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Nanotechnology: An Insight for Food Processing

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Abstract

Nanotechnology is an emerging technology gaining quantum in food processing. This novel processing technology caters various application like enhanced shelf life, controlled release, target delivery *etc*. Variety of novel foods like nanoemulsion, nanoencapsulation, nano sensors for packaging materials, edible packaging with nanoparticles are capturing the market and have potential economic value.

Introduction

Nanotechnology in recent years plays a crucial role in the food and agriculture sectors, contributes to crop improvement, enhances the food quality and safety, and promotes human health through novel and innovative approaches. Its engineered nanometer-sized particles have unique physical, chemical, and biological properties have gained importance in medicine, agro-food sectors, sewage water treatments (Sekhon, 2010). Nanomaterials particles ranging from 1 to 100 nm in size. Different sized nanoparticles are used in nanotechnologies of food science for potential production and processing of healthier, safer, and high-quality foods.

Nanofood

Food designed by using nanotechnology finds immense application in processing, production, security, and packaging of food and referred as Nanofood. Edible nano-coatings (~ 5 nm thin coatings) are used in meat, fruits, vegetables, cheese, fast food, bakery goods, and confectionery products. Nano coatings have improved gas and moisture barriers. In addition, they are incorporated with flavor, color, enzymes, antioxidants, anti-browning compounds, which enhance shelf life of the manufactured products. Various bakery goods use edible antibacterial nano-coatings for improving shelf life. Nanofilters are used for extraction of betalin and anthocyanins from beetroot juice while retaining the flavor and the red wine. In milk lactose is removed and substituted with other sugars, making the milk befitting lactose-intolerant patients. Nanoscale filters help in the elimination of bacterial species from milk or water without boiling. nanosieves developed by nanomaterials is used for the filtration of milk and beer. Nanotechnology is used in the production of healthier food containing low fat, sugar, and salt to avoid food-borne diseases. Nanogreen tea, Neosino capsules (dietary supplements), Canola active oil, Aquanova (micelle to enhance the solubility of vitamins (A, C, D, E, and K), beta-carotene, and omega fatty acids), Nutralease (fortifying nanocarriers to carry nutraceuticals and drugs) are the common commercialized nanotechnology-based products in the market which are widely sold in the USA, Australia, China, and Japan.

Nanofood Packaging Materials

Active and intelligent packaging systems have recently gained importance in the muscle-based food products, which are prone to contamination. Nanosensors can detect food spoilage or contamination alarm to the consumers by detecting toxins, pesticides, and microbial contamination in the food products, based on change in flavor compounds or colour change. Nanoparticles used for packaging in food industry have potential antimicrobial activity, acting as carriers for antimicrobial polypeptides and providing protection against microbial spoilage. Packaging material made with antimicrobial agent in starch colloids form protective coating and acts as a barrier to microbes through the controlled release of antimicrobials from the packaged material. Few metals and metal oxide nanoparticles (inorganic nanoparticles), namely iron, silver, zinc oxides, carbon, magnesium oxides, titanium oxides, and silicon dioxide nanoparticles, are widely explored as antimicrobials. Nanoclay in the nanocomposites (bentonite), used in the production of bottles and other food packaging materials, significantly improves gas barrier property and limiting oxygen and moisture from diffusion Nanocrystals developed by Nanocor (Arlington Heights, USA) is used as nanocomposite plastic beer bottles.

Chitosan-based silver-nanocomposite films, and garlic essential oil filled in the PEG-coated nanoparticles can be used as antimicrobial and control of store pests. Silicate nanoparticles in food packaging act as a barrier to gases or moisture and thus decreases food spoilage and drying. Barcodes developed with nanoparticles, called nanobarcodes, can be used as ID tags. Nanosensor application in packaging provides details of enzymes and microbs generated during the degradation of food compounds that makes food unsuitable for human intake. Coating of LDPE films with silver NPs using a layer-by-layer method significantly emerged as antimicrobial potential against *S. aureus* (gram-positive) and *Pseudomonas fluorescens* (gram-negative) organism (Sorrentino *et al*., 2007).

Antimicrobial Properties of Nanoparticles

In the market several nano-products are available for controlling microbial growth and contamination in food. *E. coli* O157: H7, *S. typhimurium, Vibrio parahaemolyticus,* and *L. monocytogenes* are four significant food-related pathogens are effectively controlled by the nanosilver product known as NanoCid® L2000 (Nano Nasb Pars Company, Tehran, Iran). Nanomaterial-related antimicrobial disinfectants are documented by Nanotechnology Consumer Product Inventory and most commonly used antimicrobial agent is nano silver. Antimicrobial coatings developed by nanoengineering are one of the efficient agents to suppress the growth of biofilms and enhance the quality and safety of the food. Surface cleaning in the food industry by nanoscale silver, TiO_2, and ZnO or nanoscale topography is gaining polpularity (Rai *et al*., 2015). The combination of two or more nanoparticles provides a synergistic effect exhibiting potent antimicrobial activity compared to a single nanoparticle. Example Silver NPs combined with titanium dioxide and carbon nanotubes effectively control growth of *E. coli* and *Bacillus cereus* spores.

