependent on the size (Morones et al., 2005). Attempts to find the nanoparticles with a size smaller among precious metals (e.g., silver, platinum, and gold), silver has unique properties that have applications such as catalysis of chemical reactions (Jiang et al., 2005), pharmaceuticals, chemical assay and bioassays (Aymonier et al., 2002; Songping and Shuyuan., 2005). Effects of Silver Nanoparticles in preventing HIV proliferation are better than gold nanoparticles and also effective against hepatitis B virus (Sun et al., 2005). From silver nanoparticles in the treatment of wounds, cuts, pimples, warts are used (Hu and Easterly, 2009). The use of nanoparticles in cosmetics and drug coverage extensively increased from day to day. Metal oxides nanoparticles, such as zinc oxide, titanium dioxide currently have appeared in compounds of household products such as sunscreens, toothpaste, cosmetics and medicines (Yu and Li., 2011). Metallic nanoparticles show a specific response to the cells into cells and cytotoxicity depends on the size and shape of the nanoparticles (Haung and El-Sayed, 2010). Synthesis of silver nanoparticles has been used to control the parasite (Marimuthu et al., 2011), inhibition of fungal growth (Lara et al., 2010).

Silver nanoparticles are used in medicine for the treatment of burns, disinfecting, dental material production, modifying and waste water treatment and metal coatings (Ales et al., 2006). Some of the nanoparticles such as metal oxide and semiconductor nano-particles were used for construction electrochemical sensors and biosensors and these nanoparticles have different roles in measurement systems. Nanoparticles have important functions, including immobilization of biological molecules, analysis of electrochemical reactions, improving the electron transfer between the electrode surfaces and proteins, labeling of biomolecules and as a reactant. From unique physical and chemical properties of the nanoparticles used to design new and enhanced sensitivity of electrochemical sensors and biosensors. Gold of nanoparticles often are used to inactivity proteins (Kalishwaralal et al., 2010).

The application of nanotechnology in the biotechnology products

The skilled use of natural agricultural assets such as water, nutrients and Chemical substances during the precision agriculture, Nano sensors and intelligent delivery systems based on nanoparticles have many lovers. This makes the use of nanomaterials and Global Positioning System satellite images of crops, crop pests or drought stress recognize. Nano sensors are capable feel of viruses in plants, the soil nutrients. For Leaving aside of fertilizer consumption and reduce environmental pollution nanoparticles that have come into the capsule slowly releases fertilizers (Liu et al., 2003). Nano materials are being developed for slow release and effective dose for plant (DeRosa et al., 2010). Nano sensors are small, portable, sensitive, accurate, reliable and repeatable and can to recognize harvesting time, safety products, biological and chemical contaminants. Nano smart sensors can also be linked to a GPS system that real-time monitoring of agricultural products (Singh, 2012). Another of interesting application of Nano-bio sensors is reduce pollution pollen to pollinate crops by wind which is a reliable method For genetic purity and can reduce pollution (Sharon et al., 2010). The seeds are also using Nano capsules and specific species of bacteria that coated called seeds smart. These seeds germinate only when enough water and is reduced seed consumption and improve the performance of crops. Also biological Nano-sensors are used to estimate the seed aging (Su XL and Y Li., 2004). For identification of infection soil microorganisms like bacteria, fungi and viruses through a quantitative measure of the difference between consumption rate of oxygen and respiration (relative activity) good microbes and bad microbes in the soil is used. It can also identify chemicals contaminants and specific herbicides (Chinnamuthu and Boopathi., 2009). Nano capsules can facilitate herbicides influx through the cuticles and tissue and allows active ingredient to be secreted regularly. It's like magic bullets containing herbicides, Chemical substances or genes that targeting hard parts of the plant to break their material (Rai et al., 2012). Nano sensors are devices that to respond environmental conditions and convert them into useful information. They are able to detect very small amounts of pollution, pests, nutrients and even stress caused by food shortages, drought, temperature or the presence of pathogens (Pérez-de-Luque and Rubiales., 2009). Nano sensors networks across fields cultivated have careful monitoring on the time crop growth. Therefore mechanisms of diffusion through carriers at the nanoscale can prevent the overuse Chemical substances and reduces waste and the chemical consumption (Johnston, 2010; De Rosa et al., 2010). An example of Nano-pesticides used in the poultry raising venues, is antibacterial coating (Chen and Yada., 2011). When the coating is exposed to natural light or ultraviolet activated. Nano fertilizer increases the efficiency and nutrient uptake by the plant and may also protection. soil quality with reduce the toxic effects related to high consumption In the coming years it is expected that the use of nanoparticles in human studies to be conducted in the agricultural sector. But these materials, due to the lack of studies related to the environmental security and food safety are very useful (Prasad et al., 2014).

