Role of Nanotechnology in Food Sector

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Introduction

The term "nanotechnology" describes the study and controlled manipulation of structures and devices with length ranges between one and one hundred nanometers at the atomic, molecular, and macromolecular levels. Nanotechnology and nanoscience have quickly come up on the top of the priority list for both commercial and medical applications as well as in several industries, including electronics, human and veterinary medicine, textiles, defence, agriculture. Moreover, nanotechnology has several other applications in cosmetics, drug delivery systems, and diagnostic biosensors. The food sector has several new prospects because of the innovative characteristics of nanoparticles. Through the use of nanotechnology, a number of intricate technical and scientific problems in the food and bioprocessing sectors may be resolved, allowing for the efficient and sustainable production of safe food with a higher quality. For instance, nanoparticles have been used significantly in the food sector to improve manufacturing, packaging, shelf life, and vitamin bioavailability. Some recent uses of nanotechnology in the food business include the detection of bacteria and the monitoring of food quality using biosensors; different packaging systems for food; and the nanoencapsulation of bioactive food components (Figure 1). The use of nanomaterials in food may have positive impacts on bioavailability, antibacterial activity, sensory acceptability, and targeted delivery of bioactive substances.

Nanoparticles

Silver zeolites (silver nanoparticles) are ideal examples as they showed distinct broad spectrum antibacterial effects. Numerous types of bacteria, fungus, algae, and even certain viruses are all fatal to silver nanoparticles. In the presence of UV rays, TiO2 is prevented from spoilage and pathogenic germs, odour, deterioration, and allergies. It has been included into a wide range of products to suppress light and generate a sparkling appearance.

Figure 1. Green synthesis of nanoparticles and their application in the food sector

ZnO particles had meritorious anti-infectious properties, and this property got better as the particle size was decreased. Evident light is required by zinc oxide for stimulation. Zinc oxide was the most effective anti-infective agent against the Staphylococcus aureus growth control when compared to MgO and CaO. Zinc oxide nanoparticles used in dental fillings which reduced the growth of microbial biofilms caused by Streptococcus sobrinus up to 80%. The most significant and stable zirconium oxide is zirconia, often known as zirconium dioxide (ZrO2). High tensile strength, strong antimicrobial characteristics, exquisite impact resistance, exceptional chemical resistance, high stiffness, and strong refractoriness are just a few of zirconia's unique qualities that make it suitable for a number of applications.

Nano edible coating

The need for eco-friendly and natural meals among consumers can be met in the future with the help of edible films and coatings. Edible films have been combined with nanotechnology to enhance the physical-mechanical qualities of the edible films that can provide safety against food contamination and deterioration. Combinations of nanoparticles are used to create composite films known as nanocomposites. The nutritional and sensory qualities of the packaged goods may also be affected by the matrix's incorporation of specific substances.These nano coatings preserve the freshness of products, improving the antibacterial, mechanical, gas barrier, and antioxidant activity of the film.

Different combinations were used as follows:

(i) Alginate, TiO_2 nanoparticle and cumin essential oil

(ii) Cellulose nanofiber, whey protein isolate and titanium dioxide nanoparticles

(iii)Pullulan films, essential oils (EOs) (oregano oil or rosemary oil) and nanoparticles (AgNPs, ZnO NPs),

(iv) zinc nanoparticles, essential oil of ginger and tilapia skin gelatin

(v) curcumin-chitosan nanoparticles and potato starch

(vi) zinc nanoparticles, nanofiber of chitosan, gelatin and betanin nanoliposomes

Nanotechnology in biosensor

Quality and microbiological safety plays a significant role in the meat sector to raise the product value. In recent years nanotechnology is widely used to maintain the quality aspects of meat. These include the use of disinfectants with nanotechnology, protective gear, biosensors, air and water filters, packaging, surface biocides, and quick methods for contamination identification, as well as technologies that guarantee the authenticity and traceability of goods.

Foodborne infections and toxins are typically detected by the use of the nanomaterial's optical sensors or electrochemical sensors. Nanosensors have various favourable qualities, including low cost, high selectivity and sensitivity, near real-time detection and portability. The special features of nanoscale materials give many opportunities for sensing research. Numerous types of analytes relevant to the food industry, including foodborne pathogens, gases, biomolecules, vapours and organic molecules, have been detected and quantified using nanosensor technology.

Conclusion and Future prospects

Although there has been study on nanoparticles to enhance quality, there is still much to understand regarding toxicity. Before the recognition of characteristics of nanoparticles, more studies are necessary. Methodologies must be improved in order to evaluate and characterise the characteristics of the materials in order to understand their metabolic activation in food. Technology is not often employed due to its high cost, complexity of the sample and unavailability of significant numbers of experiments. More study is required to determine the hazards of nanoparticles; therefore, they are consumed as food or are exposed to it. Another problem that requires more research is the migration of nanoparticles from packaging material to the foods. Such issues should be evaluated in terms of research & development. Customers

are also reluctant to adopt foods which involve nanotechnology because there is no standard structure in place for their use in food. In summary, nanotechnology fosters inventions in product development, food testing, and maintaining shelf life. Moreover, the presence of toxicity is a major concern to health and their impact on surroundings may arise. Future efforts should be made to ensure that nanotechnology is used safely and effectively.