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The use of nanoparticles in food preservation and processing

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***Abstract*---**This article focuses on the role of nanotechnology in the field of food industries. Bioactive components with an antimicrobial activity such activity against food pathogens are encapsulated into nanoparticles to improve and extend their efficiency in food preservation. However, these Nano particles are to be biocompatible and nontoxic for humans. Advancement during this field has resulted within the development of Nano particles for food packaging in some industries. The most commonly used group of Nano particles s within the food industry is metal oxide. As metal oxide Nano particles such as zinc oxide and titaniumdioxide exhibit antimicrobial activity in food materials, the NPs can be used for food preservation with enhanced func-tional properties. The application and effects of nanotechnology in correlation with the nutritional and sensory properties of foods were briefly discussed with a couple of insights into safety regulations on nano-based food formulation and preservation.

***Keywords*---**nanotechnology, nanoparticles, food pathogens, antimicrobial activity, food preservation.

Introduction

The meaning of the word "Nano," a prefix that indicates "one billionth," comes from the ancient Greek language. Taniguchi (1974) came up with the term "nanotechnology" for perhaps the first time in the scientific world at the Conference Held on Industrial Production in Tokyo in 1974. He taught at Tokyo University of Science). Nano science is a branch of nanometer-sized materials with aspects or less one micrometre (1 m). Nanometers should be used to evaluate the Nano scale (10-9m). Nanotechnology has appeared as being the most active research area in recent years, due to the ability to manipulate and control matter at the nanoscale. Nanotechnology tends to bring together awareness from physics, chemistry, biology, medicine, engineering, and informatics). Inside that 1-100 nm range, nanosized materials can be utilized their characteristics and

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properties including conductivity, ionic structure, freezing, melting, and colour. A materials can be classified in and out of macro- (50-200 m size), micro- (1-50 m size), and nano materials characteristics such as size (1-1000 nm size). Nanomaterials are used in a wide range of applications because unique optical, magnetic, electrical, and other properties emerge at this scale). Nanotechnology has always been essential for the creation and characterization of nanoparticles. Different methods are being used to synthesise and classify these materials. Nanotechnology will be a fast - growing field in the coming years, and the use of nanoparticles (NPs) in those other fields of biotechnology will lead to biomedical applications. Furthermore, nanotechnology can be used to target and deliver drugs, regenerate skin, and so on. Existing Nanoparticles, such as minerals, catalysts, and some porosities, have similar but distinct properties, owing to their Nano scale features). A most of ofnanomaterials were extracted naturally, but most were synthesised artificially and used in a wide range of purposes.

Nanomaterial synthesis methods

Hydrothermal synthesis, sol-gel synthesis, wet chemical synthesis, physical vapour deposition (PVD), and chemical vapour deposition all are techniques for establishing nanotechnology.

Thermochemical synthesis

The hydrothermal technique is amongst the most broadly utilised synthesis methods. The concepts geothermal and thermoelectric relate to water and heat, respectively. This method involves the use of water and also a heating process. Water is probably reaction at high pressure and temperature is making advances in nanomaterials. One of its most important solvents in this process is water. The benefit of using water in hydrothermal technique is that it is all environments conscious and inexpensive. Water is evaporated quickly, making it easy to remove first from product. A further benefit of this style is the ability to access clear crystal morphological characteristics and easily reduce size of the particles. The above synthesis is carried out from an autoclave (Fig. 1).

Synthesis of a sol gel

The physicochemical activities associated with hydrolysis, polymerization, drying, and densification of the precursors are now all part of the sol-gel synthesis. This procedure usually begins with both the mixing of metal oxides or salts in water or a despite appropriate at atmospheric or slightly high temperatures.

Synthesis of wet chemicals

Inorganic molecules have been widely synthesised using a wet chemical process. The advantage of this process is that it produces nanomaterials on a large scale. Wet chemical tests, also referred to as wet chemical assessment, is based on chemically fluid steps. Because wet chemical analysis was conducted on liquids, this method reduces particle size. Nanotechnology's biological applications. Nanomaterials have been used in a wide range of applications in recent years.