Application of Nanotechnology in nutrients, pests and plant hormones

Using the idea barcode food stuffs, disease detection and decoding is cost effective, fast and easy. They are generating the microscopic probes or Nano barcodes that may have labels multiple pathogens in a field and simply be identified using fluorescence-based tools (Takeuchi et al., 2014). Nanoparticles are also capable to early detection of pests and plant disease management (Li et al., 2005). Conventional methods to control pests and pathogens that affect farmers, the environment and the economy. So that 90% biocides and pesticides that are used by air and water are lost. In addition to the indiscriminate use of pesticides, pathogens and pest resistance increases and reduces the soil biodiversity and nitrogen fixation and destroys the habitat of birds (Ghormade et al., 2011). Through nanotechnology, scientists are able to study plant regulatory hormones, such as auxin, which are responsible for the growth of roots and shoots are formed .Nano sensors have been developed to respond with auxin. This will help scientists to understand how plant roots are compatible with their surroundings, especially in marginal soils (Ghormade et al., 2011).

Carbon nanotubes are various forms of carbon in cylindrical shape. That can be used as vector to deliver the desired molecules or nutrients or pesticides during seed germination (McLamore et al., 2010). The use of chemicals such as pesticides, fungicides and herbicides can cause environmental problems and the adverse effect on human and animal health. The application of chemical substances at the nanoscale appropriate solution to this problem. These materials are used in part of the plant that by the disease or pest was attacked .These materials at the Nano scale which are characteristic of self-regulation. The dosage required to be delivered to the plant tissue. Polymeric nanoparticles, nanoparticles of iron oxide and gold nanoparticles including the particles that can be easily synthesized and be exploited as a pesticide, drug delivery (Sharon et al., 2010). In the future at the nanoscale devices with new properties can be used to make intelligent agriculture. For example, a device that can be used to detect plant health before being is visible for agriculture (Gutiérrez et al., 2011).

Nanoparticles and the production of transgenic

Nano Biotechnology offers new set of tools for manipulating gene, by using nanoparticles, Nano fibers and Nano-capsule. Nano materials can carry a large number of genes and are also able to gene expression and control the release of genetic material in plants (McLamore et al., 2010; Joseph and Morrison, 2006). In a study of 3-nm silica nanoparticles have used in DNA transfer and Chemical substances into plant cells isolated. This technique first was used to generate DNA in tobacco and maize (Nair et al., 2010). The use of fluorescent-labeled starch-nanoparticles as carriers of transgenic plants have been reported where the nanoparticles are designed to be attached to it. And with instantaneous channels in cell wall, cell membranes and nuclear membrane, genes in across the plant cell wall, can be carries by using ultrasonic. DNA-coated silver nanoparticles(nanoparticles coated with plasmid) to penetrate protoplasts isolated from petunia and carrying plasma DNA inside nucleus has been shown by incubation with ethylene glycol(Torney et al., 2007). Nowadays gene gun or particle bombardment directly DNA transfers are used without injury to the plant cells. Experiments have shown that plasmid DNA was transferred to a gene gun method by using gold nanoparticles with success in tobacco and maize tissues is expressed (Rad et al., 2013).

The use of nanoparticles in product improvement

Many reports exist on the use of nanoparticles to improve the product. More carbon and metal oxide nanoparticles based on engineering has been studied (Nair et al., 2010). Nano sensors with biological stabilized receptor probes, which are specific for the target analysis molecules called Nano biosensors that their application are includes analysis diagnosis urea, glucose, pesticides, metabolites monitoring diagnostics pathogens and microorganisms(Chinnamuthu and Boopathi., 2009). Several studies show that nanotechnology will have long-term major effects in the agricultural sector. The positive effects of morphological nanoparticles are include increasing germination percent, growth rate, root and shoot biomass and seedling associated with increased physiological parameters such as increased photosynthetic activities and nitrogen metabolism in many crops. In addition, this technology improves the controlled liberalization agricultural chemicals in situ target to transfer molecules in order to plant diseases resistance (Shweta and Rathore., 2014). ZNO nanoparticles increases root growth, germination, bud root auxin levels and growth rates peas and peanuts (Pandey et al., 2010; Prasad et al., 2012). Nanotubes in the tomato seeds, increase germination efficiency and increase water absorption (Khodakovskaya et al., 2009). In another study has been showed that ZnO nanoparticles increase starch and protein content cucumber but concentration trace elements Cu and Mo significantly has reduced (Zhao et al., 2014). Tio2 nanoparticles is used for accelerate the growth of spinach by increasing the activity of Rubisco and improvement light absorption (Yang et al., 2006; Hong et al.,2005) and nitrogen metabolism becomes increase (Yang et al., 2007). Silicon nanoparticles are absorbed by the plant and increase resistance to disease and stress (Datnoff., 2004). In the report found that ZnO nanoparticles has inhibitory effect on seed germination of corn, rye and grass (De Rosa et al., 2010). It is proved that Tio nanoparticles at concentrations of 10-40 mg/l have increased Parsley seed germination percent (Dehkourdi and Mosavi., 2013).

