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Toxicology, Biological Activity, Synthesis, and Anti-Microbial Effects of Lead Nanoparticles

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Abstract

Lead is lethal metal which can be used in different fields. Lead metal has a harmful influence on human care, it effect on all body systems. Lead nanoparticles (Pb NP) can be sensitized by different methods including chemical, physical, and biological methods. The furthermost inferior method is biological method owing to its eco-friendly, low cost, simple, not consume time, and not requisite luxurious tools. Pb NP entertainment as antimicrobial medications; this may perhaps in line for its capability to penetrate cell membrane of microbe, thus increase permeability of cell membrane, accumulation of Pb NP inside microbe. Once lead separated from Pb NP, it transfers in to respiratory system and bind with respiratory enzymes and deactivated them, leading to release free radicals, increase reactive oxygen species and cell destruction, so lead nanoparticles have a significant antimicrobial influence.

Keywords: Lead nanoparticles; Lead; Reactive oxygen species; Signal transductionustered gas; Radiation therapy

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Introduction

Nanotechnology is a branch science which deals with producing and utilizing nano-sized particles that measure in nanometers. These nano-compounds are already having important proposal in different fields and in human care [1]. There are different techniques in synthesis of these compounds, they may be a chemical, physical, and biological method which is anew, simple, rapid, and not cost strategy to synthesize metal nanoparticles utilizes biological tools such as bacteria, yeasts, fungi, and plants [2].

The common of researchers prefer using biological methods in preparation of different metals nanoparticles, in this technique the various plants are used to extract different nanoparticles with different size. This technique is very cost effective, and can therefore be used as an economic and valuable alternative for the large-scale production of metal nanoparticles [3].

In this review lead nanoparticles will be discussed including their types, synthesis, and its effect on health care.

Lead Metal

Lead is extremely poisonous heavy metal. Lead metal affecting very nearly on all organ and system in the body. The major target for lead toxicity is the nervous system. Lead poisoning usually produced from consumption of food or water polluted with lead; not only but also may happen after unplanned ingestion of contaminated soil, dust, or lead-based paint. Bioremediation of lead by bacteria could be an effective measure to remove lead [4].

Lead is used in metal field and in ceramics fabrication in different countries and so continues to be of concern to public health. Low concentration of Pb toxicity causes several metabolic, neurological and behavioral disorders. Many recent studies have indicated that even lower blood Pb levels are associated with impairment in psychological progress, diminished skeletal growth, and disturbances in cardiovascular function [5].

Lead toxicity on nervous system

The nervous system is the furthermost sensitive target of lead exposure. In line for to otherwise asymptomatic individuals may experience neurological effects from lead exposure, doctors must have a high index of suspicion for lead exposure, especially in the case of children [6] **(Figure 1)**.

Lead toxicity on renal system

There were several studies which show there were vague correlation between lead exposure and renal disease. These effects included impairment of proximal tubular function, and hyperphosphaturia, these effects may be lead to nephropathy, if leave without treatment and spend long time exposure to lead [7].

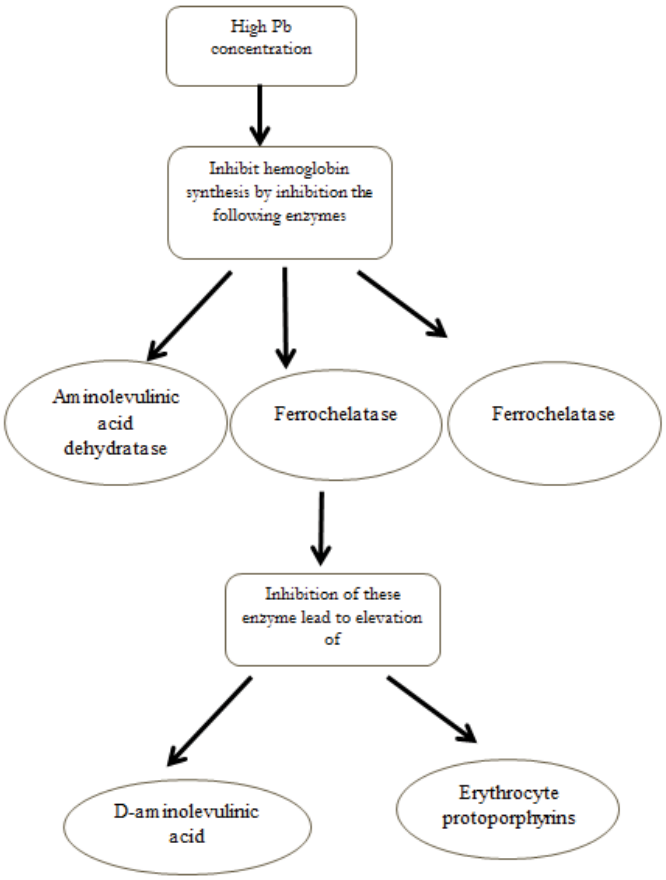

Figure 1 Lead toxicity effect on hemoglobin synthesis.

