House of Lords Science & Technology Select Committee Call for Evidence: Nanotechnologies & Food

Corporate Evidence from the Institute of Food Research, Norwich

Summary

The UK has played a leading role in the understanding of the functionality of foods at the molecular level. The major barrier to the use of knowledge to rationally manipulate natural nanostructures in foods to design novel 'functional' foods is the technological challenges of producing acceptable commercial products, clearing them as novel foods and substantiating health claims for such products. For manufactured nanoparticles based on materials that are metabolised within the body, there is a need to establish whether the nanostructures adversely affect metabolism and to demonstrate benefits from improved bioavailability. In the case of products that could lead to deliberate or incidental ingestion of non-metabolisable nanoparticles there are major barriers concerned with lack of knowledge on release, uptake, retention within the body and potential toxicity, which make assessment of risk and safety difficult at present. It is important that the initial products that emerge have tangible benefits.

If food-approved materials are to be adequately labelled then there may need to be a basis for discriminating between the native material and the nanoform. Current regulations within the UK and EU would be adequate for controlling future nanoproducts related to food or food contact materials produced or sold within the UK or EU. However, without agreed standards worldwide, regulation of imported products, either at a national or personal level may become increasingly difficult.

Nanotechnology will impact the whole food chain and there needs to be coordination between government bodies and funding agencies on research.

State of the science and its current use in the food sector

1. Nanotechnology offers potential solutions to excessive food waste through improved protection against food spoilage and improved shelf-life on storage; improved microbial safety of food products through anti-microbial packaging and food contact materials; improved authenticity and security through smart packaging and radio frequency identification technology; the development of novel functional foods with enhanced nutritional value; the design of foods to combat problems such as obesity and associated long-term chronic disease, to promote good health and protect against disease - with the potential to tailor such systems to personal needs (genetic pre-dispositions) and lifestyle.

2. If nanoscience of foods is understood to mean an understanding of the functionality of foods at the molecular level then the UK has played a leading role in this area particularly through work at the Unilever Research Laboratories, the University of Leeds, the University of

Nottingham and IFR. The use of nanoscience tools such as probe microscopy has enhanced this understanding. The current need to design foods to combat obesity and associated diseases is building on this knowledge to rationally manipulate naturally occurring nanomaterials and nanostructures in foods to tackle these problems. To our knowledge there are no food-approved food products in the UK which contain added nanoparticles. Such products are available world-wide and appear to be mainly targeted to additives that improve the nutritional properties of foods (nanoceuticals) or applications designed to enhance food safety through use of anti-microbial coatings (usually nanosilver) on packaging, containers, surfaces or devices such as refrigerators, utensils etc. Some of the anti-microbial products may be available within the UK.

3. We believe that functional foods designed to improve the bioavailability of nutrients could be on the market almost immediately, subject to regulatory approval and public acceptance. The 'next generation', foods designed to combat problems such as obesity could be available within 5 years and in the longer term there are opportunities to design foods to provide targeted protection against chronic disease and to promote good health through into old age.

4. The UK has played a leading role world-wide in developing a nanoscience understanding of food structure and materials which can underpin the development and design of novel foods. There are relevant studies on the uptake and toxicology of nanoparticles that can be of relevance to the food sector. However, there is restricted research on the ingestion of nanoparticles within a food matrix which will influence uptake and retention within the body. Although there is funding for research on the release of nanoparticles from surfaces into the environment and the consequences of their anti-microbial action, there is less opportunity to fund research on the consequences of release and uptake within foods and effects on natural human microbial flora.

5. The major barrier to the use of knowledge to rationally manipulate natural nanostructures in foods to design novel 'functional' foods is the technological challenges of producing acceptable commercial products, clearing them as novel foods and substantiating health claims for such products. Additional barriers to the use of foods or food contact materials containing manufactured nanoparticles would depend on the nature of the nanoparticles concerned. For nanoparticles based on materials that are metabolised within the body there would be a need to establish whether the nanostructures adversely affects metabolism and to demonstrate benefits from improved bioavailability. In the case of products that could lead to deliberate or incidental ingestion of non-metabolisable nanoparticles there are major barriers concerned with lack of knowledge on release, uptake, retention within the body and potential toxicity, which make assessment of risk and safety difficult at present. Such products would be perceived as 'nanofoods' and public perception with respect to benefits and risks could be a barrier to their use and development.