The hazards of nanoparticles

Environmental and health dangers caused by nanomaterials cannot be easily evaluated because they have different properties and behavior .Kinetic properties (absorption, distribution, metabolism and excretion) and toxic properties of nanoparticles are influenced by the size and shape therefore has different toxicity (Rathore et al., 2012). The application of nanomaterials, for example common foods contain a lot of Nano scale materials (milk protein, carbohydrates, DNA) is not inherently dangerous. But use of nanomaterials in the agriculture, water and Food stuffs may be harmful for humans and the environment, or both of them (Gruere et al., 2011). With rapid development of nanotechnology there are concerns about the accumulation of nanomaterials generated and its entry into the food chain (Priester et al., 2012). In nanotechnology there are concerns about side effects such as toxicity of nanoparticles in biological systems and the environment by producing free radicals which lead to lipid peroxidation and DNA damage (Shweta and Rathore., 2014). Lack of sufficient scientific knowledge about key evaluation of risk factors such as nanoparticle toxicity, aggregation, and risks becomes increasing concerns. Also negligible attribution share of funding in this area and focus on the financial support of non-agricultural and non-food show that will continue this lack of knowledge (Gruere et al., 2011). In fact, in the future, there are concerns about the disposal danger related to nanoparticles. Nowadays international programs are the risk study related to the use of them. Although the use of danger nanoparticles in the agricultural sector is still not well defined nanotechnology applications can help increase production, better management and conservation organizations. Production of nanoparticles, releasing uncontrolled and non-standard in high concentrations in nature, are dangerous for humans and the environment. And finally regardless of the methods of production, due to the high permeability of the nanoparticles, is required the observance of safety.

Devices check the properties of nanoparticles

Nanoparticles traits are important for understanding the control of nanoparticle synthesis and applications. Characterization of nanoparticles has been done by using a wide range of techniques including scanning electron microscopy (SEM), Fourier transform infrared spectroscopy, X-ray Diffraction, Transmission Electron Microscopy(TEM), Dynamic Lights Scattering(DLS), Atomic Force Microscopy(AFM), UV-VIS spectroscopy. These techniques are useful for determining parameters such as particle size, shape, crystallinity, size and surface pores. Structure and particle size is possible can be determined by TEM, SEM, AFM. Progress and performance AFM technique is more from SEM and TEM. AFM images of the 3D measurement, so that the height and size of the particles can be achieved. In addition, Dynamic light scattering (DLS) is used to determine the crystallization and determination of particle size distribution. X-ray diffraction is used to determine the crystallization whereas UV-vis spectroscopy is used to confirm the formation of the sample by showing plasmon resonance (Choi et al., 2007; Khomutov and Gubin, 2002).

Conclusions

Affordable production of nanoparticles in plants, and their applications in agriculture and biotechnology have attracted the attention of many researchers which can play a vital role in providing food for the growing population. Therefore countries that have the potential of nanotechnology in agriculture are being investing in this field. Commercial and applications are on the rise that can have an important role in improving agricultural production. So that are used in the sensors and sensors precision in agriculture, natural resource management, early detection of food diseases factors and pollutants, preventing the leaching of nutrients, drought stress detection and intelligent delivery systems for chemicals. Nanotechnology is in the early stages of development and expansion, and no one can claim that the technology is safe. So there is concerns about transgenic crops and the impact on the environment and ecosystem toxicity of nanoparticles and enter the food chain. Biological hazards of nanoparticles should be investigated in the future that can have a bright future and useful. In this paper we have discussed in the different plants to production nanoparticles and their applications in biotechnology.

References

Agarwal, P., Kumar, B.V., Kachwaha, S., and S. L. Kothari (2014)''Green synthasis of silver nanoparticles sing callus extract of capsicum annuum and their activity against microorganisms. *International Journal of Nanotechnology and Application* Vol. 4, Issue 5, 1-8.

Ales Panacek., L. Kvýtek, R. Prucek, M. Kolar, R. Vecerova, N. Pizurova, Virender, K. Sharma., T. Nevecna and R. Zboril. (2006). Silver Colloid Nanoparticles: Synthesis, Characterization, and their Antibacterial Activity. J. Phys. Chem. B., 110: 16248-16253.

Alonso, M.J (1996) Nanoparticulate drug carrier technology. In: S. Cohen, H. Bernstein (Eds.), Microparticulate systems for the delivery of proteins and vaccines. Marcel Dekker, New York, USA 203-242.

Ankanna, S., T. N. V. K. V. Prasad, E. K. Elumalai and N. Savithramma. (2010). Production of biogenic silver nanoparticles using *Boswellia ovalifoliolata* stem bark. Dig. J. Nanomat. Biostruct., 5(2): 369-372.

Arivalagan, K., Ravichandran, S., Rangasamy, K (2011) Nanomaterials and its Potential Applications. Int. J. ChemTech Res. 3: 534 538.

Ashok, B., Bhagyashree, J., Ameeta, R., Smita, Z (2010). Banana peel extract mediated novel route for the synthesis of silver nanoparticles, Colloids and Surfaces A: Physicochem. Eng. Aspects368 58–63.

