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Role of Nano Particles in Biology of Toxin Producing Fungi

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Abstract:

The use of nano particles has been spreaded widely in last year for its important in many fields of science. In addition, that this technology is useful in economy it's hygienic to environment. One of the important uses of nano technology is that of toxin producing fungi which cause injury to human and animal. There are many other used of this technology in cause of exposure to hazardous toxins. To date, we can say that science did not reach the expected peak of using the benefits of this technology, at least in fungal diseases which have direct indirect negative effect on human and animal hygiene. Accordingly, research should continue on toxin producing fungi by use of nano technology. The target of that is to use limited amounts of a nano chemical to control those fungi, without a negative effect on living organisms in the environment.

Key words: Hygenic food, fungal plant diseases, reactive oxygen species.

Interaction

Nanoparticles (NP) are very small molecules of matter of are dimension (1-100 nanometer), these NP has been used widely in late year in agriculture, medicine, and food industry. NP are spreaded in neutral environments, such as industrial (anthropogenic nanomaterial), e.g., fuel smoke, oil refinery, and mineral industrial (Rogebet et al., 2005). There are also natural NP, such as dust, sea salt, gases and those produced from biofuel on volcanic eruptions. The use NP covers many areas. Arivalagane et al. (2011) stated that NP are being used in the industry of batteries, agriculture, remote sensing, and medicine. Hernandez and Battez (2008) reported the use of NP in the industry of plastics, ceramics, adhesive materials, iron and fire control materials. They are also in food additives, in drugs combating cancer, growth retardant for E. Coli (Meuru et al., 2011), and fungicides used in agriculture (He et al., 2011) especially of toxin producing fungi, especially that 25% of agriculture products found polluted with fungi (FAO, 2001). However, the way is still too long to reach the final goal of controlling fungi.

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Application of NP in agriculture

The NP technology have started in agriculture after the year of 2000 AD (Gogos et al., 2012). That was on fertilizers and fungicides which make these chemical more soluble and less quality reported. Research is still going on some oxides such as TiO_2, ZnO, Ag, Zn, and Au for their activities in promoting photosynthesis (Kah and Homfmann, 2014).

The scientific articles on using NP in plant production consists about 70%, and on insecticides about 30% (Fig1). The NP were involved in about 41% of plant production chemical, while other additive added reached about 57%. Another trend on use of NP as transporters to DNA nitrogen base (Kah et al., 2013). However, some uses NP on human showed some injury, so, this plant of research should be improved to be safe for humans, animals, and plants.

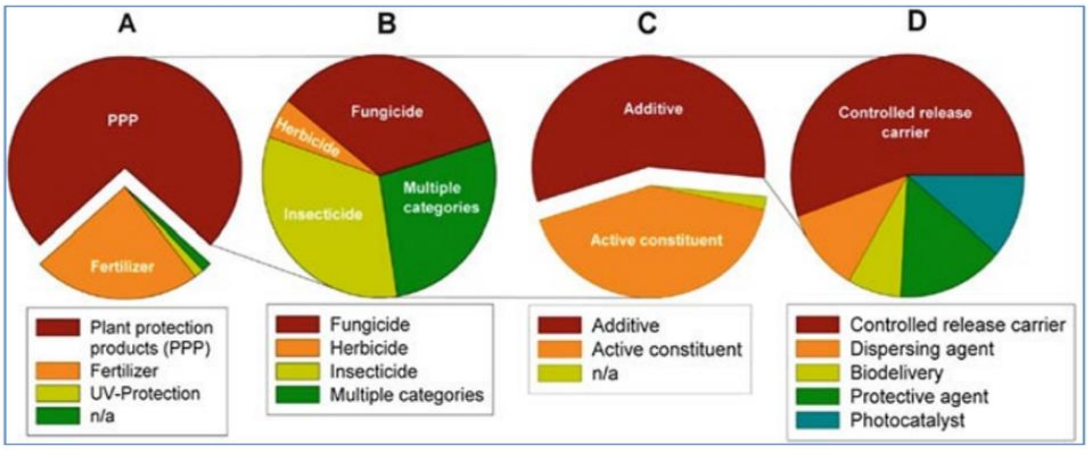

Figure 1. Applications of nanomaterials in agriculture (A), types of products used in plant protection - PPP containing nanoparticles (B), roles of nanomaterials in PPP (C), and tasks of nanomaterials Added in PPP (D). Figures adapted from Copyright (2012) American Chemical Society (Gogos et al. 2012)