Health and safety

6. Scientific knowledge related to the rational manipulation of naturally occurring nanostructures, or the use of metabolisable nanocarriers for encapsulation, is sufficiently advanced to assess the risks and safety of novel foods based on such technology. There is a gap in knowledge on the ingestion of non-metabolisable nanoparticles from complex food matrices and the consequences of such ingestion on uptake, storage and the long-term potential risks due to such accumulation within the body. There is a need for specialised, directed research on the interplay between food matrices and nanoparticles, both in terms of the release and uptake of the nanoparticles themselves, and also of the consequences of the adsorption of biologically-active materials released from food, such as peptides, oligosaccharides, etc, and their subsequent uptake and transport within the body. Generic information on the role and mechanisms of the action of nanoparticles as anti-microbials for aerobic microorganisms may not be of relevance to the behaviour of the anaerobic populations of microorganisms within the gut.

7. We believe that the distinction between environmental and food-related issues mean that there is a disproportionate level of funding in the environmental area. Nanotechnology will impact the whole food chain and there needs to be coordination between government bodies and funding agencies on research. For example the use of nanotechnology in the delivery of pesticides, insecticides, fertilisers and nutrients requires information on both their inhalation, and on ingestion through contamination of foods, in order to evaluate their safety and application. It is a food as well as an environmental issue and the research should be coordinated, although funded through different sources. Similarly the release of nanoparticles from packages or containers is a food issue related to uptake and acceptable daily intake values, particularly for edible coatings, but also an environmental issue related to disposal of coated raw materials and packaging, particularly for biodisposable packaging. Such research needs to be coordinated and may be very important in ultimately influencing consumer reactions to nanotechnology and food.

8. We believe that current risk assessment frameworks within the food sector are adequate: it is a lack of knowledge in some areas rather than a lack of adequate procedures.

9. We believe that the naturally occurring nanoparticles in foods such as proteins, carbohydrates or fats are safe because they have undergone stringent testing and assessment appropriate to the materials. Some plant proteins are NOT inherently safe - materials such as ricin and certain allergens are potentially very dangerous, but adequate procedures are in place for risk assessment and clearance of novel foods. For nanoceuticals based on metabolisable materials there may be

additional risks associated with enhanced bioavailability and overconsumption, rather than optimum consumption of nutrients or additives, and also potential consequences of changes in the sites of metabolism and nature of the metabolic products. For non-metabolisable nanoparticles the risks are currently indeterminate because of the lack of adequate information on uptake, storage and long-term potential toxicity.

Regulatory framework

10. The current regulatory framework is basically fit for purpose, certainly with regard to the safety of foods, based on the onus within European law on producers to ensure that food and food contact materials are safe. Hence they are liable to ensure adequate clearance of foods or food contact materials based on nanotechnology through the appropriate regulatory bodies. However, there are concerns which may influence public perception regarding regulations on the labelling of foods and food contact materials. If food-approved materials are to be adequately labelled then there may need to be a basis for discriminating between the native material and the nanoform, possibly through modified E numbers, where there are differences in safety aspects and ADIs for the two materials. Currently there would appear to be no requirement to label food contact materials as containing nanoparticles. This may have an adverse affect on consumers who may feel that they are being denied information and choice even where the concerns are largely with disposal rather than the safety of the product in a food context. A major problem with imported materials is that 'Nano®' is used as brand name and has no meaning in terms of the health and safety claims for the product. In addition the use of the term Nano is voluntary and products containing nanomaterials may not be labelled. This makes assessment of products at a personal and national level difficult particularly because the countries of origin for the products may have very different criteria for assessment. It would be better if there was universal agreement on standards and a branding that signified quality and safety.

11. Although there are published codes of practice it is difficult to assess how well they are followed. A general observation might be that voluntary self-regulation is often open to abuse. In this case one bad product could easily lead to a strong public backlash against nanotechnology in food, particularly if consumers felt they were being misled, deceived or exploited.

12. Current regulations within the UK and EU would be adequate for controlling future nanoproducts related to food or food contact materials produced or sold within the UK or EU. However, without agreed standards worldwide it is possible that regulation of imported products, either at a national or personal level may become increasingly difficult. For example, in terms of imports there could be potential problems with novel applications such as edible coatings on fruits and vegetables: if such coatings containing nanoparticles were made and used on

imported materials to reduce microbial spoilage then it is difficult to see how this could be detected or regulated.

13. IFR's understanding is that there is inter-Government co-operation within the EU and exchange of information between certain Governments. The lack of agreed standards is a major problem with potential imports and for individual consumers purchasing materials through the internet. The main lesson to be learned from the different regulatory systems world-wide is the need for such systems to be timely and correct, thus not stifling commercial development of products, but equally not inflaming public disquiet or mistrust about nanotechnology.

