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BIO CAPPED SELENIUM NANOPARTICLES CONJUGATED WITH BOVINE SERUM ALBUMIN FOR TARGETED THERAPY

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ABSTRACT

To perform the green synthesis of selenium nanoparticles capped with plant extract nanoparticles are nano-sized particles with the dimension ranging from 1-100 nm. The production of selenium nanoparticles typically employs one of three techniques: physical, chemical, or biological techniques. We can characterize the synthesized selenium nanoparticles through UV-visible Spectrophotometer, FT-IR, and XRD. After the characterization of selenium nanoparticles, they are bio-conjugated with bovine serum Albumin and determined the concentration of bovine serum albumin for bio-conjugation against the cancer cell lines. Finally molecular dynamic of bovine serum albumin-plant extract through bioinformatics tools using molecular docking. Green chemistry procedures emphasize the use of biological systems, which include microorganisms, and plant extract. Biological systems are used as capping, reducing, and stabilizing agents in replacement of chemical biogenic synthesis of selenium nanoparticles is nontoxic and economical and uses environmentally benign non-hazardous material such as phytochemicals from plant extracts.

Keywords: Selenium nanoparticles, Bovine serum albumin, Plant extracts.

1. INTRODUCTION

Nano oncology has emerged as the biggest boon to the field of science and technology in the last few decades and has shown rapid growth, which has dramatically transformed the material science, biomedical, environmental, agricultural, and industrial domains [1]. Because it needs a non-toxic solvent and a moderate temperature, green synthesis using plant extract has become common. It also prevents cellular damage stimulated by free radicals by incorporation into antioxidant enzymes [4]. The second biggest cause of death in the world is cancer. Still, cancer does not have a targeted drug delivery. Selenium nanoparticles may be used as a covering or directly in solution at dosages that inhibit bacterial and cancerous growth [5]. With an atomic number of 34, selenium corresponds to group 16 of the periodic table. Selenium has achieved a different position in the area of nanotechnology because of its large potential in the delivery of drugs and proteins [1]. Selenium has both crystalline and amorphous structures in nature. Although selenium is an essential trace element for human health, there is a very thin line separating it from harm [2]. It has different physiological roles in the human body such as antioxidants and prevents the formation of cancer [3]. Here, we use the *Withania Somnifera, Vitis vinifera, and clitoria ternatea* as a plant extract. The Fabaceae family includes the annual leguminous herbaceous plant known as Clitoria ternatea (butterfly pea). Around the globe, the genus Clitoria is widely dispersed in tropical and subtropical habitats. Ternatins, anthocyanins derived from C. ternatea, are responsible for the blooms' distinctively intense blue colour. By using these plant extract we synthesize the selenium nanoparticles with the addition of sodium selenite. After the selenium nanoparticle preparation, we bio-conjugated the SeNPs with the bovine serum albumin and used them for cancer therapy. Green chemistry procedure place emphasis on the use of biological systems which include microorganisms, and plant extract. Biological systems are used as capping, reducing, and stabilizing agents in replacement of chemical biogenic synthesis of selenium nanoparticles is non-toxic, and economical, and uses environmentally benign non-hazardous material such as phytochemicals from plant extracts [4]. Elemental selenium has more importance in the field of biological, physical, and chemistry [2]. For various samples, TEM analysis showed the existence of NPs with essentially identical sizes and shapes, and all NPs were protected by a layer of unwrinkled BSA. The expanded BSA coating's isoelectric point on the NP surface was consistently close to 4.7, the same as unconjugated BSA. Controls included BSA-free and cationic surfactant-coated Au NPs. Under the same circumstances, they demonstrated high hemolytic activity and very poor cell viability. As a result, BSA-coated NPs were thought to be the finest delivery systems for drugs and other potential biomedical uses.

2. MEDITIONAL PLANT

Throughout the evolution of human culture, there has been a tight connection between people and plants. Drugs from the plant world have continued to be of interest as our understanding of human diseases has grown . Only because of the essential function that the plant kingdom plays in supporting life has man's presence on this planet been made possible. Before humans arrived on the planet, medicinal plants already existed . Accordingly, the history of drugs predates the existence of mankind . This history of drugs and surgeries goes well back in time. In India, the Rig-Veda (3500–1800 BC) continues the first writings mentioning the therapeutic benefits of specific herbs. The writings of Charaka and Susruta, two significant contributors to the Indian medical system, then appeared. Due to their medicinal potential, plants have been employed in traditional medicine for a very long time as major sources of medication. Novel medication candidates used to treat a variety of disorders have been discovered thanks to research on medicinal plants. Many different diseases can be prevented and treated with natural phyto compounds.

