USE OF NANOPARTICLES AS PESTICIDES IN THE MANAGEMENT OF PLANT DISEASES

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ABSTRACT

To preserve biodiversity, it is becoming necessary to reassess our strategies and achieve disease management by alternate approaches such as nanotechnology. Nature has devised various processes for the synthesis of nano and micro length scaled inorganic materials which have contributed to the development of relatively new and largely unexplored area of research based on the biosynthesis of nonmaterial's (Mohanpuria *et al*., 2007). For the past few decades, there has been a considerable research in the area of natural product delivery using particulate for controlling plant pathology. The secondary metabolites in plants have been used in the formulation of Nanoparticles through increase the effectiveness of therapeutic compounds used to reduce the spread of plant diseases, while minimizing the side effects for being: rich source of bioactive chemicals, biodegradable in nature and non polluting (eco-friendly). Particulate systems like Nanoparticles have been used a physical approach to alter and improve the effectiveness to the properties of some types of synthetic chemical pesticides or in the production of bio-pesticides directly. Here, we review various aspects of Nanoparticles formulation, characterization, effect of their characteristics and their applications in management of plant diseases

Key words: nanoparticles, natural product, secondary metabolites, synthetic chemicals, management disease.

Introduction:

The term nanotechnology was first coined by Taniguchi (1974) to the science that largely deals with synthesis and application of nano size particles (1-100 nm or $1.0x10^{-9}$ m) of any material. When a material is reduced to nano size, it acts differently and expresses some new properties completely lacking in its macro scale form. The nanoparticles (NPs) have a high surface to volume ratio that increases their reactivity and possible biochemical activity (Dubchak et al., 2010). For example, when 1 g gold is converted into nano scale, the particles may cover an area of 100 km^2. Gold nanoparticles (2.5 nm) melt at much lower temperature (~300°C) than a gold slab (1064°C) (Buffat and Borel, 1976). Absorption of solar radiation is much higher in materials composed of nanoparticles than its thin film. The gold nanoparticles show toxic effect on bacteria, Salmonella typhimurium, in which the macro gold did not exhibit (Wang et al., 2011). Similarly, the silver nanoparticles have anti-bacterial and anti-fungal properties while silver in macro form does not do this (Sofi et al., 2012). The need for biosynthesis of Nanoparticles role as the physical and chemical Processes was costly. So in the search of for cheaper pathways for nanoparticles synthesis, scientists used microorganisms and then plant extracts for synthesis. Nature has devised various processes for the synthesis of nano-and micro-length scaled inorganic materials which have contributed to the development of relatively new and largely unexplored area of research based on the biosynthesis of nonmaterial's (Mohanpuria et al., 2007). Biosynthesis of Nanoparticles is a kind of bottom up approach where the main reaction occurring is reduction/oxidation. The microbial enzymes or the plant phytochemicals with anti oxidant or reducing properties are usually responsible for reduction of metal compounds into their respective Nanoparticles. The three main steps in the preparation of Nanoparticles that should be evaluated from a green chemistry perspective are the choice of the solvent medium used for the synthesis, the Biomimetic Synthesis of Nanoparticles: Science, Technology & Applicability choice of an environmentally benign reducing agent and the choice of a non toxic material for the stabilization of the Nanoparticles. Most of the synthetic methods reported to date rely heavily on organic solvents. This is mainly due to the hydrophobicity of the capping agents used (Raveendran et al., 2002). Synthesis using bio-organisms is compatible with the green chemistry principles: the bio-organism is (i) eco-friendly as are (ii) the reducing agent employed and (iii) the capping agent in the reaction (Li et al., 2007). These papers come to highlight on Bioactive Nanoparticles of plant which can be effective alternatives to from plant secondary metabolites as botanical biopesticides. Recently gold nanoparticles have been synthesized using the extracts of Magnolia kobus and Diopyros kaki leaf extracts. The effect of temperature on nanoparticles formation was investigated and it was reported that polydisperse particles with a size range of 5-300nmwas obtained at lower temperature while a higher temperature supported the formation of smaller and spherical particles (Song et al., 2009).

