2009 AAAS Annual Meeting: Nanofood for Healthier Living?
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Nanotechnology for Food Applications: Current Status and Consumer Safety Concerns

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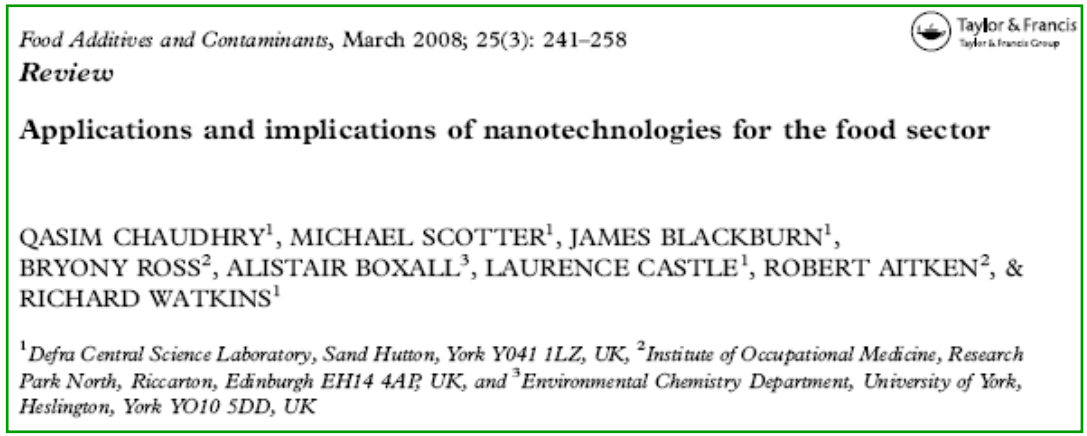
The views expressed in this presentation must not be regarded as views of the UK Government

Nanotechnology Applications for the Food Sector

- Current and projected applications of nanotechnology
    - New technological developments for (health)food sectors
    - Consumer safety concerns
    - A possible way forward

Sources of Information

- CSL assessments of the potential implications of nanotechnology for food ingredients, additives & food packaging
- Review of published literature, product information, company websites, patent databases & inventories
- EFSA draft opinion



Food Additives and Contaminants, March 2008; 25(3): 241–258

Taylor & Francis

Review

Applications and implications of nanotechnologies for the food sector

QASIM CHAUDHRY[1], MICHAEL SCOTTER[1], JAMES BLACKBURN[1], BRYONY ROSS[2], ALISTAIR BOXALL[3], LAURENCE CASTLE[1], ROBERT AITKEN[2], & RICHARD WATKINS[1]

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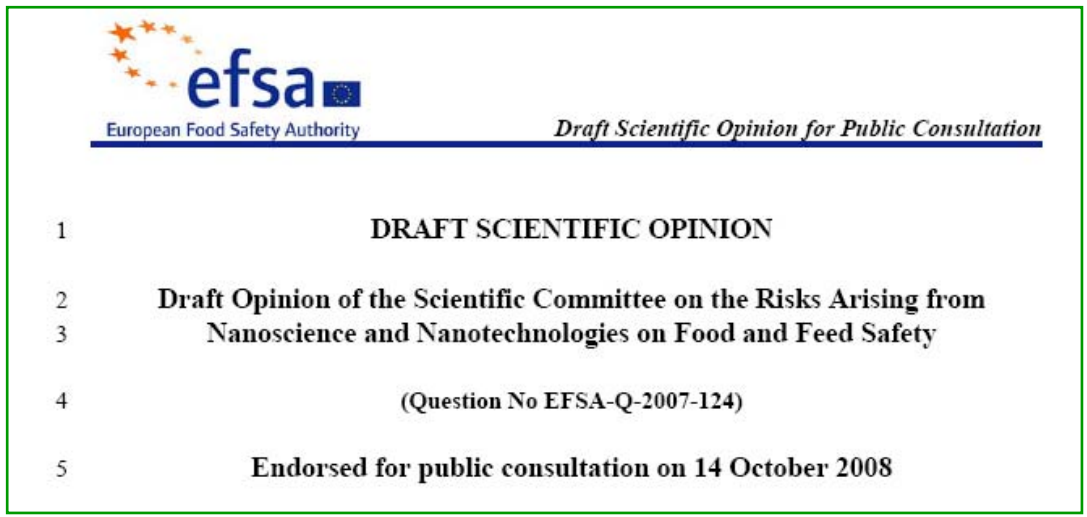


efsa

European Food Safety Authority

Draft Scientific Opinion for Public Consultation

1 **DRAFT SCIENTIFIC OPINION**

2 **Draft Opinion of the Scientific Committee on the Risks Arising from**
3 **Nanoscience and Nanotechnologies on Food and Feed Safety**