3. CHARACTERISATION OF SELENIUM NANOPARTICLES

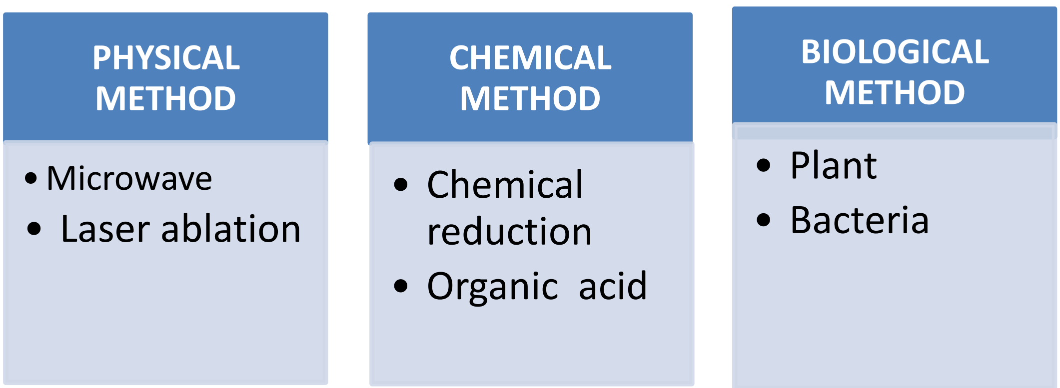
The synthesized selenium nanoparticles were characterized by using various spectroscopic and microscopic methods to evaluate their elemental composition, exact morphology, and also other physiochemical properties [4]. UV-visible spectra of the nanoparticles were gained from 200-1000 nm using a Spectra Max M3 to characterize the chemical properties of the selenium nanoparticle (SeNPs) [5]. When the color changes from uncolored to reddish color identify the selenium nanoparticles are synthesized. Fourier transform infrared spectroscopy is one of the conformation tests for the synthesis of selenium nanoparticles and also FTIR spectroscopy was used to verify the involvement of O-H, N-H, C=O, and C-O functional groups during the synthesis of selenium nanoparticles, which were link with bioactive molecule capping their surface [4]. The crystalline nature of the selenium nanoparticles was examined [10].

Different modes of nanoparticle synthesis

Nanoparticles, which have unique properties due to their size, distribution, and morphology, are critical components of any nanotechnology. In the late 1970s, used silver particles to treat infections caused by microorganisms during the treatment of orthopedic diseases, resulting in faster bone recovery. At present, varied physical, chemical, biological, and hybrid methods are utilized to synthesize distinct nanoparticles. The synthesis of nanoparticles has traditionally relied on two approaches, physical and chemical. These approaches include ion sputtering, solvo thermal synthesis, reduction, and sol-gel techniques. Nanoparticle synthesis methods can also be classified as bottom-up and top-down. Chemical methods involve the reduction of chemicals, electrochemical procedures and reduction of photo chemicals. Plant-based synthesis of nanoparticles is in contrast faster, safer and lighter; works at low temperatures; and requires only modest and environmentally safe components . Plant-based nanoparticles have attracted more attention due to growing interest in environmentally conscious products. In addition, the synthesis of nanoparticles using plants offers other advantages, such as the utilization of safer solvents, decreased use of dangerous reagents, milder response conditions, feasibility, and their adaptability in use for medicinal surgical, and pharmaceutical applications. Furthermore, physical requirements for their synthesis, including pressure, energy, temperature, and constituent materials are trivial.

4. SYNTHESIS OF SELENIUM NANOPARTICLES

The selenium nanoparticles were synthesized by the following methods are biological method, chemical method and physical method.