This investigation refers to the biological applications of nanotechnology. Figure 2 shows a list of certain specific biological applications of nanotechnology.

Cancer treatment

Cancer is one of the leading causes of mortality. We have only a few treatments for cancer available, such as chemotherapy, radiation, as well as some surgery. One of most brilliant ideas for cancer treatment is the use of nanomaterials. The biggest hurdles in cancer treatment are drug selectivity, specificity, and increased delivery effectiveness. A therapeutic drug would've been selectively targeted to cancer cells, enhancing treatment for cancer while causing minimal damage to healthy tissues. The nanocomposites is used as a drug delivery carriers to cancer cells, allowing the drug to achieve the affected cell lines more easily. Some other advantage is that drugs are not delivered to normal sites that also reduces side effects.

Sophisticated drug delivery system

Various drugs systems were designed in order to improve therapeutic efficiency while minimising side effects. Once compared to other drug delivery systems, this same smart drug delivery system has several advantages. Other drug release systems depend on a predetermined drug release rate regardless of the weather weather conditions of application. The Smart delivery of drugs, on the other hand, is based just on release-on-demand strategy. The main benefits of a drug Nano-based delivery system (Fig. 3) are low dosage and specific objective.

Enhancement of comparision in magnetic resonance imaging (MRI)

Magnetic nanoparticles have been used as a contrast material in MRI scans. Nano particles are being used to improve the image's reliability. Nano particles consist of a combination such as iron (Fe), gadolinium (Gd), as well as manganese (Mn) are presently used as contrast media in MRI. Images are created by MRI scanners utilising electromagnetic signals.

Gene Therapy

The use of nanotechnology in gene therapy is currently being used to replace viral vectors. Transgenics can successfully introduce ethical products. The use of NPs has many advantages in gene therapy. Compared with other media Silver nanoparticles for food preservation Silver nanoparticles Using Protiumserratum foil to synthesize silver nanoparticles (AgNPs). (E.coli) (IC50 = 84.28 ± 0.36 mg/mL) and Bacillus subtilis(IC50 = 94.43 ± 0.42 mg/mL1921). Mohanta et al. reported that the antioxidant activity of 1,1diphenyl2 picrylhydrazil(DHHP)-based AgNPs was IC50 = 6.78 ± 0.15 mg/mL and the hydroxyl radical assay (IC50 = 89.58 ± 1.15mg/mL. The biocompatible activity of AgNPsdid not inhibit the fibroblast cell line (L929) at lower concentrations, but increased concentrations resulted in impaired cell viability. The IC50 values against the normal L929 cell line of 600.28 ± 0.75 µg/ml showed no cytotoxic activity against the L929 cell line. The above results show that AgNPs can be used in food packaging and preservation with pharmaceutical and biomedical applications.pathogens such as

E. coli (ZOI: 23 mm, MBC: 0.010 mg/mL), Staphylococcus aureus (ZOI: 14.66 mm, MBC: 0.041 mg/mL), Salmonella enterica (ZOI: 16.66 mm, MBC: 0.041 mg/mL). Silver nanoparticles have been synthesized from white radish (Raphanussativusvar. Solid matrix) in laboratory experiments, reducing the viability of terrestrial snails (approximately 20% of snails die during treatment). nanosilver treatment) while reducing the fungal population in the Matrix solids. UsingSerratia sp.BHUS4, silver nanoparticles were synthesized and it showed antifungal resistance toBipolarissorokiniana, the pathogen of wheat spot.The three main important advantages of nanomaterials are sizes below 100 nm. Small particles with unique properties By controlling structure, function and composition, we can control properties. The size and surface will vary depending on the solvent used.

