International Food Safety Authorities Network (INFOSAN)

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INFOSAN Information Note No. 01/2008 - Nanotechnology

Nanotechnology

SUMMARY NOTES

- Nanotechnology concerns materials that are generally 1 to 300 nanometres in size (one nanometre is 10^{-9} of a metre).
- Nanotechnology is being developed for use in the food industry from farm to table and is already being used in food packaging applications.
- As for all new materials used in food and food processing, the potential health and environmental risks of nanoscale materials need to be assessed before they are introduced into food.
- Benefits and risks of nanotechnology need to be well understood and openly discussed among all stakeholders, including industry, regulators and consumers.
- A strategy for communicating about the introduction of nanotechnology by the food industry needs to be developed and implemented.

Nanotechnology
Nanotechnology can be described as the design, production and application of structures, devices, systems and materials by controlling the size and shape of materials at the atomic and molecular scales. Most applications are generally dealing with structures <300 nm in size. A nanometre (nm) is one thousand millionth of a metre (10^{-9} of a metre). The diameter of a single human hair is about 80 000 nm, that of a red blood cell approximately 7000 nm, that of a DNA molecule 2 to 2.5 nm, and that of a water molecule almost 0.3 nm. The interest in nanotechnology lies in the fact that the small size results in physical and chemical properties that differ significantly from those at larger scale. Differences in definitions about what constitutes nanotechnology have led to some confusion about the technology and an official definition has not yet been established by Codex.

Applications of nanotechnology in the food industry
Nanotechnology will have a major impact on consumers' lives as is reflected in the increasing availability of nanoproducts through the internet. Food industry experts predict that nanotechnology will also have a significant impact on food products in a variety of ways both directly and indirectly. Most foodstuffs contain natural particles in the nanoscale range. For example, proteins are generally globular structures 1-10 nm in size. The majority of polysaccharides (carbohydrates) and lipids (fats) are linear polymers with thicknesses less than nanometres in size. The functional properties of many raw materials and the successful processing of food materials are due to the presence, modification or generation of self-assembled nanostructures. Particular examples of such nanostructures include the planer assemblies of cellulose fibrils in plant cell walls, the crystalline structures in starch and processed starch-based foods that determine gelatinisation and influence the nutritional benefits of starch-based foods during digestion, the fibrous structures that control the melting, setting and texture of gels, and the nanostructure (micelles), which are generated at oil-water or air-water interfaces and control the stability of food foams and emulsions. Better understanding of the nature of nanostructures in foods will allow for better rational selection modification and processing of raw materials. Therefore, the application of nanotechnology is likely to contribute to continued improvements in food quality and safety.

A perusal of the products available or under development suggests that a major growth area will be in the development of new formulations of food additives. The general approach is to develop nano-size carriers or materials in order to improve the function of food additives. The properties of nanoparticles also make them attractive for improving absorption and bioavailability of added nutritive substances, such as vitamins, nutrients and minerals.

A further example of the use of nanotechnology in the food industry is in the area of food contact materials. Nanocomposite materials are already available as packaging or as coatings on plastic containers to control gas diffusion and prolong the shelf life. Nanotechnology-based products are increasingly being used to produce antimicrobial food contact materials commercially available as packaging or as coatings. Current research on such 'smart' surfaces is aimed at the development of surfaces that can detect bacterial contamination and react against bacterial growth.

There are also examples of the indirect application of nanotechnology that have implications for the food industry. Silicon chips have been made using nanotechnology for over 20 years and nano-enabled sensors, which can detect chemical and biological contaminants, could reasonably be expected to have a substantial impact on food safety and quality. In addition, the use of nanoscale filters in water and in environmental remediation could have implications for food safety, particularly in developing countries... Advances in labelling technology, are also expected to offer new ways to store, display and interrogate information on packaging. For example, these types of advances might allow individuals to access more information on the source, history and storage of specific foods, their nutritional characteristics and their suitability to the genetic makeup and life-style of individual consumers.

Regulatory approaches to nanotechnology in the food industry

Many regulatory authorities are presently evaluating whether their traditional framework of regulation and approval of food ingredients to ensure safety fully encompasses the use of nanotechnology in food and food-contact materials. It is likely that the approach will vary from country to country but the evaluation of nanoparticles would presumably follow similar safety evaluation pathways to those used for other materials proposed for use in foods or food contact materials. Most scientific committees that have reviewed the initial applications of nanotechnology conclude that while consumers are likely to benefit from this technology, new data and new measurement approaches may be needed to ensure that the safety of products using nanotechnology are properly assessed. For example, certain nanoparticles possess the ability to cross the blood-brain barrier and can serve as carriers for other molecules. Information on the bioaccumulation and potential toxic effects of inhalation and/or ingestion of free engineered nanoparticles and their long-term implications for public health is needed. Nanoscale materials may also present new challenges in relation to exposure assessment, including measurement of nanoparticles in the body and in complex food matrices.

Food additives: In the past, approval systems for food additives have not generally taken into consideration the particle size of the additive. For nanoparticles, this is obviously an important aspect since nanoparticles may be handled differently in the body than their previously approved, macro counterparts. Future food regulations may therefore need to be more specific in relation to such issues. In 2007, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) affirmed that neither the specifications nor the ADIs for food additives that have been evaluated in other forms are intended to apply to nanoparticulate materials. These considerations have led food companies to focus attention on pre-market approval, traceability and other regulatory aspects related to the risk management of these materials.

Food contact materials: There are various nanotechnology components approved for use in food contact materials. The particular types of materials and their conditions of use vary among the different countries. However, as with any new food contact material it is important to assess the potential release of nanoscaleparticles into food products and, if exposure is anticipated, the safety of those particles with respect to human health needs to be assessed. The environmental consequences associated with the ultimate disposal of these materials also need to be evaluated carefully.

References and additional information

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INFOSAN serves as a vehicle for food safety authorities and other relevant agencies to exchange food safety information and to improve collaboration among food safety authorities at both the national and international level.

INFOSAN Emergency, embedded in INFOSAN, links official national contact points to address outbreaks and emergencies of international importance and allows for the rapid exchange of information. INFOSAN Emergency is intended to complement and support the existing WHO Global Outbreak Alert and Response Network (GOARN).

INFOSAN is operated/managed by WHO, Geneva. It currently includes 166 Member States.

More information is available at: www.who.int/foodsafety