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Application of Nanoparticles In Ensuring Food Safety

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ABSTRACT

Recent innovations in nanotechnology have transformed a number of scientific and industrial areas including the food industry. Applications of nanotechnology have emerged with increasing need of nanoparticle uses in various fields of food science and food microbiology, including food processing, food packaging, functional food development, food safety, detection of foodborne pathogens, and shelf-life extension of food and/or food products. This review summarizes the potential of nanoparticles for their uses in the food industry in order to provide consumers a safe and contamination free food and to ensure the consumer acceptability of the food with enhanced functional properties.

Keywords : Nanomaterials, Nanosensors, Nanocomposites, Nanocoatings.

I. INTRODUCTION

Nanomaterials have been progressively integrated into food products since the late 1990s. Manufactured nanomaterials provide specific properties at the nanoscale – whether it be as an additive, a nutrient, or in packaging. However, the wide-scale use of manufactured nanomaterials – both in food and non-food products – has raised a number of questions and concerns, particularly surrounding their impact on human health and the environment, as well as how best to regulate them.

The ever-rising complaints of the consumer regarding food quality compel researchers to develop more technologies that ensure food safety without affecting the nutritional value of the product. Nanotechnology offers novel techniques that promise high-quality food, by checking food products at various levels such as food manufacturing, processing, and packaging.

II. APPLICATION OF NANOPARTICLES TO FOOD SAFETY

1. Nanosensors

Nanosensors are highly sensitive to food spoilage and can indicate small changes in food color or gases produced when the food is spoiled. For example, gold-based nanoparticles are used for the detection of aflatoxin B1 that is often found in milk. In agriculture, nanosensors are used to indicate pesticides present on the surface of vegetables and fruits. Some nanosensors can also identify carcinogens in food materials. In the field of food microbiology, nanosensors are effectively used to alert consumers and distributors on the safety status of food, as it can precisely indicate the presence of any pathogens in food material.

Nanosensors indicate minor changes in the storage environment (e.g. warehouses) such as humidity, temperature, and microbial contamination, which may cause product degradation. Many nanostructures (nanorods, nanoparticles, and nanofibers) are used as biosensors. However, carbon nanotube-based

biosensors have proved to be more efficient due to their rapid detection, simplicity, and cost-effectiveness.

2. Nanocomposites

A nanocomposite is ideally made up of a combination of nanoparticles with polymers. These nanocomposites help in maintaining the quality of food products, for example, in the case of carbonated drinks, it minimizes the carbon dioxide by acting as gas barriers. Such nanocomposites are utilized by the manufacturing industries in place of cans and glass bottles to layer their bottles and save on cost in the process. This also considerably improves the shelf life of the product.

3. Nanoparticles

In food processing industries, nanoparticles are used to enhance food stability and maintain food color. Silicate nanoparticles can restrain the flow of oxygen in packaging containers and restrict moisture leakage. This ensures the food remains fresh for a longer duration. Several nanoparticles can also selectively bind to pathogens, which can be removed altogether in the process.

Nanoparticles can inhibit biofilm formation. Biofilms are tightly packed bacterial cells that are attached to various substrates and form a barrier that inhibits any kind of penetration. In the food processing industries, these biofilms generate problems such as biofouling, biocorrosion, and accumulation. Glycerol monolaurate acts as an antimicrobial agent against many Gram-positive bacteria. This is used to inhibit the biofilm formation of three different strains of Staphylococcus aureus and MRSA. Organic compounds (essential oil) have antimicrobial properties and are highly sensitive to extreme physical conditions.

However, inorganic nanoparticles show strong antibacterial activity in low concentrations and are more stable in extreme conditions. Therefore, manufacturers have recently shown a great interest in using these nanoparticles in antimicrobial food packaging.

4. Nanoencapsulation

Bioactive compounds present in food often get degraded and ultimately inactivated in extreme environmental conditions. Nanoencapsulation of these bioactive constituents is essential because these bioactive compounds can enhance the shelf life of food products by reducing the process of degradation or by stopping the process of degradation until the product reaches the target site. For example, curcumin, the highly unstable bioactive compound of *Curcuma longa* (turmeric) is stable at different ionic strengths upon encapsulation.

5. Nanocoatings

Nanocoatings comprise uniform layers of nanoparticles of a 10–100 nm thickness. Researchers have recently developed a powerful nanocoating film that is able to detect minor contaminations during storage. The edible nanocoatings on various food materials could provide an obstruction to moisture and gaseous exchange and, therefore, maintain colors, flavors, enzymes, antioxidants, and anti-browning agents. The presence of oxygen inside the packaging can reduce the shelf life of the product because oxygen promotes microbial growth.

Nanocoatings could also enhance the shelf life of manufactured food products, even after the packaging is opened. For example, a nano-sized titanium dioxide (TiO_2) based photo-indicator is used as a detector that gradually changes color in response to minor changes in the quantity of oxygen.

III. CONCLUSION

In the last decade, nanotechnology has been greatly explored in the area of food technology, especially in

the food processing and packaging industry. Nanobiotechnology has provided various devices or technology that are small in size and highly sensitive. Although great progress has been made in the field of nanotechnology, various challenges and opportunities still exist. Issues regarding the toxic side effects of the use of nanomaterials in the food processing industry must be addressed to reduce consumer concerns.

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