Nanoemulsions

Nanoemulsions are colloidal suspension system of oil-in-water emulsions, characterized by droplet size from 10 to 1000 nm and containing solid spheres with amorphous and lipophilic surfaces. The nanoemulsions serve as excellent carriers for various bioactive compounds as compared with conventional emulsion. Nanoemulsion exhibits with enhanced properties compared to conventional emulsions like high optical clarity, physical stability, and enhanced bioavailability. The small particle size of nanoemulsions increases the surface area which improves interaction of various bioactive compounds transported in the gastrointestinal tract. Nanoemulsions help in rapid transfer of naturally occurring hydrophobic bioactive compounds present in functional foods. Various functional foods use nanoemulsion technology to enhance bioavailability, controlled release of bioactive compounds in the body.

The inclusion of isolated bioactive compounds into the emulsion-based delivery systems leads to enhanced bioavailability. Study on stability and oral bioavailability of the epigallocatechin gallate and curcumin established enhancement of bioavailability by the nanoemulsion method, and the nanoemulsion was used to enhance the yellow color pigment in turmeric. The major applications of nanoemulsions include curing and treatment for enzyme replacement therapy in the liver, infection of the reticuloendothelial system, cancer prevention, and vaccination.

Nanoencapsulation

Nanoencapsulation is a process active ingredient is encapsulated in tiny structures, via nano-structuration, nano-emulsification, or nanocomposites resulting in controlled release of the core. Encapsulation of bioactive nutraceutical molecules using nanoformulations improves their bioavailability and biodistribution. Different types of nanoencapsulations (nanoparticles, liposomes, nanospheres, micelles, nanocochleates, and nanoemulsions) are used as nutritional supplements, to conceal unpleasant taste, improve the bioavailability, and permit efficient dispersion of insoluble supplements without the requirement for surfactants or emulsifiers nanoencapsultion of curcumin and quercetin in turmeric extract were developed in PLA-based nanoparticles. Stevioside nanoparticles, nontoxic natural noncaloric sweeteners, were used as antidiabetic nutraceutical agents. BSA nanoencapsulation improved stability and bioavailability of the polyphenols (catechin and epicatechin) in tea. Controlled release of bioactive components from nanocapsules improved antioxidant potential and enhances the effectiveness of the bioactive molecules. Nanoencapsulation of curcumin in hydrophobically modified starch improved anticancer activity of curcumin. Nanoencapsulation of live mixtures of bacterial is demanding food supplement *i.e.*, probiotics. Nanoencapsulated probiotics can be specifically administrated into specific regions of the GI tract where they bind to the specific receptors.

Toxicology Impact of Nanotechnology

Emerging popularity of nanotechnology field is increasing its public concern regarding the toxicity and environmental impact of nanomaterials is also increasing. Nanoparticles on the surface of the packaging material are not harmful to human beings, but their translocation and integration into food may affect the human health. Silver nanoparticle is the only commercial nanoparticles. Although silver NP has been used in many commercial nanoproducts, only a few in vivo toxicological studies with silver NP have been conducted using the mammalian models (*e.g.*, mice and rats). Tumor-like changes have been observed in the human cells exposed to TiO_2 NP. However very detail in-vitro study is essential for better toxcicological impact study.

Conclusion

Nanotechnology is emerging technology in the food sector through the quality food production ends with advanced processing, packaging, and long-term storage. The nanomaterials and nanosensors help the consumers providing information regarding quality, nutritional and microbial insight of food. Nanoparticles are manufactured all over the world, however their use in commercial products lack regulatory rules. Insufficient scientific exploration on nanosystems creates difficulties in arriving at any conclusions regarding their efficacy. The applications of nanoparticles in food packaging are less harmful than the utilization of nanoparticles as a food ingredient as they will not be consumed.

References

Rai, M., Jogee, P.S., Ingle, A.P., 2015. Emerging nanotechnology for detection of mycotoxins in food and feed. *Int. J. Food Sci. Nutr.* 66, 363–370.

Sekhon, B.S., 2010. Food nanotechnology—an overview. *Nanotechnol. Sci. Appl.* 3, 1–15.

Sorrentino, A., Gorrasi, G., Vittoria, V., 2007. Potential perspectives of bio-nanocomposites for food packaging applications. *Trends Food Sci. Technol.* 18, 84–95.