SILVER NANOPARTICLES FOR A NEW GENERATION OF ANTIMICROBIAL DRUG DELIVERY

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ABSTRACT

The most prominent nanoparticles for medical uses are nanosilver particles which are famous for their high anti-microbial activity. Silver ion has been known as a metal ion that exhibit anti-mold, anti-microbial and anti-algal properties for a long time. In particular, it is widely used as silver nitrate aqueous solution which has disinfecting and sterilizing actions. The purpose of this study was to evaluate the antimicrobial activity as well as physical properties of the silver nanoparticles prepared by chemical reduction method.

Keywords: Antimicrobial Activity, Nanotechnology, Nanoparticle, Peg, Silver Nitrate

I INTRODUCTION

Nanotechnology (sometimes shortened to "nanotech") is the manipulation of matter on an atomic and molecular scale.The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macro scale products, also now referred to as molecular nanotechnology. A more generalized description of nanotechnology was subsequently established by the National Nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers. This definition reflects the fact that quantum mechanical effects are important at this quantum-realm scale, and so the definition shifted from a particular technological goal to a research category inclusive of all types of research and technologies that deal with the special properties of matter that occur below the given size threshold. It is therefore common to see the plural form "nanotechnologies" as well as "nanoscale technologies" to refer to the broad range of research and applications whose common trait is size. Because of the variety of potential applications (including industrial and military), governments have invested billions of dollars in nanotechnology research. Through its National Nanotechnology Initiative, the USA has invested 3.7 billion dollars. The European Union has invested 1.2 billion and Japan 750 million dollars.

II SLIVER NANOPARTICLES

Silver nanoparticles are nanoparticles of silver, i.e. silver particles of between 1 nm and 100 nm in size. While frequently described as being 'silver' some are composed of a large percentage of silver oxide due to their large ratio of surface-to-bulk silver atoms.

Silver nanoparticles have unique optical, electrical, and thermal properties and are being incorporated into products that range from photovoltaics to biological and chemical sensors. Examples include conductive inks, pastes and fillers which utilize silver nanoparticles for their high electrical conductivity, stability, and low sintering temperatures. Additional applications include molecular diagnostics and photonic devices, which take advantage of the novel optical properties of these nanomaterials. An increasingly common application is the use of silver nanoparticles for antimicrobial coatings, and many textiles, keyboards, wound dressings, and biomedical devices now contain silver nanoparticles that continuously release a low level of silver ions to provide protection against bacteria.

III ANTIMICROBIAL ACTIVITY

An antimicrobial is an agent that kills microorganisms or inhibits their growth.Antimicrobial medicines can be grouped according to the microorganisms they act primarily against. For example, antibacterials (commonly known as antibiotics) are used against bacteria and antifungals are used against fungi. They can also be classed according to their function. Antimicrobials that kill microbes are called *microbicidal*; those that merely inhibit their growth are called *microbiostatic*. Disinfectants such as bleach are *non-selective antimicrobials*.

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IV POTENTIAL USE OF THE ANTIMICROBIAL ACTIVITY OF SILVER NITRATE

Silver nitrate is an inorganic compound with chemical formula AgNO3. This compound is a versatile precursor to many other silver compounds, such as those used in photography. It is far less sensitive to light than the halides. It was once called lunar caustic because silver was called luna by the ancient alchemists, who believed that silver was associated with the moon.

* Effective topical antimicrobial agents decrease infection and mortality in burn patients. Silver sulphadiazine continues to be the antimicrobial agent most often used in burn care facilities. Combined topical use of silver sulphadiazine and other antimicrobials may be a possible solution to bacterial resistance in burn wounds. Other agents seem to be useful in isolated clinical situations. None of the available topical antimicrobials, whether alone or in combination.will however prevent colonization of burn wounds. although invasive infections are infrequent.

