Chapter 45
Nanotechnology in the Food Industry

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ABSTRACT

This chapter addresses the potential application of nanotechnology in various areas of the food industry. Nanotechnology is having an impact on several aspects of the food industry, from product development to packaging processes. Nanotechnology is capable of solving the very complex set of engineering and scientific challenges in the food processing industries. This chapter focuses on exploring the role of nanotechnology in enhancing food stability at the various stages of processing. Research has highlighted the prospective role of nanotechnology use in the food sector, including nanoencapsulation, nanopackaging, nanoemulsions, nanonutraceuticals, and nanoadditives. Industries are developing nanomaterials that will make a difference not only in the taste of food but also in food safety and the health benefits that food delivers. While proposed applications of nanotechnologies are wide and varied, developments are met with some caution as progress may be stifled by lack of governance and potential risks.

INTRODUCTION

Nanotechnology offers much promise to food science. Food nanotechnology includes a range of potential applications, including alterations to the properties of foods (e.g., nano-additives and nano-ingredients), improvements to the delivery, quality, and safety of food; and the development of enhanced food packaging (i.e., food contact materials). For example, scientists are creating food packages that contain nano-sized particles devised to warn consumers that a food product is unsafe to eat, and are inventing nanoencapsulated materials that can distribute nutrients to human cells. The food industry has been researching how nanoscience can be used to improve food since 1999, and there are signs that the research and development of food nanotechnologies is likely to grow quickly in the coming years. Nanotechnology is expected to influence numerous areas of food science in ways that will benefit both the food industry

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and consumers. For example, nanotechnology is being used to improve the quality and safety of food. Nano sensors are being developed that can detect and signal the presence of spoilage microorganisms, and potentially even differentiate the presence of pathogenic from benign microorganisms. Nanotechnology is also being used to create healthier foods that can deliver nutrients and medications to different parts of the human body and can alleviate allergenic.

The food and beverage sector is a global multi trillion dollar industry. The major food industries and companies are consistently looking for ways to improve production efficiency, food safety and food characteristics. Extensive research and development projects are ongoing with the ultimate goal of gaining competitive advantage and market share. For an industry where competition is intense and innovation is vital, nanotechnologies have emerged as a potential aid to advances in the production of improved quality food with functionalised properties. Advances in areas such as electronics, computing, data storage, communication and the growing use of integrated devices are likely to indirectly impact the food industry in the areas of food safety, authenticity and waste reduction.

Nanotechnologies involve the manipulation of matter at a very small scale generally between 1 and 100 nanometres. They exploit novel properties and functions that occur in matter at this scale. Nanomaterials and nanoparticles may include any of the following nano forms: nanoparticles, nanotubes, fullerenes, nanofibres, nanowhiskers, nanosheets. A nanoparticle is defined as a discrete entity that has three dimensions of the order of 100 nm or less. A nanomaterial is defined as an "insoluble or biopersistent and intentionally manufactured material with one or more external dimensions, or an internal structure, on the scale from 1 to 100 nanometres. Nanotubes have a cylindrical lattice arrangement of material; fullerenes have a spherical molecular arrangement; and nanofibres have a length to diameter ratio of at least and are in the nano range. Nanowhiskers are fine fibres in the nano range; they are 5-20 nm in cross-section with lengths of several micrometres. Nanosheets are an arrangement of material where only one dimension is in the nano range. Many of these different nano forms are either in use or under investigation for use within the food industry.

Many common elements and compounds behave differently at the molecular and atomic scales of nanotechnology than they do at larger particle sizes. When discussing properties which change with decreasing size, it is important to distinguish between properties that change smoothly over a series of size reductions and properties that change abruptly below a certain critical size. The abrupt change of properties below a certain size is the key novelty of nanotechnologies. This critical size depends on the property in question and on the material, hence the difficulty with defining an upper size range. Although there are many benefits of these technologies there is also concern over potential negative effects. In the case of particulate nanomaterials coming into contact with the human body by design or by accident, for example, the reduction in particle size associated with nanotechnologies potentially reduces the effectiveness of barriers to the penetration of foreign materials into the human body and to their movement within the body. There is growing concern that the use of nanomaterials in the food industry could result in particulate nanomaterials gaining access to tissues in the human body, resulting in accumulation of toxic contaminants and therefore adversely affecting human health. Many new consumer products containing nanoparticles have been launched to the market and are beginning to impact on the food associated industries. Nanotechnologies are set to impact on the food industry at all stages of production from primary production at farming level, due to advances in pesticide efficacy and delivery (novel formulations and better crop adherence), to processing where emulsion creation and encapsulation have progressed to the nanoscale.