Aymonier, C.; Schlotterbeck, U.; Antonietti, L.; Zacharias, P.; Thomann, R.; Tiller, J.C.; Mecking, S. Hybrids (2002) of silver nanoparticles with amphiphilic hyper branched macromolecules exhibiting antimicrobial properties. *Chem. Commun*, *24*, 3018–3019.

Benjamin, G., Bharathwaj, S (2011) Biological Synthesis of Silver Nanoparticles from Allium Cepa (Onion) and Estimating Its Antibacterial Activity, Int. Conf. Biosci. Biochem. Bioinformat. IPCBEE.; 5:35-38.

Bindhani, B., K and, A., K. Panigrahi (2014) Green Synthesis of Chitosan Based Gold Nanoparticles Using Leaf Extracts of *Terminalia catappa* L. And Study of Their Effects on Cancerous Cells. World Applied Sciences Journal 32 (6): 1153-1158.

Borkovskaya, O. Y., Dmitruk, N. L. & Fursenko, O. V. (1997) Characterization of thin metal films with over layers by transparency and multi angle including surface plasmon excitation reflectance ellipsometry method. Proceedings of SPIE, 3094, 250–254.

Castro-Longoria E. Alfredo R. Vilchis-Nestor, M. Avalos-Borja (2011) Biosynthesis of silver, gold and bimetallic nanoparticles using the filamentous fungus *Neurospor acrassa*, Colloids and Surfaces B:Biointerfaces 83 42–48.

Chandran, SP., Chaudhary, M., Pasricha, R., Ahmad, A., Sastry, M (2006) Synthesis of gold nanotriangles and silver nanoparticles using Aloe vera plant extract. Biotechnol Prog 22: 577-583.

Chen, H., Roco, M.C., Li X, Lin, Y (2008) Trends in nanotechnology patents. Nat Nanotechnol 3: 123-125

Chen, H., Yada, R (2011) Nanotechnologies in agriculture: New tools for sustainable development. Trends in Food Science & Technology 22:585-594.

Chinnamuthu, C.R., Boopathi, P.M (2009) Nanotechnology and Agro ecosystem. Madras Agric. 96: 17 31.

Choi, Y., Ho, N.H., Tung, CH (2007) Sensing phosphatase activity by using gold nanoparticles. AngewChemInt Ed Engl 46: 707-709.

Chwalibog, A., Sawosz, E., Hotowy, A., Szeliga, J., Mitura, S., Mitura, K., et al. (2010). Visualization of interaction between inorganic nanoparticles and bacteria or fungi. International Journal of Nanomedicine, 5, 1085–1094.

Datnoff, L.E (2004) Silicon Suppresses Leaf Spotting on Bermuda grass.

Dehkourdi, E.; Mosavi, M (2013) Effect of Anatase Nanoparticles (TiO2) on Parsley Seed Germination (*Petroselinum crispum*) In Vitro. Biological trace element research, 155, (2), 283-286.

De Rosa, M.C., Monreal, C., Schnitze, R M., Walsh, R., Sultan, Y (2010) Nanotechnology in fertilizers. Nature nanotechnology, 5(2): 91-91.

De Matosa, R, A., T. da S. Cordeirob, R. E. Samad, N. D. Vieira Jr and L. C. Courrola. (2011). Green synthesis of stable silver nanoparticles using *Euphorbia miliilatex*. Colloid. Surface A: Physicochem. Eng. Aspects, 389: 134–137.

Dubey, M.; Bhadauria, S.; Kushwah, B.S. (2009) Green synthesis of nanosilver particles from extract of *Eucalyptus Hybrida* (Safeda) leaf. *Dig. J. Nanomater. Biostruct*,*4*, 537–543.

Fakruddin, M., Hossain, Z., Afroz, H (2012) Prospects and applications of nano-biotechnology: a medical perspective. Journal of nanobiotechnology, 10(1): 1-8.

Ferrari, M (2005) Cancer nanotechnology: opportunities and challenges. Nat Rev Cancer 5: 161-171.

Gade, A.K, Bonde, P., Ingle, A.P., Marcato, P.D, Durän, N., et al. (2008) Exploitation of *Aspergillus niger* for synthesis of silver nanoparticles. Journal of Biobased Materials and Bioenergy 2: 243-247.

Gardea-Torresday, J.L., E. Gomez, R.J., Peratta-Videa, G.J., Persons, H., Troiani and M., Jose-Giljohann, D. A. and C. A., Mirkin. (2009) Drivers of biodiagnostic development. Nature, 4: 461-462.

Gardea Torresdey, J.L.,R Peralta-Videa, J., Rosaa, G., Parson, G.J (2005) Phytoremediation of heavy metals and study of the metal coordination by X-ray absorption spectroscopy, Coordination Chemistry Reviews, 249, 1797–1810.