*Metal ions were evaluated as potential antimicrobial agents suitable for local delivery in the oral cavity for the treatment of periodontitis. Silver nitrate, copper chloride, and zinc chloride were tested for antimicrobial activity in in vitro killing assays conducted in phosphate buffered saline with a series of oral bacteria including gram-negative periodontal pathogens and gram-positive streptococci.

*An antimicrobial therapeutic hydrogel composition comprises a pharmaceutical and/or medical grade silver salt, and an Aloe vera gel or extract. The composition could also include stabilizing agents, a non-ionic surfactant, polyol, and hydrophilic hygroscopic polymers. The resulting product has potent antimicrobial activity against bacteria, protozoa, fungi and viruses. The antimicrobial therapeutic composition can serve as a treatment for burns and as a wound/lesion dressing that either donates or receives moisture to provide a physiologic environment for accelerated wound healing and the relief of pain.

V MATERIALS AND PREPARATION OF SILVER NPS

Silver nitrate was used as precursor in the preparation of silver NPs.
Two colloidal forms of silver NPs were prepared by one-step synthetic method using ethylene glycol and glucose as reducing agents. Uniform silver nanoparticles were obtained by reduction of silver nitrate at 50°-70°C under atmospheric pressure. Poly vinyl pyrrolidone (PVP) was used as stabilizer. Ethylene glycol silver NPs were synthesized by dissolving $AgNO_3$ (160 mg) and PVP (6g) in 100 ml of 99.9% ethylene glycol (9). For the preparation of glucose silver NPs, $AgNO_3$ (160 mg) and PVP (6g) were dissolved in 100 ml of 40% (w/w) of glucose syrup. In order to be confident that the reaction is complete and all the ionic silver have been converted to nanoparticles, 5ml of sodium chloride was added to the samples. Creation of turbidity in the reaction solution indicates the presence of ionic silver while a clear solution confirms completion of the reaction.

Gravimetric method was utilized to measure the total nanosilver content of solutions. Nano silver particles were dissolved in 10% nitric oxide. Subsequently, sodium chloride (in excess) was added to the solution. The total amount of silver was determined by weighing the precipitated AgCl.

5.1 Anti-Bacterial Determination

The antimicrobial activities of the NPs suspension were determined by measurement of their minimum inhibitory concentrations (MICs) using the standard micro dilution method .The bacterial strains used in this study were Staphylococcus aureus and Escherichia coli.

VI PHYSICAL CHARACTERIZATION OF THE PARTICLES

SEM image of synthesised silver NPs by glucose are spherical in shape and have a smooth surface morphology. It is also apparent that resulting NPs are more and less uniform in size and shape. The UV-Vis spectrum shows absorption between 400 – 450 nm is usually characteristic of silver NPs in the UV-Vis region . Most of them were around 10-100 nm, smaller particles (8nm) were produced in glucose colloid rather than EG (15nm).

6.1 Anti-bacterial activity

Figures below shows the MICs of silver NPs and silver nitrate against the individual tested bacterial strains. These results tend to indicate that the EG silver NPs had higher anti-bacterial activity than glucose silver NPs.

Synthesis of silver nanoparticles by chemical reduction is considered a cheap and simple method. In the current study poly vinyl pyrolidone (PVP) was used as a stabilizer of the silver NPs. PVP could also control the reduction rate of silver ions as well as aggregation of metal atoms . The reducing agent showed to have an important impact on the uniformity of the nanoparticles. The silver nanoparticles produced by using glucose as the reducing agent compared to those produced by ethylene glycol showed better uniformity.

Fig :1 Glucose reduced silver nanoparticles showing antimicrobial activity against S.aureus.

Fig :2 Ethylene glycol reduced silver nanoparticles showing antimicrobial activity against S.aureus.

Fig :3 Ethylene glycol reduced silver nanoparticles showing antimicrobial activity against E.coli.

Fig :4 Glucose reduced silver nanoparticles showing antimicrobial activity against E.coli.

Fig :1

Fig :2

Fig :3

Fig :4

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