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Nanotechnology in Food Industry

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INTRODUCTION

It is a nanometer-scale technology that works with atoms, molecules, and macromolecules with sizes ranging from 1-100 nm to make and use materials with unique features. The nanomaterials developed have one or more external dimensions, as well as an internal structure, on a size ranging from 1 to 100 nanometers, allowing for nanoscale observation and manipulation. Due to the high surface to volume ratio and other novel physiochemical features like colour, solubility, strength, diffusivity, toxicity, magnetic, optical, thermodynomics, and others, these materials are observed to have distinct qualities unlike their macroscale counterparts. The food industry has expanded its need for nanoparticle-based products because many of them include critical nutrients and have been found to be non-toxic. They've also been discovered to be stable under extreme temperatures and pressures. Food manufacture, processing, and packaging are all made possible by nanotechnology. Nanomaterials make a significant difference in food quality and safety, as well as the health advantages that food provides. Many organizations, researchers, and industries are coming up with novel techniques, methods, and products that have a direct application of nanotechnology in food science.

Nanotechnology in Food Processing

Food pollutants, mycotoxins, and microbes can all be detected with nanosensors. Nanoencapsulations can be used to mask odours or tastes, control interactions of active ingredients with the food matrix, control the release of active ingredients, ensure availability at a specific time and rate, protect them from moisture, heat, and degradation during processing, storage, and use, and have chemical or biological compatibility with other compounds in the system.

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Furthermore, due to their tiny size, these delivery methods can penetrate deeply into tissues, allowing for efficient administration of active chemicals to specified areas throughout the body. Furthermore, the usefulness of nanotechnology in food processing can be assessed by looking at its impact on I food texture, (ii) food appearance, (iii) food flavour, (iv) food nutritional value, and (v) food shelf life.

Nanoencapsulation

Nanoencapsulation-encapsulation in the submicron range, has the potential to protect sensitive bioactive food ingredients from unfavourable environmental conditions, reduce incompatibilities, improve solubilization, mask taste and odour, and improve bioavailability of poorly absorbable function ingredients. Human health can be improved by nanoencapsulation technology. The benefits of using nanoparticulate formulations for food and taste ingredient encapsulation include increased solubility, which leads to enhanced bioavailability, improved shelf stability, and controlled release of actives.

Nutritional Value

Nanomaterials are utilised as components and additives in nutrients and health supplements to improve absorption and bioavailability (e.g., vitamins, antimicrobials, antioxidants). The bulk of bioactive molecules, such as lipids, proteins, carbohydrates, and vitamins, are sensitive to the stomach and duodenum's acidic environment and enzyme activity. Encapsulation of these bioactive compounds not only allows them to withstand such harsh circumstances, but it also allows them to easily absorb into food products, which is difficult to achieve in non-capsulated form due to their low water solubility.

Food storage

In functional foods, where bioactive components are frequently degraded and inactivated as a result of the hostile environment, nanoencapsulation of these bioactive components extends the shelf-life of food products by slowing or preventing degradation until the product is delivered to the target site. Furthermore, edible nano-coatings on various food components could operate as a moisture and gas barrier while also delivering colours, flavours, antioxidants, enzymes, and anti-browning agents, extending the shelf life of manufactured meals even after the packaging is opened. By manipulating the features of the interfacial layer surrounding them, encapsulating functional components within droplets can typically slow down chemical breakdown processes. For example, curcumin the most active and least stable bioactive component of turmeric (Curcuma longa) showed reduced antioxidant activity and found to be stable to pasteurization and at different ionic strength upon encapsulation.

Food Nanosensors

Nanomaterials are utilised to detect pollution and regulate the food environment as sensors. They can detect microbial contamination as well as other food pollutants. As a result, they're used as sensors in the food and packaging industries. They can keep an eye on food while it's being transported and stored. They can identify nutrient deficiencies in food plants and give nutrients to them as needed. As a result, nanoparticles have virtually limitless potential in the food sector as nanosensors and nanotracers. The nanosensor acts as an indication, reacting to changes in environmental parameters such as storage room humidity or temperature, microbial contamination, or product degradation. Various nanostructures, such as thin films, nanorods, nanoparticles, and nanofibers, have been investigated for biosensor applications. Rapid and very sensitive detection devices have resulted from thin film-based optical immunosensors for detection of microbial chemicals or cells. Specific antibodies, antigens, or protein molecules are immobilised on thin nano-films or sensor chips in these

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immunosensors, which generate signals when target molecules are detected. For quick detection of food borne pathogens, a dimethylsiloxane microfluidic immunosensor with particular antibody bound on an alumina nanoporousmembrane was created. Electrochemical impedance spectrum of Escherichia coli and Staphylococcus aureus Nanotechnology can also help with pesticide detection.

Nanotechnology on Preservation

Nanoencapsulation of bioactive components enhances the shelf-life of food products by slowing or preventing degradation until the product is delivered to the target site in functional foods where bioactive components are frequently degraded and eventually inactivated due to the hostile environment. Furthermore, edible nano-coatings on various food components could operate as a moisture and gas barrier while also delivering colours, flavours, antioxidants, enzymes, and anti-browning agents, extending the shelf life of manufactured meals even after the packaging is opened. By manipulating the features of the interfacial layer surrounding them, encapsulating functional components within droplets can typically slow down chemical breakdown processes.

CONCLUSION

The usage of nanometer-scale structures in the food industry has grown in popularity in recent years, resulting in a surge in interest and activity in this study area. As nanobiotechnology advances, nanobiotechnology-based devices and materials grow smaller and more sensitive. Its use in the fields of food packaging and food safety is well established. Furthermore, promising findings have been obtained in the field of food preservation utilising nanomaterials, which may preserve food from moisture, lipids, gases, off-flavors, and aromas. They provide effective delivery mechanisms for bioactive chemicals to target tissues. Although nanotechnology breakthroughs are creating new routes every day, there are still numerous problems and chances to improve present technology, as well as issues surrounding nanotechnology's implications that must be addressed in order to assuage customer concerns. When dealing with the growth of nanotechnology in food systems, transparency, safety, and environmental effect should be prioritised, and hence mandatory testing of nano foods is essential before they are given to the market.