**COLLEGE OF AGRICULTURAL ENGINEERINGJNKVV JABALPUR**

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**Course : DAIRY AND FOOD ENGINEERING**

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## Reading Material for iv year Part 3 Nanotechnology

## International concerns about Nanotechnology year 2009 and a few glossary terms

## Background

**1**. Governments, industry and science have identified the potential of nanotechnology in the food and agriculture sectors and are investing significantly in its application to food production. However, owing to limited knowledge of the effects of these applications on human health, the need for early consideration of the food safety implications of the technology is recognized by stakeholders.

2. In response to this accelerating development, **FAO and WHO** convened an **Expert Meeting** on **the "application of nanotechnologies in the food and agriculture sectors: potential food safety implications**" in order to identify further work that may be required to address the issue at global level.

3. **Seventeen experts** from relevant disciplines, **such as food technology, toxicology and communication, met at FAO headquarters on 1–5 June 2009** and focused in working groups and during plenary sessions on three main areas: **the use of nanotechnology in food production and processing; the potential human health risks associated with this use; the elements of transparent and constructive dialogues on nanotechnology among stakeholders.**

**Use of nanotechnology**

4. Nanotechnology offers considerable opportunities for the development of innovative products and applications for agriculture, water treatment, food production, processing, preservation and packaging, and its use may bring potential benefits to farmers, food industry and consumers alike.

5. Nanotechnology-based food and health food products, and food packaging materials, are available to consumers in some countries already and additional products and applications are currently in the research and development stage, and some may reach the market soon. In view of such progress, it is expected that nanotechnology-derived food products will be increasingly available to consumers worldwide in the coming years. Executive summary On the application of nanotechnologies in the food and agriculture sectors: potential food safety implications xviii Executive summary

6. Materials that are produced intentionally with structural features at a nanoscale range (between 1 and 100 nm) may have different properties when compared with their conventional counterparts. They will be employed in a variety of applications e.g. in food packaging materials where they will prevent microbial spoilage of food, as food additives modifying for example a food's texture and taste, in nutrients (e.g. vitamins) leading to increased bioavailability, and in agrochemicals where, for example, they will provide novel routes to deliver pesticides to plants. The impact on human health will depend on whether and how the consumer is exposed to such materials eventually, and whether these materials will behave differently compared to their conventional, larger dimensioned, counterparts.

7. The Expert Meeting recognized the need to agree on clear and internationally harmonized definitions related to the application of nanotechnologies to the food chain, and to develop a procedure for classifying nanostructures that would assist risk managers. At the international level, possible gaps in the food standard setting procedures as applied by the Codex Alimentarius Commission need to be identified and addressed.

## Assessment of human health risks

8. The Expert Meeting acknowledged that the current risk assessment approaches used by FAO/WHO and Codex are suitable for engineered nanomaterials used in food and agriculture and emphasized that additional safety concerns may arise owing to the characteristic properties of nanomaterials, which need to be addressed.

9. As the size of the particles decreases, the specific surface area increases in a manner that is inversely, and non linearly proportional to size, until the properties of the surface molecules dominate. This results in novel features that are determined by the high surface-to-volume ratio, which may also give rise to altered toxicity profiles. This very high surface area of engineered nanomaterials has consequences that need to be considered in their risk assessment, because it makes them different from their micro/macroscale counterparts.

10. As a result of their specific physicochemical properties, it is to be expected that nanoparticles may interact with other substances present in foods, such as proteins, lipids, carbohydrates and nucleic acids. Therefore, it is important that the effects and interactions of engineered nanomaterials are characterized in the relevant food matrix.

11. It is also important to consider life cycle aspects in the risk assessment of engineered nanomaterials, for example to analyse their fate in the environment, which may result in indirect human exposure to substances not used intentionally on food products.

12. The experts agreed that FAO/WHO should continue to review its risk assessment strategies, in particular through the use of tiered approaches, in order to address the On the application of nanotechnologies in the food and agriculture sectors: potential food safety implications xix Executive summary specific emerging issues associated with the application of nanotechnologies in the food chain. A tiered approach might enable the prioritization of types or classes of materials for which additional data are likely to be necessary to reduce uncertainties in the risk assessment.

13. The experts recommended that FAO/WHO should encourage the innovative and interdisciplinary research that may lead to novel risk assessment strategies for the application of nanotechnologies in food (inclusive of water) and feed, while maintaining or improving the current level of protection. It was also agreed that the development of validated testing methods and guidance would help to address specific data gaps.

**Stakeholder confidence and dialogue**

14. The Expert Meeting analysed the general requirements for the engagement of stakeholders, which is acknowledged as imperative for any emerging or controversial issue in the area of food safety. The introduction of nanotechnology into foods and the ongoing corresponding discussion were considered with respect to the main interest groups that have been engaged so far, as were the initiatives for dialogues that have been started by governments, think tanks and international organizations.