Toxin producing fungi

Fungi toxin infested agricultural products is a source of unrest in the world. This threat is of two sides, low economic value, and danger on humans and animals, especially when fungicides used on large scale plantations of crops. Fungi toxins are under effects of some variables, such as; temperature, water pH (Georgianna and Payne, 2009). Most of plants fungi are aerobic, using oxygen, and consume organic compounds of plants, although the reason of releasing these toxins are still not known. These fungi make use of factors available on plants and the surrounding environment. These toxins are so different in their toxicity

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according to host sensitivity, and defense mechanisms (Hussein and Brasel, 2001).

The type of major final toxins

1–Aflatoxin:

This group of toxins is produced by fungi species of *Aspergillus* spp, such as, *A. flavius*, and *A. parasiticus*. This group involves four kinds of toxins; B_1, B_2 and G_1 and G_2. B_1 aflatoxin is considered the most toxic among their four kinds. It is considered as a carcinogenic toxin to many animal's (Bennett and Klick, 2003 a).

2- Ochratoxin:

They are into three forms; A, B, and C. These toxins are produced by *penicillium spp*. and *Aspergillus spp*. It was found the toxin of *Aspergillus ochraceus* covers a wide range of staples; such juice drinks and alcohol. *Aspergillus carbonarius* was the most found grape fruits (Mateo et al., 2007)

3- Citrinin:

This was isolated for the first time from *Penicillium citrinum*, but it was found later that many species of Aspergillus are producing this toxin, some of this genus (*Penicillium camemberti*), being used in cheese, while *Aspergillus oryzae* is being used in soysauce. Grains of wheat, rice, soybeans and barley contain some of this toxin (Bennett and Klick, 2003).

4- Ergot Alkaloids:

There are compared produced as a mixture of alkaloids in the ergot of fungus *Claviceps*. This fungus is widely spreaded on grain, and even bread produced of infested flour. Ergot cause human disease called St. Anthony's Fire (Bennett and Klick, 2003).

5- Patulin:

A toxic compared produced by *P. expansum*, *Aspergillus, Penicillium*, and *Paecilomyces*. *P. experiment* is found in common on rotten vegetables (Moss, 2008).

6- Fusarium

There are around 50 species of fungi producing this kind of toxin, and it attacks germinating grains of wheat and sorghum (Comely, 2008). This group induced toxins fumonisins which are lethal to humans and animals.

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One of the most dangerous fungi of this group is Deoxynivalenol (DON), and it is known to cause vomiting can animals fed on infested feed (Mosse, 2012).

Effect of NP on fungi

There are numbers of research deal with variables affect the production of toxins and growth of fungi of different genera. However, the ways to prevent infestation with those fungi are still not available, but the NP technology gave researchers a new promising application by using some NP compounds to treat the surface of melons, apples and citrus fruits to keep them protected (Kotzybik et al, 2016). On the other hand, there is another probable way to use NP technology against surface fungi found on surfaces of fruit to length their shelf life and to act against fungi and viruses (Kim et al, 2009).

Among those NP compounds used TiO_2(E171) against uv in tooth paste and S_1O_2 against aggression in spices, sugars, and skin powder. NP of silver are being used in wound medication creams, gauze pads, and food binding. In the EU, NP of silver, gold and tetanus oxide are used as food supplement (Regulation, 2010).

Effect of NP on fungi toxins producing

NP fungicides have the ability to retard fungi growth and toxin producing, although these compounds are more effective on bacterial diseases than on fungi. This could be attributed to the single cell bacteria and multi-cells fungi (Sureka et al, 2014). Honky et al. (2016) reported that some food supplements have the ability to enhance the immunity system of living organs against fungi toxins, such as, zinc, selenium, and tocopherol. Adele et al. (2016) stated that there are two strategies against pathogens fungi: the first is by coating fungicides by secondary polymers,and the second is by using NP fungicides, and this is better than first one.