Lead toxicity on hematological parameters

Lead suppresses the body's ability to synthetize hemoglobin by its effect on several enzymes which responsible for hemoglobin synthesis. These effects included inhibition activity of aminolevulinic acid dehydratase, Ferrochelatase and ferrochelatase. As well as increase the levels of d-aminolevulinic acid and free erythrocyte protoporphyrins [8].

Lead toxicity on endocrine system

Several studies which examined the effect of long exposure to lead on children were found that there were inverse correlation between elongated lead exposure and BLLs, vitamin D levels. Opposite relation between lead exposure and vitamin D level reflect on the maintenance of extra- and intra-cellular calcium homeostasis, in addition its badly effect on thyroid function [9] .

Lead toxicity on gastrointestinal tract

In many cases of elongated lead exposure for all children and adults may be accompanied with disturbance in gastrointestinal manifestation as cramping, abdominal pain, malabsorption, nausea, and diarrhoea [8].

Lead toxicity on cardiovascular system

Statistics indicates that there was positive correlation between lead exposure and increase the blood pressure which lead to increased risk of hypertension [4].

Lead toxicity on reproductive system

Lead exposure has a significant badly effect on the rate of reproductive in both male and female. In males long-term lead exposure may be responsible for decrease sperm concentration, increase abnormal sperm frequencies, and make distortion in sperm mobility [7]. While for female cases there was association between lead exposure and pregnancy outcomes. Lead exposure increase frequency of spontaneous abortions, miscarriages and stillbirths. Several studies on women living near source of lead smelters as in industry country were reported that increased frequency of spontaneous abortions, as well as miscarriages as compared with those living some distance away [10].

Lead Nano Particles

The new trends in nanotechnology synthetized lead nanoparticles to make improvement on the properties of lead to be use in different proposal like in industry, or in medical field. There were different researches for synthesis of lead nanoparticles. Lead nanoparticles may be synthetized by three different methods, physical, chemical, and biological methods. The major lead nanoparticles lead oxide, and lead sulfide nanoparticles [11].

Lead oxide nanoparticle

Lead element has different oxide forms containing PbO, Pb_2O_3, and PbO_2. The major type of lead nanoparticles is (PbO), is an important industrial compound, this due to its unique electronic, mechanical and optical properties and its potential applications in nano devices and functionalized materials. Owing to their unique properties, lead oxides have wide applications such as network-modifiers in luminescent glassy materials, pigments, gas sensors, paints, storage batteries like lead acid, valve regulated lead acid batteries and lithium secondary batteries and nanoscale electronic devices. Because of the simplicity of design, low cost of manufacturing, reliability and relative safety there is improve and develop lead oxide characteristics [4].

Synthesis lead oxide nanoparticles: Lead oxide nanoparticles are synthesized through the chemical reaction between lead acetate and polyvinyl alcohol by sol-gel methodology. The characterization of lead oxide is determined by different technique including XRD, UV spectroscopy and FTIR [1].

Lead sulfide nanoparticle

Lead sulfide is one of more important semiconductor, this because it's special small direct-band gap (0.41 eV) and large excitonic Bohr radius of 18 nm. The lead sulfide nanoparticles have widespread applications in different fields such as solar absorbers, solar cells, lasers, photographs, LED devices, telecommunications, detectors, optical switches, in addition to gas-sensing agents in the solid-state sensors. Also, there were few reports around using PbS as a gas- sensing agent is available. Markov and Maskaeva stated some interesting data about using a PbS film as a solid- state sensor to detect nitrogen oxides, such as NO_2. Bandyopadhyay synthesized nano-sized PbS based on the sol- gel method and showed that the synthesized nanocrystalline. PbS was influenced predominantly by NH_3 and NO_2 amongst many other gases at room temperature [12].

Chemically synthetized lead sulfide nanoparticles: Lead sulfide nanoparticles are synthesized by the chemical reaction between different lead salts and sodium sulfide, thiourea, or hydrogen sulfide under the adjust condition from temperature and pressure to precipitate lead sulfide. The pHs of the solutions was adjusted by adding HNO_3 or NaOH solutions. In these methods, concentration of reacting compounds is a limiting factor to control the morphology and the particle sizes of lead sulfide nanoparticles [13].

Biological synthesis of lead sulfide nanoparticles: The green chemistry is an application, improvement, strategy of chemical Products and procedures to overcome using of harmful compounds which may be destroy the environment. Biological method was found to be the Grade A method when compared to chemical and physical methods. It contains many advantages as compared to other methods like cheaply, available reactants, save a time, and protect the environment from hazard compounds; furthermore it is well-matched for medical and food applications. Recent research was effectively synthesized lead nanoparticles by using plant called "GingiberOfficinale' by using its stem extract [3].