Food Packaging with Nanomaterials

By using targeted nanocarriers, we can reduce toxicity and delivery efficiency. The micelle size is about 5,100 nm in diameter (spherical) capable of encapsulating non-polar molecules such as lipids, flavors, antimicrobials, antioxidants and vitamins. The use of nanoparticles can develop the mechanical and heat-resistant properties of food packaging, leading to an increase in shelf life due to disturbance of water vapor or air permeability. For example, polymers are not naturally impermeable to water vapor or gas, but polymeric silicate nanomaterials have the potential to develop gas-blocking, heat-resisting and mechanical strength properties for food packaging. The addition of montmorillonite (35%) in the nanocomposite structure makes the plastic lighter, more thermally stable, and increases its barrier properties against oxygen, carbon dioxide, moisture and volatiles. The addition of nanolayers in biopolymers (lactic acid) and in ethylene-vinyl alcohol copolymers increases the barrier properties of oxygen and water vapor, leading to an increase in the shelf life of foods. In recent days, lipids, carbohydrates and proteins are used to form films and coatings. These nanomaterials (consisting of 2 or more layers of nanomaterials physically or chemically bonded together) are used as coating materials on food surfaces because their maximum fineness makes them very fragile.

Nanomaterials derived from carbon

Huang et al. have defined the feature of carbon nanotubes in protein structure prediction as well as the construction of bioreactors as well as biosensors. This same adding of silver to titanium dioxide nanoparticles helps improve their own bactericidal properties against E. coli. Even though nanomaterial's have a high surface area, they can easily bind to food packaging.Nanomaterial's are used for the food business to combat microorganisms which spoil food. In the food products, nano particles such as reduced grapheme oxide are used for packaging. The combination of titanium dioxide and carbon nanotubes significantly improves disinfectant properties against B. cereus spores. In the food business, nanotubes can be used for functions such as membrane separation of biomolecules (proteins, peptides, vitamins, or minerals) and single - molecule detection (enzymes, antibodies, various proteins, and DNA).

Nanoparticles of zinc oxide

Tayel and colleagues created zinc oxide nanoparticles and evaluated their antimicrobial activities against foodborne pathogens. Determination of the Minimal Inhibitory Concentrations and Paper Cylinder Dispersion Assay are two antimicrobial tests. Salmonella typhimurium (22 mM) is impeded by ZnO nanoparticles, and S. aureus is hindered by ZnO nanoparticles (10 mM). The presence of much more zinc oxide nanoparticles increases the chances of nanoparticles complying to S. typhimurium and S. aureus cells.

Silver nanoparticle in food packaging

Nishimaet et al. Synthesis of functional silver nanoparticles Sodium Benzoate from silver nitrate Compared with sodium benzoate, functional silver nanoparticles Sodium benzoate has high antibacterial activity against food-borne pathogens such as E. coli, S.aureus, S.typhimurium type 2, Bacillus cereus. Therefore, they can be used for food packaging by applying a switchable concentration of functional silver nanoparticles with silver sodium benzoate.This can lead to high productivity as well as ease of production at low cost., Synthesis Synthesis of a vial of Synthesis of silver nanoparticles was treated with sodium acetate from silver nitrate using a coating agent as well as a reducing agent with sodium acetate. Such as E.coli, methicillin-resistant S.aureus (MRSA), P.aeruginosa and Klebsiellapneumoniae. Absorption spectroscopy, dynamic light scattering, Zeta potential, Fourier transform infrared spectroscopy (FTIR), proton nuclear magnetic resonance (1H NMR spectroscopy) and transmission electron microscopy (TEM). Natural nanoparticles are mainly used to control the growth of food spoilage pathogens Silver nanoparticles play an important role in biotechnology, electrical appliances, refrigerators and home appliances a kitchen. The ions present in silver nanoparticles have the ability to block a wide range of biological processes in bacteria.Zinc nanoparticles synthesized from Moringaoleifera leaf extract showed effective antibacterial activity against some bacterial strains such as S.aureus, B.subtilis, P.aeruginosa, Proteus mirabilis, E.coli and fungal strains such as Candida albicans and Candida Tropicalis.