While fungi and bacteria require a comparatively longer incubation time for the reduction of metal ions, water soluble phytochemicals do it in a much lesser time. Taking use of plant tissue culture techniques and downstream processing procedures, it is possible to synthesize metallic as well as oxide Nanoparticles on an industrial scale once issues like the metabolic status of the plant etc. are properly addressed. Recently much work has been done with regard to plant assisted reduction of metal nanoparticles and the respective role of phytochemicals. The main phytochemicals responsible have been identified as terpenoids, flavones, ketones, aldehydes, amides and carboxylic acids in the light of IR spectroscopic studies. The main water soluble phytochemicals are flavones, organic acids and quinones which are responsible for immediate reduction. The phytochemicals present in Bryophyllum sp. (Xerophytes), Cyprus sp. (Mesophytes) and Hydrilla sp. (Hydrophytes) were studied for their role in the synthesis of silver nanoparticle. The Xerophytes were found to contain emodin, an anthraquinone which could undergo redial tautomerization leading to the formation of silver Nanoparticles. The Mesophytes studied contained three types of benzoquinones, namely, cyperoquinone, dietchequinone and remirin. It was suggested that gentle warming followed by subsequent incubation resulted in the activation of quinones leading to particle size reduction. Catechol and protocatechaldehyde were reported in the hydrophyte studied along with other phytochemicals. It was reported that catechol under alkaline conditions gets transformed into protocatechaldehyde and finally into protocatecheuic acid. Both these processes liberated hydrogen and it was suggested that it played a role in the synthesis of the nanoparticles. The size of the Nanoparticles synthesize during Xerophytes, Mesophytes and Hydrophytes were in the range of 2-5nm (Jha et al., 2009). Applicability bacteria and fungi, plants are better candidates for the synthesis of Nanoparticles. Taking use of plant tissue culture techniques and downstream processing procedures, it is possible to synthesize metallic as well as oxide Nanoparticles on an industrial scale once issues like the metabolic status of the plant etc. are properly addressed.

Plant and plant extracts:

Plants are known to be an important component of different ecosystems. From the ancient times to modern days, plants serve numerous sources to mankind. The twenty-first century witnessed vast improvement in the technology to sophisticate the lifestyle. The advent of techniques such as plant biotechnology, tissue culture and transgenesis improved the applied value of plants. The plant systems are reported as reliable green, ecofriendly approach for metal nanoparticle synthesis. The advantage of using plants for the synthesis of nanoparticle is that they are easily available, safe to handle and possess a broad variability of metabolites that may aid in reduction. A number of plants are being currently investigated for their role in the of nanoparticle. Gold Nanoparticles with a size range of 2-20 nm have been synthesized using the live Alfa alfa plants (Torresday et al., 2002). Nanoparticles of silver, nickel, cobalt, zinc and copper have also been synthesized inside the live plants of Brassica juncea (Indian mustard), Medicago sativa (Alfa) and Heliantus annus (Sunflower). Certain plants are known to accumulate higher concentrations of metals compared to others and such plants are termed as hyper accumulators. Of the plants investigated, Brassica juncea had better metal accumulating ability and later assimilating it as nanoparticle (Bali et al., 2006).

Use of plants to synthesize nanoparticles:

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Catechol and protocatechaldehyde were reported in the hydrophyte studied along with other phytochemicals. It was reported that catechol under alkaline conditions gets transformed into protocatechaldehyde and finally into protocatecheuic acid. Both these processes liberated hydrogen and it was suggested that it played a role in the synthesis of the nanoparticles. The size of the Nanoparticles synthesized using xerophytes, Mesophytes and hydrophytes were in the range of 2-5nm (Jha et al., 2009).

Synthesis of nanoparticles in plant:

Studies indicated that the reducing phytochemicals in the neem leaf consisted mainly of terpenoids. It was found that these reducing components also served as capping and stabilizing agents in addition to reduction as revealed from FT IR studies. The major advantage of using the neem leaves is that it is a commonly available medicinal plant and the antibacterial such best, bacteria and fungi in plant activity of the biosynthesized silver nanoparticle might have been enhanced as it was capped with the neem leaf extract. Biomimetic Synthesis of Nanoparticles. The major chemical constituents in the extract were identified as nimbin and quercetin this compound possible to be anti-pathological causes of plants. (Shankar et al., 2004, Tripathy et al., 2009). Study is because of the Increase in new resistant strains of insect, bacteria and fungi against most potent antibiotics. Has promoted research in the well known activity compounds, including Nanoparticles and was more pronounced against pest than organisms.

Application of nanoparticles against anti-microbiology in plants:

The use of nano-sized silver particles as antimicrobial agents has become more common as technological advances make their production more economical. One of the potential applications in which silver can be utilized is in management of plant diseases. Since silver displays multiple modes of inhibitory action to microorganisms (Clement and Jarret1994), it may be used for controlling various plant pathogens in a relatively safer way compared to synthetic fungicides (Kim et al, 2006). Until now, limited research provided some evidence of the applicability of silver for controlling plant diseases (Kim et al, 2006). Silver Nanoparticles have shown promise against gram positive S. aureus. As Metal nanoparticles embedded paints have been synthesized using vegetable oils and have been found to have well anti microbiology activity (Kumar et al., 2008).