15. It is understood that it will be critical to the success of a research strategy for nanomaterials to address the key interests, priorities, and concerns of stakeholders and ensure that pathways and potential risks are addressed by sponsored research.

16. The experts recognized that consumer attitudes towards the application of nanotechnology in food and agriculture are complex: they want to understand the potential risks and benefits of nanotechnology and they want clear tangible benefits. Without obvious benefits, consumers are unlikely to have positive impressions of nanotechnology-enhanced food products.

17. As a common denominator across nearly all advocacy groups, the experts identified the request for a discussion to determine the necessity of policy interventions on the introduction of nano-engineered particles and processes into commercial products for as long as the potential safety threats cannot be measured and evaluated adequately. Nearly all have expressed a desire for industry and governments to implement measures to protect the health and safety of workers and the public from the

consequences of the unregulated release of commercial nanoproducts into the environment.

18. Greater access of scientists to the public debate, where their evidence and expert arguments can be shared, would support informed public debate and assist the public in forming their own conclusions once they have heard a rich mix of competent voices.

19. The meeting proposed that FAO/WHO should provide a forum for continued international dialogue to develop strategies to address stakeholder issues surrounding the development of nanotechnologies in food and agriculture. On the application of nanotechnologies in the food and agriculture sectors: potential food safety implications xx Executive summary

20. FAO/WHO should encourage Member Countries to engage the public on applications of nanoscience and the nanotechnologies in food and agriculture. In support of this engagement, FAO/WHO should provide guidance, training, and capacity building resources for governments to engage stakeholders. FAO/WHO should also review the existing FAO/WHO food safety risk analysis framework in light of other analytical deliberative frameworks, in particular with regard to engaging stakeholders.

21. In recognition of its importance for the building of trust, the experts proposed that FAO/WHO identify mechanisms to support the need for transparency and traceability of nano-enabled products or engineered nanomaterials in food and agriculture and their associated risks. The importance of communication and cooperation with other inter-governmental organizations was stressed

## Definitions

Definitions for nanotechnologies adopted for the purposes of the FAO/WHO Expert Meeting on Nanotechnology Applications for Food and Agriculture

| Terms | Definition |
|---|---|
| **Agglomerate** | Collection of weakly bound particles or aggregates or mixtures of the two where the resulting external surface area is similar to the sum of the surface areas of the individual components. A group of particles (also termed secondary particles) held together by weak forces such as van der Waals forces, some electrostatic forces and/or surface tension. |
| **Aggregate** | Particle comprising strongly bonded or fused particles where the resulting external surface area may be significantly smaller than the sum of calculated surface areas of the individual components. A group of particles (also termed secondary particles) held together by strong forces such as those associated with covalent bonds, or those resulting from sintering or complex physical entanglement. |
| **Aspect ratio** | A ratio describing the primary dimension over the secondary dimension(s). |
| **Coalescence** | The formation of a new homogeneous entity out of two initial entities, e.g. after the collision of two nanoparticles or nanostructures. Degradation A breakdown in the physicochemical structure and/or organoleptic characteristics of a material. |
| **Engineered nanomaterial** | Any material that is intentionally produced in the nanoscale to have specific (also known as manufactured properties or a specific composition. nanomaterials) (Continued) On the application of nanotechnologies in the food and agriculture sectors: potential food safety implications |
| **Nanocarrier** | A nanoscale structure whose purpose is to carry and deliver other (or nanocapsule) substance(s) |
| **Nanocomposite** | A multi-phase material in which the majority of the dispersed phase components are nanomaterials(s). |

**Nanocrystalline material** A material that is comprised of many crystals, the majority of which are in the nanoscale.

**Nanomaterial** Any form of a material that has one or more dimensions in the nanoscale. **Nanoparticle** A discrete entity that has all three dimensions in the nanoscale.

**Nanorod (nanofibre**, Materials shaped into rods, fibres, wires, whiskers, etc that have at least two nanowire, nanowhisker) dimensions in the nanoscale.

**Nanoscale** Size dimensions typically between approximately 1 and 100 nm. This is the size range where material properties are more likely to change from bulk equivalents. The actual size range will depend on the functional properties under consideration.

**Nanosheet** Nano-object with one external dimension in the nanoscale.

**Nanostructure** Any structure that is composed of discrete functional parts, either internally or at the surface, of which one or more are in the nanoscale. Often used in a similar manner to ‘nanomaterial’.

**Nanotube** A discrete hollow fibre entity, which has two dimensions in the nanoscale.

**Biopersistent** A substance that has been absorbed but is not readily broken down or excreted.