Was maximal for S.aureus at about 23,80,76 compared with other zinc nanoparticles synthesized from hysterophorusParthenium which exhibited strong antifungal activity against plant pathogens such as Aspergillusflavus and Aspergillusniger.The maximum inhibition zone of is 275 nm. Zinc nanoparticles synthesized from leaves of Catharanthusroseus (L.) showed antibacterial activities against gram-negative E.coli (ATCC 25922), P. aeruginosa (ATCC 15442), gram-positive S.aureus (ATCC 15442), and gram-positive S.aureus. ATCC 6538) and B. thuringiensis (ATCC 10792). The results showed that P.aeruginosa was more sensitive and B.thuringiensis is very resistant to zinc nanoparticles. The antibacterial activity of zinc nanoparticles has been demonstrated against gram-positive bacteria such as B. subtilis and S.aureus indicating that they are sensitive to this nanoparticle46). Xie et al., have shown that zinc nanoparticles have high antibacterial activity against some gram-negative bacteria such as P.aeruginosa, C.jejuni and E. coli4.Zinc nanoparticles also showed potential antifungal activity against Botrytis cinerea and Penicilliumexpansum at concentrations greater than 3 mmol/L.

These results suggest that P.expansum is more sensitive than the widely used B.cinerea.nm as an antibacterial agent and food additive for food containers and packagingZinc and zinc oxide are effectively used as antimicrobial agents in food packaging and also as nutritional additives.

Ana Raquel Madureira and her colleagues used chitosan nanoparticles to fight foodborne pathogens. Hundred nm are used as food additives and food packaging. Platinum and gold nanowires are widely used as biosensors for advanced food analysis. Zou et al. confirmed that the effective use of antibacterial activity of nis-loaded liposomal nanoparticles against L. monocytogenesand S. aureusPrombutara et al., 2012 also investigated the antibacterial activity of free and nisin-loaded lipid nanoparticles. Their results showed that strong and stable antibacterial activity was observed in nisin-loaded nanoparticles against L. monocytogenes DMST 2871 compared with free nisin, indicating that nisin was released from the particles nano during storage. The natural phenolic compound delivered by the nanoparticles has been shown to be an effective antibacterial agent against L.monocytogenes in raw and cooked meat systems. In cow's milk. The thymol-containing nanodisc also plays an effective role in food applications against foodborne pathogens.Enzymes embedded in gold nanoparticles are effectively used to detect bacteria and gases to observe the condition of food. Plays a potential role in indicating spoilage of meat and fish by detecting gaseous amines. For the detection of volatile organic compounds, zinc oxide and titanium oxide nanocompounds are used.

Nutritionbenanotech is marketed as a supplement. losecolor and taste of the product. The vitamin nozzle disperses the nanoparticles which are essential for better nutrient absorption. The blade includes several nanosensors that are widely used to detect emissions from spoiled food. These spoiled foods cause sensor bands to change color to indicate whether the food is fresh or not.Using nanotechnology, an analysis technique known as reflective interference. Developed and used to ensure food quality by detecting E.developed to monitor S.typhimuriumand S.tyPhimurium DT10455).The Piezoelectric biosensor is evolved from the electrical residences of gold nanoparticles which can be used for the real-time detection of foodborne pathogens like E. coli 0157:H7. The precept at the back of this sensor is to goal precise ssDNA- functionalized Au NPs sure first off to the goal DNA and finally to a complementary probe immobilized onto the piezoelectric biosensor floor ensuing in a frequency shift of the piezoelectric biosensor.