5. BIOLOGICAL METHOD

Due to the complexity cause of the chemical synthesis method, we started to use green synthesis. The green synthesis method was low cost and complexity. In a single step, we can synthesize selenium nanoparticles from bioactive plant extract. The product is act as a herbal capping and reduces the stabilizing agent. These results give a higher yield compared to the chemical synthesis [1]. Biogenic synthesis of selenium nanoparticles is non-toxic, commercially available, and uses environmentally begin non-hazardous material. However, some disadvantages are inherent to the use of microorganisms for the synthesis of biosynthesis nanoparticles. The use of plant extract is considered environmentally, friendly. Because the selenium nanoparticles are free of chemical impurities, they are appropriate for use in active food packaging where food safety is crucial. After synthesized nanoparticles are harvested by centrifugation, washed with water, and dried before use [3]. In the selenium nanoparticle's biosynthesis process reducing and stabilizing agents are the important factors. The creation of selenium nanoparticles with the smallest possible particle size and the greatest possible stability is the primary goal of biological selenium synthesis [4].

6. CHEMICAL METHOD

Pre-defined selenium nanoparticles can be easily identified by using this chemical synthesis method. In this chemical synthesis method, the hydrothermal route is considered a simple and easy way to prepare trigonal selenium nanorods with a diameter of 400nm [1]. The chemical method for synthesizing selenium nanoparticles is lowly favored because the long time required for synthesis and use of the chemical makes it dangerous for humans and the environmental [3]. However, according to the need in the biomedical field, chemically synthesized nanoparticles are not suitable thus preventing the use of selenium nanoparticles [1]. The chemical method of the organic or inorganic agent is used to reduce the selenium salt into selenium nanoparticles [3].

7. PHYSICAL METHOD

It is the method to synthesis the selenium nanoparticles. It involves the use of hydrothermal technique, UV-radiation and laser ablation [3].

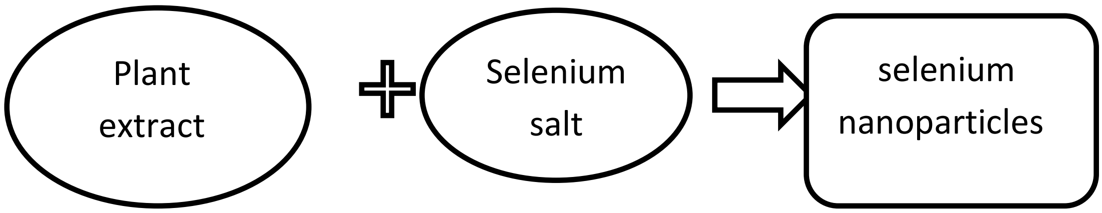


Fig.no.1 Synthesis of selenium nanoparticles

There are numerous methods available to create nanoparticles and their various forms, such as powders, tubes, rods, and thin films, as well as to create the desired sort of nanomaterial. Methods are being created, or occasionally, already existing methods are being adjusted. The type of nanomaterial to be manufactured largely determines the method to be employed. However, the many types of physical synthesis techniques are primarily based on the bottom-up approach for the synthesis of nano-sized materials. One method is the physical method based on top-down and bottom-up approaches. The material is evaporated in the first process, and then quickly regulated condensation is used in the second step to create the desired particle size.

8. METHODS AND MATERIALS

APPARATUS:

UV-visible spectrophotometer, Fourier transform infrared (FT-IR) and XRD.

Material Advances:

- Anti-oxidative activity
- Anti-diabetic activity
- Anti-microbial activity
- Anti-fungal activity
- Anti-parasitic activity
- Anti-carciogenic activity

Synthesis: Plant extract samples (Vitis vinifera-4.8g, Clitoria ternatea-0.6g, Withania somnifera-4.6g) were mixed with 50ml distilled water and then the keep the extract in a water bath at 90˚C for 20mins. Finally, we filtered. 5 ml of plant extract mixed with 20 ml of 40mM selenate acid and mixed with 45 ml of distilled water. The mixed solution was kept in the water bath until the colour changes to reddish colour. After the colour changes the solution was kept in the centrifugation process for 20 minutes at 3500 rpm. Finally, the supernatant was removed and the pellet was diluted with distilled water.