Various forms of silver ions and Nanoparticles were tested by (Kim et al 2009) in the current study to examine the antifungal activity on two plant-pathogenic fungi, Bipolaris sorokiniana and Magnaporthe grisea. In vitro Petri dish assays indicated that silver ions and Nanoparticles had a significant effect on the colony formation of these two pathogens. Effective concentrations of the silver compounds inhibiting colony formation by 50% (EC50) were higher for B. sorokiniana than for M. grisea. The inhibitory effect on colony formation significantly diminished after silver cations were neutralized with chloride ions. Growth chamber inoculation assays further confirmed that both ionic and nanoparticle silver significantly reduced these two fungal diseases on perennial ryegrass (Lolium perenne).

Particularly, silver ions and Nanoparticles effectively reduced disease severity with an application at 3 h before spore inoculation, but their efficacy significantly diminished when applied at 24 h after inoculation. The in vitro and in planta evaluations of silver indicated that both silver ions and Nanoparticles influence colony formation of spores and disease progress of plant-pathogenic fungi. In planta efficacy of silver ions and Nanoparticles is much greater with preventative application, which may promote the direct contact of silver with spores and germ tubes, and inhibit their viability (Marek et al 2010) studied a significant reduction in mycelial growth was observed for spores incubated with silver Nanoparticles. The sporulation test showed that, relative to control samples, the number of spores formed by mycelia increased in the culture after contact with silver Nanoparticles, especially on the nutrient-poor PDA medium. The 24 h incubation of FC spores with a 2.5 ppm solution of silver Nanoparticles greatly reduced the number of germinating fragments and sprout length relative to the control.

Silver nanoparticles (WA-CV-WA13B) at various concentrations were applied before and after disease outbreak in plants to determine antifungal activities. In the field tests, the application of 100 ppm silver nanoparticles showed the highest inhibition rate for both before and after the outbreak of disease on cucumbers and pumpkins. Also, the application of 100 ppm silver nanoparticles showed maximum inhibition for the growth of fungal hyphae and conidial germination in invivo tests. Scanning electron microscope results indicated that the silver nanoparticles caused detrimental effects on both mycelial growth and conidial germination (Kabir et al, 2010). The antibacterial potentiality of zinc oxide (ZnO) nanoparticles (NPs), compared with conventional ZnO powder, against nine bacterial strains, mostly food borne including pathogens, was evaluated using qualitative and quantitative assays. ZnO nanoparticles were more efficient as antibacterial agent than powder. Gram-positive bacteria were generally more sensitive to ZnO than Gram negatives. The exposure of Salmonella typhimurium and Staphylococcus aureus to their relevant minimal inhibitory concentrations from ZnO nanoparticles reduced the cell number to zero within 4 and 8 h, respectively. Scanning electron micrographs of the treated bacteria with nanoparticles exhibited that the disruptive effect of ZnO on S. aureus was vigorous as all treated cells were completely exploded or lysed after only 4h from exposure. Promising results of ZnO nanoparticles antibacterial activity suggest its usage in food systems as preservative agent after further required investigations and risk assessments (Ahamed et al;2011).

In study was planning to evaluate the potential of nano silver (NS) and nano dioxide titanium (TiO2) to remove bacterial contaminants. Experiment involved NS and TiO2 in Murashige and Skoog (MS) medium. Tobacco explants were cultured on modified MS medium and evaluate after four weeks. This research shows that NS and TiO2 had a good potential for removing of the bacterial contaminants in tobacco plant tissue culture procedures (Kamran et al; 2011).

Conclusion:

Use Nano particles for delivery of anti-microbiological or drug molecules will be at its helm in near future for therapy of all pathological sufferings of plants. There are myriad of Nanomaterials including polymeric nanoparticles, iron oxide nanoparticles, gold nanoparticles and sliver ion which can be easily synthesized and exploited as pesticide. Antimicrobial activity of nano partials and after confirm the ability of nano to reduce the microorganism, we decide to using and adding NS to MS tissue culture media and the application of nanotechnology in the chemical and bio-based industries besides making a special reference on its usage in the nanoparticle formulations from plant secondary metabolites as botanical biopesticides. Here, we review various aspects of Nanoparticles formulation, characterization, effect of their characteristics and their applications in management of plant diseases. Particulate systems like Nanoparticles have been used a physical approach to alter and improve the effectiveness to the properties of some types of synthetic chemical pesticides or in the production of bio-pesticides directly.

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