Methods of healing function on NP

Welch et al. (2017) mentioned two Methods for hedging these compounds

1 **Adsorption:**

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This counts on physical attraction between surface of both bodies, or could by facilitated by streptavidin and biotin.

2 **Carboxylic acids**:

The acids are the most common in use, especially what so called nanostructures. This combination needs to be stable to act for longer time.

Role of NP fungicides to control fungi:

The form of fungicides in NP structure was found very effective on fungi growth and toxin producing. Results obtained by Niemirowicz et al. (2017) summarized some of that mechanism. He et al. (2011) studied the effect of nano ZnO on *Botrytis cinerea*and and *Penicillium expansum*, that this compound attacked cell wall of fungi's then the images obtained from electron microscopy showed some kind of swelling on fungi mycelia after being treated with 12 mmole/l. Lara et al, (2015) indicated that Ag NP prevent fungi growth by causing morphological changes in fungi structure. On the other hand, Pietrzak et al. (2015) found that treating *Aspergillus niger* and *Penicillin chrysogenum* with 45 mg/l of Ag NP have decreased the organic acids (oxalic, citric, and malic), followed by decreased toxins by about 80%. Sun and Mills (2019) stated that external siloxane and internal aluminum from the hallo site are active in absorbing toxins nuclear acids, bacterial oxidizing agent and antioxidants. Kim et al. (2007) reported that Ag NP act through reactive oxygen species, which lead to protein activation and cause programmed cell death through mitochondria, also found non Ag have a depressing effect on enzymes which lead later to cell walls damge. Another researcher found that nano Ag (0.65 nanometer) caused aggregations in cytoplasm which cause cytoplasm organelles to co-aggregate and lose their functions (Abdual-shahid et al, 2013).

Impact of NP on microorganism's DNA.

The very minute NP of matters used against these gives these particles higher power to act against these organisms, this could be related to the more active charge on NP to react against pathogenic organisms (Maleki Dizaj et al., 2014) (Table 1).

Aziz et al. (2015) reported that cell damge on fungi caused by NP compound is attributed to high level prodaction of reactive oxygen species which cause direct damage of cells. Klaine et al. (2008) mentioned that NP caused more reactive oxygen species could bind with

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disulfide bonds among amino acids containing sulfer, and make use of metals sensitive to light targeting nucleic acids and DNA by negative effect of reactive oxygen species.

Table 1. The proposed mechanism of antimicrobial action of some nanoparticles (Maleki Dizaj et al. 2014)

NMs	Proposed mechanism	The factors that influence antimicrobial activity
AgNPs	Ion release: induction of pits and gaps in the bacterial membrane; interact with disulfide or sulfhydryl groups of enzymes that lead to disruption of metabolic processes. DNA loses its replication ability and the cell cycle halts at the G2/M phase owing to the DNA damage (in the case of Ag2O)	Particle size and shape of particles
ZnO NPs	ROS generation on the surface of the particles; zinc ion release, membrane dysfunction; and NP internalization into cell	Particle size and concentration
TiO_2 NPs	Oxidative stress via the generation of ROS; lipid peroxidation that causes to enhance membrane fluidity and disrupts the cell integrity	Crystal structure, shape, and size
Au NPs	Attachment of these NPs to membrane which change the membrane potential and then cause the decrease the ATP level and inhibition of tRNA binding to the ribosome	Roughness and particle size
Si NPs	Influencing the cell functions such as cell differentiation, adhesion, and spreading	Particle size and shape
CuO NPs	Crossing of NPs from the cell membrane and then damaging the vital enzymes of bacteria	Particle size and concentration
MgO and CaO NPs	Damaging the cell membrane and then causing the leakage of intracellular contents and death of the bacterial cells	Particle size, pH, and concentration

On the other hand, fullerenes could affect binding of DNA nucleic acids, then the unstable genetic combination which lead to fungi death. This damage could be proceed to break the DNA backbone or its splitting when subjected to light. Replication of DNA could also be altered by NP compounds to stop DNA replication or at least stops the gene action of organic (Yuan et al., 2009).

Conclusion

The use of NP compounds to control bacterial diseases has been approved to be very effective. The research is still running to find better routes to control fungal diseases with affect human, animal as plant health. According to the results available for the being time, these was no accurate and complete fungal control by using NP compounds.

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