4 **(Question No EFSA-Q-2007-124)**

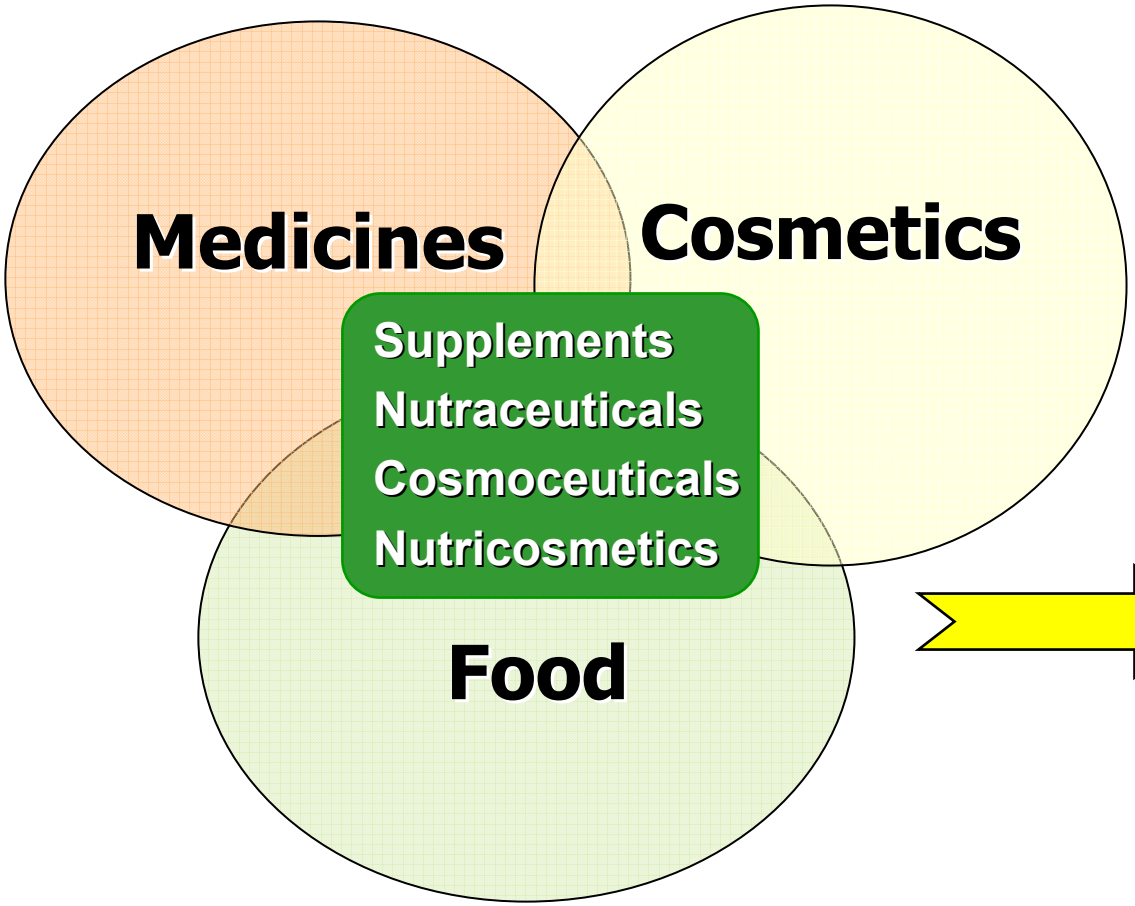
5 **Endorsed for public consultation on 14 October 2008**

Products and Applications of Nanotechnology

- Cosmetics and personal care products ~60%
- Paints & coatings ~10%
- Catalysts & lubricants
- Security printing
- Textiles & sports
- Medical & healthcare
- Food and nutritional supplements ~10%
- Food packaging
- Agrochemicals
- Veterinary medicines
- Water decontamination
- Construction materials
- Electrical & electronics ~10%
- Fuel cells & batteries
- Paper manufacturing
- Weapons & explosives