Effect of lead nanoparticles on microorganisms

Several researches indicate that lead nanoparticles may be act as significant antimicrobial drugs for many microorganisms' species. There are numerous theories on the action of lead nanoparticles on microbes to cause the microbicidal effect [7]. Lead nanoparticles have the ability to attach with the microbe cell wall and consequently penetrate it to make holes in cell membrane these holes lead to accumulation of lead nanoparticles on the cell surface, thus make happen disturbance in the cell membrane properties as cell membrane permeability and death of the cell. There was another route for antimicrobial action of lead nanoparticles in which lead nanoparticles have the ability to penetrate the respiratory system of microbe and inhibit some of respiratory enzymes by making change in their conformational structures After that reactive oxygen species (ROS) generate which finally lead to cell destruction [7].

It has also been found that the lead nanoparticles can modify the signal transduction in microbe by dephosphorylating of its protein, hence this effect on its signal transduction, and finally stop the growth of microbes, thus lead nanoparticles act as powerful antimicrobial agent (**Figure 2)** [14].

Pb NP attach with microbe cell membrane [2]. Bind of Pb NP on cell membrane caused holes in it these allow accumulation of Pb NP in side microbe [3]. In side microbe lead separated from lead nano particles and migrates to respiratory tract and inhibits the activity of respiratory enzymes. This lead to releasing of free radicals and elevated of reactive oxygen species (ROS) which in turn caused cell destruction through caspase mediated apoptosis pathway [4]. The other mechanism in which lead nanoparticles caused kill of microbe, lead caused dephosphorylating of microbe's protein and change its conformational structures and thus inhibit signal transduction and caused stop growth of microbe.

Effect of lead nanoparticles on healthy

Lead nanoparticles are frequently characterized for their chemical, physical and optical properties in their pure form or in simple idealized matrices. However, when lead nanoparticles work together with biological systems, their properties mainly changed and this reflect on their properties [15]. Lead

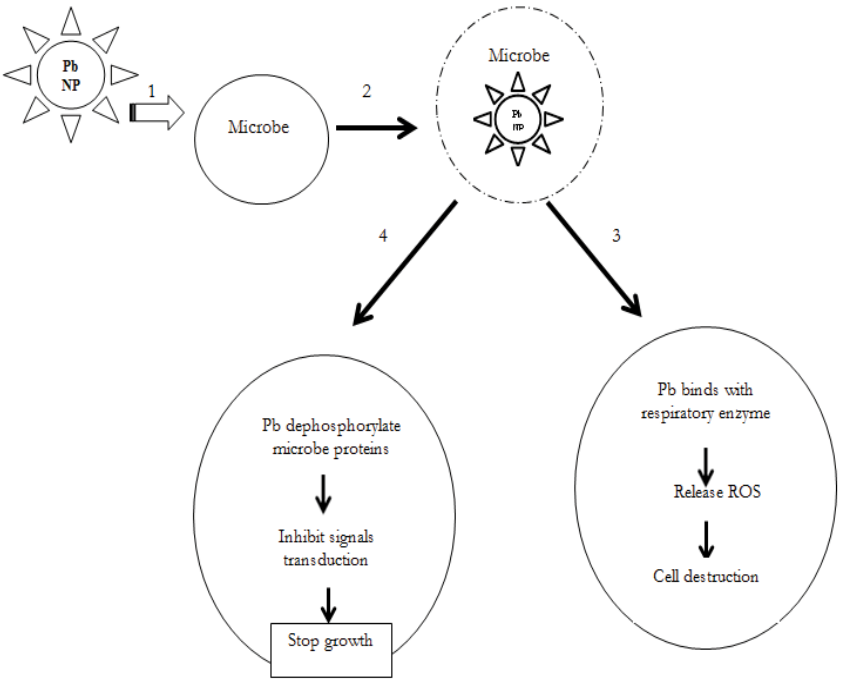

Figure 2 Antimicrobial mechanisms of lead nanoparticles (Pb NP).

nanoparticles usually have superior or dissimilar assets than the bulk material of the same element and this due to its small size nature. For long time, People have escaped from using lead in their life, due its poisonous nature. Amalgams containing lead have adverse effect on human healthy, such as oxidative stress and neurological effects. Although interesting of researchers with using PbO-NPs as industrial materials, very little is acknowledged about their biological or environmental interfaces [8].

Conclusion

Exposure to lead caused elevation of ROS which in turn result in mitochondrial perturbation, inflammation, in addition to brain and peripheral nervous system injury, enzyme activity loss and disturbance in hematological parameter, kidney and liver functions. Lead toxicity can effect on all human body .so, it is very important to protect ourselves from exposure to lead.

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