Bio Conjugation: Bovine serum albumin was refined by liquid chromatography before use using a Superdex 75 column that had been calibrated with 0.01 M phosphate. To completely cover the surface of a specified volume of nanoparticle solution (1012 NPs/mL), 1 mL of a bovine serum albumin stock solution with a concentration 10 times higher was added. Spectrophotometric analysis was used to measure the protein concentration using a molar absorption coefficient of 35 219 M1 cm1. To track the development of protein adsorption on the nanoparticle surfaces, 24 Protein nanoparticle bioconjugates were incubated at various periods (between 0 and 48 h) with slow stirring. The bioconjugate samples were centrifuged for 20 minutes between 8000 and 16000g (the bigger the size, the lower the speed) to remove excess unbound or loosely bound protein molecules to the NP surfaces followed by resuspension in a protein-free aqueous solution.22,25

Biomedical Application: Selenium nanoparticles have important applications in various domains such as the environmental, biomedical, and agriculture fields. In this current study various therapeutic roles of selenium nanoparticles such as antimicrobial activity, and anticancer activity [1]. Selenium nanoparticles have also been used as wound dressing materials. Basically, To treat cancer cells external radiation therapy is used widely. Pharmaceutical uses and dietary additives can both benefit from selenium nanoparticles in the future [2]. Additionally, selenium nanoparticles can lessen the harm of other metal ions. The synthesis of selenium nanoparticle by using plant extracts have also a be a very effective material for the photocatalytic degradation of dyes, because of their high surface-to-volume ratio [4].

Anti-Diabetic: Glucose was taken up from the diet and can be controlled by insulin, which is secreted by the pancreas. However, when the pancreas cannot secrete insulin properly, this leads to the generation of a metabolic disorder in which the blood glucose level is significantly higher than normal, Which is known as diabetes[1]. Demonstrated that extract of mulberry leaf and Pueraria lobata-coated selenium nanoparticles exerting a hypoglycemic effect can cure diabete mellitus[2].

Anti-Cancer: The uncontrolled division of cells and their spread to surrounding tissue leads to cancer or malignancy of cells, and annually, around 8.2 million deaths are due to different types of cancer, which is one of the major causes of death globally. Deaths caused by cancer globally will continue to increase, and where it has estimated that by 2030 it will reach around 13.1 million, which is about a 70% increase. Further, almost 200 types of cancer are known to date, consisting of six types of biological features, including angiogenesis, proliferation, resistance to cell death, evasion of growth suppression, invasion and metastasis, and replicative immortality[2]. In addition to having a unique anti-cancer potential, selenium nanoparticles are more selective for cancer cells than normal cells at the same concentrations of selenium (Se+).(IV).263 Through endocytosis, these nanoparticles are specifically internalised by cancer cells, triggering the apoptotic signal transduction cascade and ultimately leading to cancer cell death.264,265 Due to their small size, selenium nanoparticles are advantageous because they have a wide surface area that enables them to efficiently internalise tumour cells while also passively targeting free radicals [2].

9. CONCLUSION

Nanotechnology is a new branch of science that mainly deals with very small-sized particles, ranging from 1–100 nm. Nano biotechnology is a combination of nanotechnology with biology, which produces enhanced eco-friendly and biocompatible products that are beneficial for humankind and the environment. This field has gained limelight from the day it evolved in the biomedical domain. Nano-selenium in the form of nano-formulations along with bovine serum albumin offers excellent properties such as anti-microbial, anti-cancer, and anti-oxidant. It is a preliminary study for targeted drug delivery. We used several methods to characterize the surface modifications of SeNPs. Nanotechnology is a new branch of science that mainly deals with very small-sized particles, ranging from 1–100 nm. Nanobiotechnology is a combination of nanotechnology with biology, which produces enhanced eco-friendly and biocompatible products that are beneficial for humankind and the environment. This field has gained limelight from the day it evolved in the biomedical domain. However, a detailed study is still required to fill the gap of knowledge between elemental selenium and selenium nanoparticles to explore their potential in the biomedical domain. Because they are more bioactive, biocompatible, and have lower cytotoxicity than chemical reduction techniques, biological procedures are more advantageous. Economical and environmentally sustainable, biological synthesis and secure as opposed to chemical reduction methods that need for risky substances, high temperatures, and acidic pH. The use of plant extracts, however, is preferable to the bacterial route since it does away with the time-consuming processes and expensive costs associated with maintaining the cell cultures.

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