*Source: www.nanotechproject.org/inventories/consumer/

Nanotchnology Applications for (health)Foods



- ✓ New tastes, flavours, and textures of food
- ✓ Less amount of fat, salt, sugar and preservatives
- ✓ Enhanced uptake and bioavailability of nutrients and supplements
- ✓ Increased nutritional value
- ✓ Maintenance of food quality and freshness,
- ✓ 'Improved', 'Active', 'Intelligent', and 'Smart' packaging
- ✓ Better traceability and safety of food

Nanotechnology Applications for (health)Foods

- **<u>Here & Now</u>**
  (health)food supplements, nutraceuticals, flavours, stabilisers, antibacterials, nano-membranes, nano-filters, novel food packaging, sensing and warning devices
- **<u>Under R&D</u>**
  novel & functional foods, pathogen and contaminant sensors, environmental monitors
- **<u>Unlikely</u>**
  Unlimited synthetic food through assembling atoms and molecules

Current Status of Food Applications

- Increasing applications of nanotechnology for (health)food and related sectors worldwide
- Virtually all current applications are outside Europe, although some supplements and food packaging materials are available in the EU
- Virtually all products are available through the internet to consumers worldwide
- Global nanofood applications (including packaging) estimated at US$4 million in 2006, predicted to range between US$6 billion by 2012 and >20 billion by 2010
- The most promising areas predicted for the near-future are 'Active' and 'Smart' packaging, healthfoods and functional foods.

Nano-sized Ingredients/ Additives

Technology

- Processing of food ingredients to develop nano-structures
- Use of nano-sized ingredients & additives

Benefits

- Improved texture, flavour, taste
- Reduction in the amount of salt, fat, sugar, and other additives
- Enhanced bioavailability/ health benefits

Examples

- Nano additives (colours, flavouring agents, preservatives, antioxidants)
- Nano-salt, WOW Mayonnaise

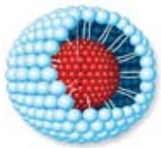
Concerns

- Need to show that they are solubilised/ digested in the gut and that insoluble free nanoparticles do not enter the blood

Delivery Systems for Supplements/ Nutraceuticals

Technology

- Nanoencapsulation of ingredients, additives and supplements
- Based on micelles & liposomes



Benefits

- Taste masking, protection from degradation during processing
- Enhanced bioavailability of nutrients/ supplements
- Antimicrobial and other health benefits

Examples

- Food additives (benzoic acid, citric acid, ascorbic acid), Supplements (vitamins A and E, isoflavones, ß-carotene, lutein, omega-3 fatty acids, coenzyme-Q10)

Concerns

- Need to ensure that greater bioavailability does not lead to increased health risks
- Tissue distribution is not different from that of conventional forms

*** Tip Top UP Bread contains microencapsulated tuna fish oil**

Engineered Nanoparticulate (ENP) Additives

Technology

- Manufactured nanoparticle forms of additives and supplements

Benefits

- Enhanced bioavailability of nutrients/ supplements
- Antimicrobial and other health benefits

Examples

- Mineral supplements (calcium, magnesium, iron, zinc, silica, diatomaceous earth, silver, gold)
- Nano-tea; "slim-shake chocolate"


Concerns

- Possible exposure to insoluble free ENPs, inside and outside the gut
- Toxicological properties of most ENPs are not yet known

Food Packaging Applications

- **Improved nano-composites**
  - Polymers incorporating nanomaterials to improve flexibility, durability, temperature/ moisture stability, barrier properties
- **'Active' nano-composites**
  - Plastic polymers incorporating nanomaterials with antimicrobial properties
- **'Intelligent' & 'Smart' packaging**
  - Packaging incorporating nanosensors to monitor condition of the food

Examples

Concerns

- Potential risks due to migration of ENPs into food and drinks

Nanomaterial Migration In FCMs

Two nanotech food contact materials tested at CSL:

- No detectable migration of nanoclay from PET bottles that had a nanoclay composite embedded between PET layers.
- Very low level of silver migration (less than the limit of quantification) from food containers made of polypropylene-nanosilver composite.
- In either case, the presence of nanoparticles did not affect migration of non-nano components.

- A published study (Avella et al., 2005) found insignificant increases in the levels of minerals in vegetables packaged in nanoclay composites with potato-starch and potato starch-polyester blend. The study showed a consistent increase in the amount of Si (the main component of nano-clay).
- Some reassurance in the safety of nanotech FCMs based on data from these limited tests, but migration patterns may be different for other polymers.