Gardea-Torresdey, J.L., Gomez, E., Peralta-Videa, J.R., Parsons, J.G., Troiani, H., Jose-Yacaman, M. (2003) Alfalfa sprouts: a natural source for the synthesis of silver nanoparticles', Langmuir, 19, (4), pp.1357– 1361.

Gardea-Torresdey, J.L., Tiemann, K.J., Gamez, G. Dokken, K., Tehuacanero, S., Jose´-Yacama ´N. M (1999) Gold nanoparticles obtained by bio-precipitation from gold(III) solutions, J. Nanopart Res, 1, (3), pp.397– 404.

Gaumet, M., Vargas, A., Gurny, R., & Delie, F. (2008) Nanoparticles for drug delivery: The need for precision in reporting particle size parameters. European Journal of Pharmaceutics and Biopharmaceutics, 69, 1–9.

Ghormade, V.; Deshpande, M.; Paknikar, K. (2011) Perspectives for nano-biotechnology enabled protection and nutrition of plants. Biotechnology advances, 29, (6), 792-803.

Girling, C.A., Peterson, P. J (1978) Uptake, transport and localization of gold in plant", Trace Subst. Environ Health.,12, 105-118.65, 2,34-36.

Gruère, G., Clare, N., Linda, A (2011) a. Agricultural Food and Water Nanotechnologies for the Poor Opportunities, Constraints and Role of the Consultative Group on International Agricultural Research. J.

Gruère, G., Narrod, C., Abbott L (2011) b. Agriculture, Food, and Water Nanotechnologies for the Poor: Opportunities and Constraints. IFPRI Policy Br. 1 4.

Gruère, G.P., Narrod, C.A., Abbott L (2011) Agricultural, food, and water nanotechnologies for the poor: opportunities, constraints, and the role of the consultative group on International Agricultural Research. International Food Policy Research Institute.

Gurav A, Kodas T, Wang L, Kauppinen E, Joutsensaari J (1994) Generation of nano-meter size fullerene particles via aerosol routes. Chem Phys Lett 218:304-308.

Gurunathan, S., Kalishwaralal, K., Vaidyanathan, R., Deepak, V., Pandian, S.R.K., Muniyandi, J (2009). Biosynthesis, purification and characterization of silver nanoparticles using *Escherichia coli*. Colloids Surf. B, *74*, 328–335.

Gutiérrez, F.J., Mussons, M.L., Gatón, P., Rojo, R (2011) Nanotechnology and Food Industry. Scientific, Health and Social Aspects of the Food Industry, In Tech, Croatia Book Chapter.

Haung, X., M. A. El-Sayed. (2010). Gold nanoparticles: optical properties and implementations in cancer diagnosis and photothermal therapy. J. Adv. Res., 1:13-28

Honary, S., Ghajar, K., Khazaeli, P., Shalchian, P (2011) Preparation, characterization and antibacterial properties of silver-chitosan nano-composites using different molecular weight grades of chitosan. Trop J Pharm Res ;10:69-74.

Hong, F., Zhou, J., Liu, C., Yang, F., Wu, C., et al. (2005) Effect of nano-TiO2 on photochemical reaction of chloroplasts of spinach. Biological trace element research, 105(1-3): 269-279.

Huang, J.; Li, Q.; Sun, D.; Lu, Y.; Su, Y.; Yang, X.; Wang, H.; Wang, Y.; Shao, W.; He, N.; Hong, J.; Chen, C. (2007) Biosynthesis of silver and gold nanoparticles by novel sundried *Cinnamomum camphora* leaf. *Nanotechnology*, *18*, 105104–105115.

Hu, M., Easterly, C., (2009) Anovel them alelectero chemical synthesis method for production of stable colloids of "naked" metal (Ag) nanocrystals Materials Science and Engineering, 29, 726-736.

Ingle, A., Rai, M., Gade, A., Bawaskar, M (2009) *Fusarium solani:* A novel biological agent for the extracellular synthesis of silver nanoparticles. J Nanopart Res 11:2079-2085.

Jang, H., Kim, Y.K., Ryoo, S.R., Kim, M.H., Min, D.H (2010) Facile synthesis of robust and biocompatible gold nanoparticles, Chem. Commun (Camb.), 46(4): 583–585.

Jiang, Z.J.; Liu, C.Y.; Sun, L.W (2005) Catalytic properties of silver nanoparticles supported on silica spheres. J. Phys. Chem. B., *109*, 1730–1735.

Johnston, C.T (2010) Probing the nanoscale architecture of clay minerals Clay Minerals 45: 245-279.

Joseph, T., and Morrison, M (2006) Nanotechnology in Agriculture and Food .A Nano forum report, Institute of Nanotechnology May 2006, www.nanoforum.org.

Kalishwaralal, K, Deepak, V, Ram Kumar Pandian, S, Kottaisamy, M, Barathmani Kanth, S, Kartikeyan, B, et al. (2010) Biosynthesis of silver and gold nanoparticles using Brevi bacterium casei Colloids Surf B Biointerfaces.; 77: 257-62.

