NANOTECHNOLOGY AND SILVER NANOPARTICLES

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ABSTRACT

Nanotechnology is a multidisciplinary science, in which physics, chemistry, engineering and biology work together. In various fields, nanoscience and nanotechnology take places in our life quickly. For instance, nanoscience and nanotechnology is applied by computer, electronic, communication, producing energy, food industry, nutrition, agriculture and medicine. Forthcoming 10-15 years nanotechnology is believed to be a new technological revolution.

In animal nutrition, antibiotic usage causes development of antibiotic resistant microorganisms. On this account, in many countries antibiotic based growth promoters are banned. Silver and ions has known to have antibacterial content. Silver nanoparticles (nanobiotic-Ag) are synthesized by various techniques. This nanoparticles posses good biocapability and also have low toxicity. Thus nanotechnology is used by animal nutrition and it is developing day by day.

In world trade, nanotechnological product’s market share is increasing rapidly. Countries are racing against each other to increase their market share. In Turkey, this technology and science is developing, researches are doing and institutes are established.

Keywords: Nanotechnology, Silver nanoparticle, Antibacterial

INTRODUCTION

What is Nanotechnology and Terminology of Nanotechnology?

Nature has been performing nanotechnological success for millions of years by arrangement of atoms and molecules. Nano usually refers to size between 1 and 100 nanometers (nm). In nanometric scale (one millionth of a millimeter), nanotechnology contains physical, chemical and biologic events’ understanding and control. Nanotechnology; allows us to manipulate at atomic and molecular level (picture-5). Nanotechnology processes materials which are measured by nanometers. Nanotechnology works with various research areas. Nanotechnology is a multidisciplinary technology. ‘Nanoscience’ is interested in this technology and when this science is applied to medicine it is called ‘Nanomedicine’ [1].
Nanoprocessing term means processing product in atomic level. Today’s technology has started to process this product and discover the unknown parts of it. Nanotechnology has enabled us to produce high quality, low price materials. In this technology, such as communication, medicine, agriculture and food industry can produce better-built, safer and long lasting materials [2]. Nanotechnology is broad and interdisciplinary area of research and past few years it has developed so rapidly [3]. Nanoscale materials are nanocrystals, nanoparticles, nanowires, nanotubes and nano films. This materials have potential to have different characteristics and functionality than they normally have [4, 5]. Nanosized inorganic particles shows unique physical and chemical properties. These are increasingly important material [6-9]. In scientific world nanotechnology has revolution potential [10].

**History Of Nanotechnology**

In a speech Stephan Hawking (picture-1) said that today’s science fiction generally tomorrow’s science reality. In ancient Greek Nano term derive from “nanos” which means dwarf. Physicist Richard Feynman (picture-2) who was awarded by Nobel Prize talk presented in American Physical Society in 29 December 1959. This date is initial day for nanotechnology [11]. Eric Drexler (picture-4) was the first who used nanotechnology term. He was interested in molecular production, molecule screening and nanofabrication [12]. Richard Feynman, Eric Drexler and Richard Smalley (picture-3) played an important role developing of nanotechnology [13].
How To Get Nanoparticles?
Nanoparticles are generally different from other commercial products and also have superior characteristics (Figure-1). Nanoparticles have great surface atom characteristic and very high surface/volume ratio. Recently, it is possible to produce nucleus-crust, alloyed, sandwich, cavity, spherical, rod shape nanoparticles [14]. Generally for producing nanoparticles two methods are used. This are ‘Top Down’ and ‘Bottom Up’. For producing metals or oxide nanoparticles, chemical steam intensification, hydrogen reduction, inert gas intensification and ultrasonic spray pyrolysis methods are used. In Top Down method, energy is given to material by mechanical or chemical procedure. During this method aim is to get nano size from material. For this method very high energy is consumed. In Bottom-Up method, through chemical reaction atomic or molecular size structures are expanded. Commonly used reductants are citrate, ascorbate and elemental hydrogen [15-18].
Silver Nanoparticles (Ag NPs) and Their Antibacterial Effects

Most of nanoparticles is in the form of metallic silver nanoparticles. Remaining silver is in ionic form. Surface area of silver is maximized, it results the highest effect per unit of silver [19]. Ionic silver becomes silver chloride in the stomach or bloodstream. Solubility of silver chloride is low. The silver-chloride is less effective than metallic one. There are many processes to synthesize silver nanoparticles. For instance, electrochemical reduction and irradiation [20-25]. Silver enters body through various ways like ingestion, inhalation of dust or fumes which contains silver [26, 27]. For centuries, silver has been in use for treatment of burns and wounds [28, 29]. In 1700 for venereal diseases and perianal abscesses silver nitrate was used [30, 31]. After penicillin was introduced, usage of silver for bacterial infections treatments minimized [32-34]. Moyer introduced the use of 0.5% silver nitrate for the treatment of burns. He proposed that it posses antibacterial property against Staphylococcus aureus, Pseudomonas aeruginosa and Escherichia coli [35, 36]. Silver’s antimicrobial property is related to the amount of silver and the rate of its releasing. Silver in the form of metallic state is inert. When it reacts with the moisture in the skin and the fluid, it get ionized. Ionized silver is highly reactive. It binds to tissue proteins and makes structural changes in the bacterial cell wall. These processes lead to cell distortion and death [31, 37]. Mechanism of silver action is linked with silver interaction with thiol group compounds found in the respiratory.
enzymes of bacterial cells. Silver binds to bacterial cell wall and cell membrane than inhibits the respiration [38]. Compared to other salts nanoparticles show efficient antimicrobial property. Because of their large surface area. Large surface area provides better contact with microorganism. Nanoparticles attach the bacterial cell membrane and that penetrate inside the bacteria. Bacterial cell membrane contains sulfur containing proteins. Silver nanoparticles interact with these proteins and also phosphorus containing compounds. DNA is also phosphorus containing compound. When silver nanoparticles enter the bacteria, it forms a low molecular weight region. Bacteria conglomerates and protect the DNA from silver ions. Nanoparticles preferably attack the respiratory chain. This event causes cell death [39-42].

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