Concentrations as little as of 1.2 × 102 CFU/mL of E. coli O157:H7 have been detectable. Quantum Dots were used as fluorescent labels in severa assays for the detection of meals borne pathogens consisting of L. monocytogenes, C. jejuni, E. coli O157:H746), S. typhimurium, S. aureus and Shigellaflexneri. Yiping et al. synthesized magnesium oxide nanoparticles with small particle size, with excessive antibacterial interest in opposition to a few meals pathogens. Micro plate assay is used for measuring increase region in magnesium oxide nanoparticles. It confirmed increase inhibition for unique awareness and unique bacteria, 104 CFU/mL of C. jejuni, E. coli O157:H7, and S. Enteritidis have been decided to be 1, 2, and 0.five mg/mL, respectively. To absolutely inactivate 108-nine CFU/mL bacterial cells in 4hrs, a minimum awareness of MgO nanoparticles became required 2 mg/mL for C. jejuni while that became required as a minimum eight mg/mL for E. coli O157:H7 and S. Enteritidis.

Zinc oxide nanoparticles

Tayel et al. invented zinc oxide nanoparticles and evaluated their antibacterial activity against food - borne pathogens. Determination of the Minimal Activity in vitro Concentrations and Paper Disc Diffusion Test seem to be two very different antimicrobial experiments. ZnO nanoparticles prevent Salmonella typhimurium (22 mM) and S. aureus (10 mM). An increment in zinc oxide nanoparticles increases the possibility of nanoparticles attaching to S. typhimurium and S. aureus cells.

Biosensor

For the detection and quantification of glucose, an electrochemical glucose biosensor is used. The biosensor is nanofabricated by self-assembly layer by layer by polyelectrolyte. to detect E.).An electronic nose is a device used to detect different types of odors. The device mainly consists of gas sensors made of zinc oxide nanowires. The use of a polydimethylsiloxan (PDMS) chip together with a liquid bilayer membrane has the potential to be used for the immunological detection of Staphylococcus enterotoxin B (SEB) bacteria in milk. Antibodies against enterotoxins are double-membrane-bound in PDMS channels from a biosensor. The nanoparticles amplify the signal and improve the detection limit of pathogenic bacteria. Nanoparticles have a number of applications in biology. Researchers have developed a nanomaterial-based sensor that uses nanoparticles such as metal oxides, quantum dots, and carbon nanotubes to detect foodborne pathogens.It can easily detect food contamination caused by bacteria or any other microorganism. These nanoparticles easily bind to microorganisms using sensors.forfoodborne pathogens. During the synthesis of Au and Ag nanoparticles, various parameters such as pH, temperature, and reaction time are controlled to adjust the size and shape of the nanoparticles. These nanoparticles had antibacterial activity at concentrations of 30 ± 14.3 and 20 ± 12.8 μg/mL compared to spp.

Correspondingly, however, no inhibition was observed for Bacillus spp.The role of metal nanoparticles in the food industry.The synthesized nanoparticles showed antibacterial activity against foodborne pathogens such as B.cereus, L.monocytogenes, S.aureus, E.coli and S.Typhimurium.100 μg/ml. When using antibiotics (kanamycin and rifampicin) and AgNPs to study synergistic antibacterial activity, the zone of inhibition was 10.Diameter 62 to 14.33 mm resistant to all pathogens. Similarly, antibacterial agent and AgNPs were used to study synergistic antibacterial activity, showing an inhibition zone of 9.74-14.75 mm against some Candida species such as C.albicans, C.glabrata, C. geochares and C. saitoana.

Conclusion

This review investigated at just how nanoparticles are used in the food products. Metal oxide nanoparticles are primarily used to prevent contamination of food and to dramatically reduce pathogens. Nanoparticles with a large surface area and varying size can be used in a variety of applications. Some nanoparticles are used in sensing applications to detect pathogens in food. Bacterial spores that contaminate food have been easily spotted. To detect foodborne pathogens, we can use nanoparticles and thin films in biosensors. In commercial applications, nanoparticles including such gold, silver, zinc oxide, titanium oxide, and graphene oxide are used to control foodborne pathogens. Food germs can also be identified using biosensors made from thin films.

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