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Nanotechnology applications in treatment of parasitic diseases

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A B S T R A C T

The nanoparticles technology is one of modern technologies that are manufactured in different ways and one of the easiest, fastest and cheapest methods is the biological methods for its use in diagnosis and treating human diseases such as cancer and parasitic diseases . Target parasites have shown resistance to traditional drugs and treatments , so nanoscience has given way to start new types of drugs and treatments either from nanoparticles alone or drugs that combine nanoparticles ,peptides and oils to give a multiplier effect, inhibiting the growth of parasites and killing them.

Introduction

Parasites are living organisms that live on or in other organisms and use the resources of their host. They are classified into groups depending on genetic diversity, appearance, and adaptions to the host. They are transmitted by mouth, faeces, vectors, or direct contact. The number of deaths from infection and parasitic diseases high and constantly increasing. This infection is treated with chemical pharmaceutical treatments and drugs, after the discovery of nanotechnology and its application in medicine, pharmacy, engineering ,water sterilization, diagnosis and treatment of diseases such as cancer and parasitic diseases [1].

Nanoparticles properties

1- They are particles with dimensions of (1-100)nanometers.
2- They are classified according to size , shape and properties.
3- They have Large surface area in relation to its volume ,its chemical activity increases with the increase in number of atoms on outer surfaces [2].
4- Ability to enter and penetrate physiological barriers and plays an important role in infection resistance [3].
5- Highly mobile in free state.
6- Acts as catalysis that interact strongly with toxic gases.
7- 7-They work more efficiently than larger materials with the same chemical composition [4].

Preparation of nanoparticles

It is prepare or built by two ways , the first one is chemical methods by construction from the bottom to up through the engineering of building nanomaterials starting from their ions , or by physical method to built it, by Smashing from top to bottom ,its done by physical methods such as grinding [5] [6].

Biological methods

Chemical and physical methods used in the manufacture of nanoparticles requires long time , solvents and dangerous materials to humans and environment . These materials are difficult to dispose of later and requires a high source of energy compared to biological methods which are more productive , cheaper, simpler, faster , safer ,environmentally friendly, don't require high energy and depend on the metabolism of living microscopic organisms and plant extracts as plants contain organic compounds such as flavonoids, amino acids ,carboxylic acids, ketones , phenols and proteins , these substances play an important role in return and recovery of mineral salts and production nanoparticles in easy, fast, cheap ways and provides a better treatment, in which the shape, size, growth and stability for nanocrystals are controlled , as well as the it ensures the purity of the product this is called green chemical pathway [7] [8].

Green chemical pathway

It is the technique of extracting NPs from different parts of plant ,where the active substances in these parts act as reducing agents to reduce the metal ions .this technology is characterized by the following:

1- Low cost economically.
2- Less toxic , it consumes simple and effective raw materials in smaller quantities.
3- It consumes less energy , does not high heat and pressure.
4- It takes a shorter time.
5- It is friendly to environment and gives less dangerous and toxic pollutants in smaller quantities [9] [10].

Nanoparticles diagnosis

Various techniques and equipment were used such as :

1- Ultrasonic wave.
2- UV and visible spectroscopy.
3- X-ray diffraction spectroscopy.
4- Infrared spectroscopy.
5- Aerosol technique.
6- Electron microscopy including atomic force microscopy (AFM).
7- Scanning electron microscope (SEM).
8- Transmission electron microscope (TEM) [11] [12].

Mechanism action of nanoparticles

The basis of its effectiveness is due to generation of reactive oxygen species that damage the cytoskeleton and cumulatively . It is a major mechanism for programmed cell death(apoptosis)which is caused by oxidative stress induced by nanoparticles .

The strong bonding force between sulfur and phosphorous due to the presence of nanoparticles enables it to damage the cell membrane by it obstructs the formation of proteins and may penetrate the cells of the organism and damage enzymes containing sulfur and phosphorous to the DNA of parasite and prevent protein synthesis and damage the parasite membrane thus killing the parasite ,or it may accumulate inside the mitochondria and weaken , disrupt its function and depolarize its membrane due to the breakdown of phospholipids of membrane by oxidative stress [2] [13] [8].

Nanoparticles applications in medicine and biology :

1- Cell manipulation (cell separation and purification).
2- Delivery of drugs to target organ .
3- Speed and accuracy pathogen detection .
4- Treatment of cancer, malignancy ,epidemics and endemic diseases.
5- Protein detection.
6- Restructuring and engineering genes. [14] [15] [16] [17] [18].

Diagnosis of parasitic disease

Microscope and blood drop for a long time is the malaria diagnosis program ,which can not diagnose low concentrations of parasite s .Then diagnostic techniques such as microscopic examination, in vitro culture and immunology tests were advanced , in addition to the polymerase chain reaction technology in the early diagnosis of infection diseases . These techniques are characterized by being it is slow ,expensive , and inaccurate and requires skilled technicians ,which are not available in many countries of third world.

It is easy to advance using nanomaterials in examination ,early diagnosis ,and detection with high sensitivity for very small quantities of patients blood and sample.

Coupling of NPs with immunoglobulins , protein helps and facilitates early diagnosis of parasitic diseases . for example Au nanoparticles were used to amplify DNA in blood samples of people with leishmaniasis , the electric al stimulation activity of AuNPs gave a fast and accurate detection of DNA by contrast . PCR which is less sensitive to the sample and more expensive .

The presence of AuNPs and sensitivity of leishmanial to formed ROS impairs their metabolism and reduce s their survival rates , this effect is doubled by adding UV light or UV light with infrared radiation with NPs.

Diagnostics Metallic nanoparticles such as gold and silver are the most widely used NP compared to magnetic and fluorescent NP. The change in color of AuNPs from red to blue was detected in nanodiagnostics to detect DNA. Enzymes , antibodies and antigens can be linked to AuNPs such as signal transducer amplifiers and labels. Electrochemical and optical reagents for the diagnosis of various diseases [19].

Treatment of parasitic disease

Can reduce harmful side effects and improve the effectiveness of antiparasitic drugs on the surface of nanomaterials or inside them . AgNPs alone or Ag NPs , chitosan and curcumin molecules combined have been used to treat toxoplasmosis and giardiasis and achieved very high success and cure rates , due to the low presence of parasite in liver and spleen.

The liposomes reduced size of infection and the presence of leishmanial parasites in mice spleen, The coupling of AgNPs with Trichoderma spp raised the efficiency of fascioliasis treatment.

We can increase the body immunity by foods such as carrot, pomegranates, coconut, turmeric, honey, olives, ginger, cloves and oils such as thyme, olives [20].

Conclusion

1- Some of parasites demonstrated drug resistance and there is no vaccine available for prevention of many parasitic infections. Therefore ,nanomedicine has the potential to provide applicability for old and toxic drugs by improving their bio distribution , modify bio availability and decreasing toxicity.
2- The bio distribution of conventional drugs can be improved and their toxicity reduced by using nanoparticles that are coupled with peptides and immunoglobulins , increasing the probability of accurate diagnosis of parasite diseases ,raising and increasing the improved efficacy of drugs, and reducing their side effects by installing antiparasitic drugs on or in nanoparticles .

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Competing Interests
The authors declare that there is no conflict of interest.

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