Kannan, N., M.S. Shek hawat, C.P., Ravindranand M. Manokari (2014) Preparation of silver nanoparticles using leaf and fruit extracts of *Morindacoreia* Buck., Ham. –A green approach. Journal of Scientific and Innovative Research; 3(3): 315-318.

Karimi Andeani, J., Kazemi, H., Mohsenzadeh, S., Safavi, A (2011) Biosynthesis of gold nanoparticles using dried flowers extract of Achillea Wilhemsii plant. Dig J Nanomater Bios; 6(3):1011-1016.

Khodakovskaya, M., Dervishi, E., Mahmood, M., Xu Y, Li Z, et al (2009) Carbon nanotubes are able to penetrate plant seed coat and dramatically affect seed germination and plant growth. Acs Nano, 3(10): 3221-3227.

Khomutov,GB., Gubin, SP (2002) Interfacial synthesis of noble metal nanoparticles. Mater Sci Eng C 22: 141-146.

Kim, F., Connor, S., Song, H, Kuykendall T, Yang, P (2004). Platonic Gold Nano-crystals. AngewChem; 116: 3759-3763.

Kreuter, J (1994) Nanoparticles. In Colloidal drug delivery systems. Marcel Dekker Inc., New York, USA 219-342.

Lara, H, H., N. V. Ayala-Nunez, T. L. Ixtepan and P. C. Rodriguez. (2010) Mode of antiviral action of silver nanoparticles against HIV-I. *J. Biotechnol*., 8-1.

Leela, A., Vivekanandan, M. (2008) Tapping the unexploited plant resources for the synthesis of silver nanoparticles. *Afr. J. Biotechnol*., *7*, 3162–3165.

Li, X., Xu, H., Chen, Z.S., and G. Chen, (2011) Biosynthesis of nanoparticles by microorganisms and their applications, *Journal of Nanomaterials*, 270974, 16.

Li Y, Cu YT, Luo D (2005) Multiplexed detection of pathogen DNA with DNA based Fluorescence nanobarcodes. Nat Biotechnol 23: 885-889.

Li Y., Duan, X., Qian, Y., Yang, L., Liao, H (1999) Nano crystalline silver particles: synthesis, agglomeration, and sputtering induced by electron beam. J Colloid interface Sci 209: 347-349.

Liu S, Leech D, Ju H (2003) Application of colloidal gold in protein immobilization, electron transfer, and biosensing. Anal Lett 36: 1-19.

Loo, Y. Y., B. W., Chieng, M., Nishibuchi and S. Radu. (2012) Synthesis of silver nanoparticles using tea leaf extract from *Camellia sinensis*. Int. J. Nanomed., 7: 4263-4267.

Marimuthu, S., A. A. Rehuman, G. Rajakumar, T. Santhoshkumar, A. V. Kirthi, C. Jayaseelan, A. Bagavan, A. A. Zahir, G. Elango and C. Kamaraj (2011) Evaluation of green synthesized silver nanoparticles against parasites Parasitol. Res., 108:1541-1549.

Marshall, A.T., Haverkamp R.G., DaviesCE, Parsons, J.G., Gardea-Torresdey J.L., Agterveld, DV, (2007) Accumulation of gold nanoparticles in *Brassica juncea*, Int J Phytoremediation, 9, 197-206.

Martin, C. R. and D. T. Mitchell. (1988). Nanomaterials on analytical chemistry. Anal. Chem., 9: 322-327.

McConnel, W. P., J. P. Novak, L. C. Brousseau, R. R Fuiere, R. C. Tenent and D. L. Feldheim (2002) Electronic and optical properties of chemically modified nanoparticles and molecularly bridged nanoparticles arrays. J. Phys. Chem., B 104: 8925-8930.

McCutcheon, S.C., Jorgensen, S.E (2008) Phytoremediation. Ecological Engineering, 2751

McLamore, E.S., Diggs, A., CalvoMarzal, P., Shi, J., Blakeslee, J.J., et al. (2010) Noninvasive quantification of endogenous root auxin transport using an integrated flux microsensor technique. Plant J 63: 1004-1016

Misra, A.N., Misra, M., Singh, R (2013) Nanotechnology in Agriculture and Food Industry. Int. J. Pure Appl. Sci. Technol. 16: 1 9.

Mohanpuria, P., Rana N.K., Yadav, S K (2009) Biosynthesis of nanoparticles: technological concepts and future applications. J. Nano part Res; 10: 507–517.

Morones JR., Elechiguerra, JL., Camacho, A., Holt K, Kouri JB, Ramírez JT, et al. (2005) the bacterial effect of silver nanoparticles. Nanotechnology; 16: 2346-53.

MubarakAli, D., Thajuddin, N., Jeganathan, K., and M. Gunasekaran, (2011) Plant extract mediated synthesis of silver and gold nanoparticles and its antibacterial activity against clinically isolated pathogens, Colloids and Surfaces B, 85(2): 360–365.