Public engagement and consumer information

14. Purely from involvement with workshops and meetings concerned with nanotechnology and food, IFR's impression is that there is a general awareness of nanotechnology and an awareness of its potential use in food. A general question asked seems to be 'are nanotechnology applications in food safe?' The difficulty is that such a generic question is difficult to answer because the risks and safety aspects depend on the product or application and need to be assessed for individual cases. The answer that there are procedures in place to ensure the safety of the use of nanotechnology in the food area in the UK is not entirely convincing because there does appear to be an underlying mistrust of the Government and industry in issues of this type.

15. Having taken part in public engagement activity we believe that Government, certain industries and stakeholders have made good efforts to engage and inform the public about nanotechnology and food. However, the coverage in the media, with notable exceptions, is often negative, less balanced or informative, but probably reaches a wider audience. Wider publicity could be given to the general problems that face the food and agricultural industries which could be tackled using nanotechnology.

16. The most interesting lessons that can be learned from other technologies are from what happened in the initial debate on the use of GM technology. The public wishes to have the right to choose based on information on benefits and risks. It is important that the initial products that emerge have tangible benefits, and are not trivial or seen to have shallow commercial benefits for a restricted group of multinationals.

17. The ability to exercise choice is very important to the public and raises the issue of labelling. Many applications of nanoscience or nanotechnology in food need not be labelled or called nanofoods. However, there are some areas where labelling could be important. Where approved food ingredients or additives have been reduced in size to alter and improve their function, and there are differences in the safety data and recommended intake levels, then there is a need to discriminate between the two forms in the use of labelling. Use of

conventional E numbers or named materials may not be sufficient on labels if safety data and ADIs are different for the two forms. The use of nanoparticles in foods or food contact materials which are not metabolised in the body should require labelling to allow consumers to exercise choice in the purchase and use of these materials. Even if the food contact products are shown not to contaminate foods and the foods to be safe on ingestion then consumers may have concerns relating to the disposal of waste material such as packaging and the consequent environmental effects.

Other aspects

18. Although touched upon in some of the answers to some of the above questions we believe that there are wider issues that affect the use of nanotechnology related to food and that these issues are also important to the public perception of the use of nanotechnology in the food sector.

19. Nanotechnology will impact across the whole food chain. 'Smart' farms and 'smart' delivery systems offer routes to improving agricultural yields, responding to local climatic variations and reducing the use of pesticides, insecticides and fertilisers. Selective and targeted use of chemicals, through sensing environmental variations locally, or sensing chemical signals related to pests, or plant wound responses, offer routes to reduced use of chemicals in farming. Some of the advantages of nanoencapsulation and delivery could be offset by problems related to contamination of crops, soils and streams, or problems associated with the detection of contaminants on food materials, possible new routes of uptake, distribution and bioaccumulation within the body, and the subsequent long-term effects of such accumulation Thus it is not just the advantages to agricultural production weighed against environmental factors that need to be considered but also the downstream effects in the food sector. Given that funding is these areas is often through different agencies there is a need to ensure adequate and co-ordinated funding covering all aspects.

20. Another aspect that will impact on the food sector, but not directly related to food or food contact materials, is the use of GPS and RFI technologies in the tracking of food and food materials from source through transport and storage to shops and distribution centres. Coupled with smart packaging this could improve authentication of foods, inhibit or allow more rapid identification of food contamination or adulteration, and reduce waste.

21. At the far end of the chain there is the ultimate disposal of waste material. This raises questions about the fate of packaging and food contact material containing manufactured nanoparticles, particularly if such technology is used in conjunction with biodisposable packaging. The containment of anti-microbial nanoparticles within matrices may answer the questions raised about accidental release of these particles

into foods. However, the question remains as to the fate of these nanoparticles on disposal of these food contact materials and the consequences for the environment. The contamination of rivers or streams could ultimately lead to the re-introduction of these materials back into the food chain but in a different, perhaps more easily ingested form. Again, different agencies deal with the funding of research and with the regulation of food and environmental issues. Different agencies can be reactive or proactive in their approaches and this can lead to disproportionate levels of funding, gaps in knowledge and different approaches to regulation. There needs to be a way of co-ordinating activities to ensure that regulation and decisions on the use of nanotechnologies in food and agriculture are based on knowledge of the long-term effects of these products. IFR hopes that the Ministerial Group on Nanotechnologies (led by the Minister of State, DIUS) will provide a catalyst for action.

22. In terms of public opinion, portrayal of the wider benefits of nanotechnology in both food and agriculture, and the demonstration of a co-ordinated approach to assessing risks across the whole food chain, would counter some of the negative media rhetoric directed to applications directly related to food.

Submitted on behalf of the Institute of Food Research
11th March 2009