Mukherjee, P., Ahmad, A., Mandal, D., Senapati, S., Sainkar, S.R., Khan, M.I., Parishcha, R., Ajaykumar, P.V., Alam, M., Kumar, R., Sastry, M (2001) Fungus-mediated synthesis of silver nanoparticles and their immobilization in the mycelial matrix: a novel biological approach to nanoparticle synthesis, Nano Lett, 11, 515–519.

Mukunthan, K and S. Balaji (2012) Cashew apple juice (*Anacardiumocc identale* L.) speeds up the synthesis of silver nanoparticles, International Journal of Green Nanotechnology, 4(2): 71–79,.

Murray, C.B., Kagan , C.R., Bawendi, M.G (2000) Synthesis and characterisation of monodisperse nanocrystals and close-packed nanocrystal assemblies. Annu Rev Mater Res 30: 545-610.

Nadagouda, M.N., Hoag, G., Collins, J, Varma, R.S (2009) Green synthesis of Au nanostructures at room temperature using biodegradable plant surfactants. Cryst Growth, Des; 9: 4979-4983.

Nair, R., Varghese, S.H., Nair, B.G., Maekawa, T., Yoshida, Y., Kumar, D.S (2010) Nanoparticulate material delivery to plants. Plant Sci. 179: 154 163.

Narayanan, K.B., Sakthivel, N (2011) Green synthesis of biogenic metal nanoparticles by terrestrial and aquatic phototrophic and heterotrophic eukaryotes and biocompatible agents, Journal of Advances in Colloid and Interface Science, 16959–79.

Pandey, A.C., Sanjay, S.S., Yadav RS et al (2010) Application of ZnO nanoparticles in influencing thegrowth rate of Cicerarietinum. J Exp Nano sci 5:488–497.

Park, Y., Hong, Y.N., Weyers, A., Kim, Y.S., and R. J. Linhardt (2011) Poly-saccharides and phytochemicals: a natural reservoir for the green synthesis of gold and silver nanoparticles, IET Nanobiotechnology, 5(3): 69–78.

Pérez-de-Luque, A., Rubiales, D (2009) Nanotechnology for parasitic plant control. Pest Manag Sci 65: 540-545.

Prasad, R., Kumar, V., Prasad, K.S (2014) Nanotechnology in sustainable agriculture: Present concerns and future aspects. African Journal of Biotechnology 13: 705-713.

Prasad, T.; Sudhakar, P.; Sreenivasulu, Y.; Latha, P.; Munaswamy, V.; Reddy, K.; Sreeprasad,T.; Sajanlal, P.; Pradeep, T (2012) Effect of nanosecal zinc oxide partickes on the germination, growth and yield of peanut. Journal of plant nutrition, 35(6), 905-927.

Priester, J.H et al (2012) Soybean susceptibility to manufactured nano-materials with evidence for food quality and soil fertility interruption. Proc Natl Acad Sci USA: 0937:E2451 E2456.

Rad, S.J., Naderi, R., Alizadeh, H., Yaraghi, A.S (2013) Silver-nanoparticle as a vector in gene delivery by incubation. IRJALS 02: 21 33.

Rai V, Acharya S, Dey N (2012) Implications of Nanobiosensors in Agriculture. J. Biomaterials Nano - biotechnology 3: 315 324.

Rathore et al (2012) Nanomaterials: A future concern. Int. J. Res. Chem. Environ. 2 2: 1-7.

Raveendran, P., Fu, J., Wallen, SL (2003) Completely "green" synthesis and stabilization of metal nanoparticles. J Am ChemSoc 125: 13940-13941.

Schmidt-OttA (1988) New approaches to *in-situ* characterization of ultrafine agglomerates. J Aerosol Sci 5: 553-563.

Shankar, S.S.; Rai, A.; Ahmad, A.; Sastry, M.J (2004) Rapid synthesis of Au, Ag, and bimetallic Aucore–Ag shell nanoparticles using Neem (*Azadirachta indica*) leaf broth. J. Colloid Interface Sci., 275, 496–502.

Shankar, S.S., Rai, A., Ankamwar, B., Singh, A., Ahmad, A., Sastry, M (2004) Biological synthesis of triangular gold nanoprisms, Nature Materials, 3,482–488.

Shankar, S.S., Ahmad, A., Pasricha, R., and Sastry, M (2003) Bio reduction of chloroaurate ions by geranium leaves and its endophytic fungus yields gold nanoparticles of different shapes, *Journal of Materials Chemistry*, 13(7): 1822–1826.

Sharma, N.C., VSahi, S., Nath, S., Parsons, J.G., Gardea- Torresdey, J.L., Pal, T (2007) Synthesis of plant-mediated gold nanoparticles and catalytic role of biomatrix-embedded nanomaterials, Environ Sci Technol, 41,14, 5137–5142.

Sharon, M., A. K, Choudhary and R. Kumar (2010) Nanotechnology in agricultural diseases and food safety. Journal of Phytology, 2(4):83-92.

Shekhawat, M.S., Kannan, N., Manokari, M (2012) Biogenesis of silver nanoparticles using leaf exract of Turneraulmifolia Linn and screening of their antimicrobial activity. J. Ecobiotech.; 4(1):54-57.

Shweta, A., and P. Rathore (2014). Nanotechnology Pros and Cons to Agriculture: A Review. *Int. J.Curr.Microbiol. App.Sci*3(3): 43-55.

Singh, S (2012) Achieving Second Green Revolution through Nanotechnology in india. Agric. Situations India 545 572.

Song, J.Y., Kim, B.S (2009) Rapid biological synthesis of silver nanoparticles using plant leaf extracts, Bioprocess Biosyst. Eng, 32, (1), pp. 79–84.

Song ping, W.,Shuyuan, M. (2005) Preparation of ultrafine silver powder using ascorbic acid as reducing agent and its application in MLCI. Mater. Chem. Phys, 89, 423–427.

Sperling, R.A, Zhang, F., Zanella, M., Parak, W.J (2008) Biological applications of gold nanoparticles. ChemSoc Rev, 37:1896-1908.

Su, XL and Y, Li (2004) Quantum dot bio labeling coupled within munomagnetic separation for detection of *Escherichia coli* O157:H7.Anal. Chem. 76:4806-4810.

Sun, R., Chen, R., Chung, N., Ho, C. Lin, C.M., Che, C.M (2005) Silver nanoparticles fabricated in Hepes buffer exhibit cytoprotective activities toward HIV-Infected cells, Chem. Commun, 40, 5059-5061.

Sunkar, S., Nachiyar, C.V, (2012) Microbial synthesis and characterization of silver nanoparticles using the endophytic bacterium *Bacillus cereus*: a novel source in the benign synthesis. Global Journal of Medical Research 12: 43-49.

Takeuchi MT, Kojima M, Luetzow M (2014) State of the art on the initiatives and activities relevant to risk assessment and risk management of nanotechnologies in the food and agriculture sectors. Food Research International.

Tavera-Davila, L., Liu, H.B., Herrera-Becerra, R., Canizal, G., Balcazar, M., Ascencio, J.A (2009) Analysis of Ag nanoparticles synthesized by bioreduction. J. Nanosci. Nanotechnol., 9, (3), pp. 1785–1791.

Thirumurugan, A., N. A. Tomy, H. P. Kumar and P. Prakash. (2011). Biological synthesis of silver nanoparticles by *Lantana camara* leaf extracts. Int. J. Nanomat. Biostruct., 1(2): 22-24.

Tolaymat, T.,Badawy, A., Genaidy, A., Scheckel, K (2010) An evidence-based environmental perspective of manufactured silver nanoparticle in and applications, Sci. Total Environ., 408,99

Torney, F., Trewyn, B.G., Lin, V.S, Wang, K, (2007) Mesoporous silica nanoparticles deliver DNA and chemicals into plants. Nat Nanotechnol 2: 295-300.

Vankar PS, Bajpai D (2010) Preparation of gold nanoparticles from *Mirabilis jalapa* flowers. Indian J Biochem Biophys 47: 157-160.

Vauthier C, Beanabbou S, Spenlehauer G, Veillard M, Couvreur P (1991) Methodology of ultradispersed polymer system. S T P Pharm Sci 1: 109-116.

Vigneshwaranm, N.; Ashtaputre, N.M.; Varadarajan, P.V.; Nachane, R.P.; Paralikar, K.M.; Balasubramanya, R.H (2007) Biological synthesis of silver nanoparticles using the fungus *Aspergillus flavus*. Mater. Lett. *61*, 1413–1418.

Xingmao, M., Geiser-lee, J., Deng, Y.,Kolmakov, A (2010) Interactions between engineered nanoparticles ENPs and plants: Phytotoxcity, uptake and accumulation. Sci. Total Environ.408: 3053 3061.

Yang, F., Hong, F., You W, Liu, C., Gao, F., et al (2006) Influence of nano-anatase TiO2 on the nitrogen metabolism of growing spinach. Biological trace element research, 110(2): 179-190.

Yang, F., Liu, C., Gao, F., Su, M., Wu, X., et al (2007) The improvement of spinach growth by nano-anatase TiO2 treatment is related to nitrogen photo reduction. Biological trace element research, 119(1): 77-88.

Yu JX, Li TH (2011) Distinct biological effects of different nanoparticles commonly used in cosmetics and medicine coatings. Cell Biosci 1: 19.

Zhao, L.; Peralta-Videa, J. R.; Rico, C. M.; Hernandez-Viezcas, J. A.; Sun, Y.; Niu, G.; Servin, A., Nunez, J. E.; Duarte-Gardea, M.; Gardea-Torresdey, J. L., CeO2 and ZnO (2014) Nanoparticles Change the Nutritional Qualities of Cucumber (*Cucumis sativus*). Journal of Agricultural and Food Chemistry, 62, (13), 2752–2759.