Nanotechnology Applications for 'Smart' Packaging

Nanotechnology derived intelligent packaging

- nanoparticle based intelligent inks
- reactive nanolayers
- analyte recognition at nanoscale

Safety requirements

- non-toxic & compatible with legislation
- reliability of products
- waste issues

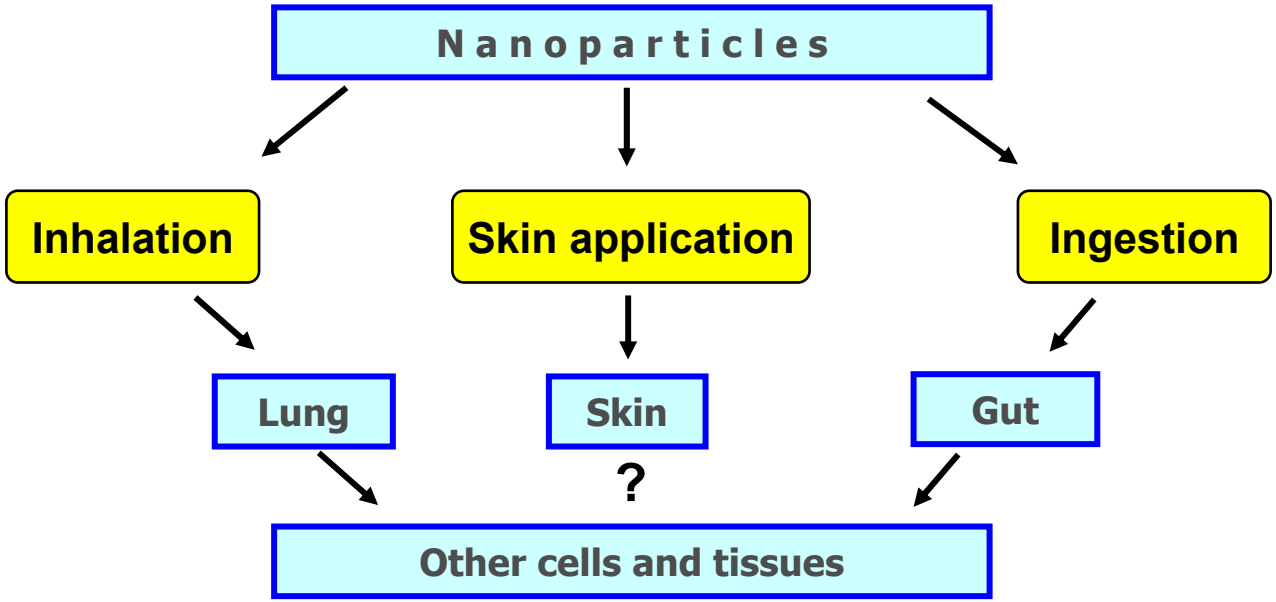
- Temperature
- Pathogens
- Freshness
- Integrity
- Humidity

Slide courtesy of Dr. Maria Smolander, VTT Finland

Consumer Concerns over Nanotechnology Risks

- Concern over safety of nanotechnologies raised by:
  - Greenpeace
  - The ETC Group
  - Friends of the Earth
  - The Soil Association
  - Which?
  - The Royal Commison on Environmental Pollution
- Consumer perceptions:
  - A German report (BfR, 2008) shows that whilst consumers are comfortable with many applications, e.g. cleaning products or varnishes, they are sceptical of the use of nanoparticles in food.
  - A US report (The Woodrow Wilson International Center for Scholars, 2008) shows that around ¾ of Americans have little or no awareness of nanotechnology, but there is a positive association between awareness of the technology and the belief that benefits will outweigh the risks.

Consumer Health Concerns



- Properties of nanoparticles may differ widely from 'conventional' forms
- Growing scientific evidence indicates that:
  - free nanoparticles can cross cellular barriers, and may reach those targets in the body where larger equivalents could have not reached
  - exposure to some ENPs can increase production of oxyradicals that may lead to oxidative damage and inflammatory reactions

- Geiser et al. (2005) Ultrafine particles cross cellular membranes by nonphagocytic mechanisms in lungs and in cultured cells, Environmental Health Perspectives 113 (11): 1555-1560.
- Li et al. (2003) Ultrafine particulate pollutants induce oxidative stress and mitochondrial damage, Environmental Health Perspectives 111(4): 455-460.

Absorption of Nutrients Through the Gut

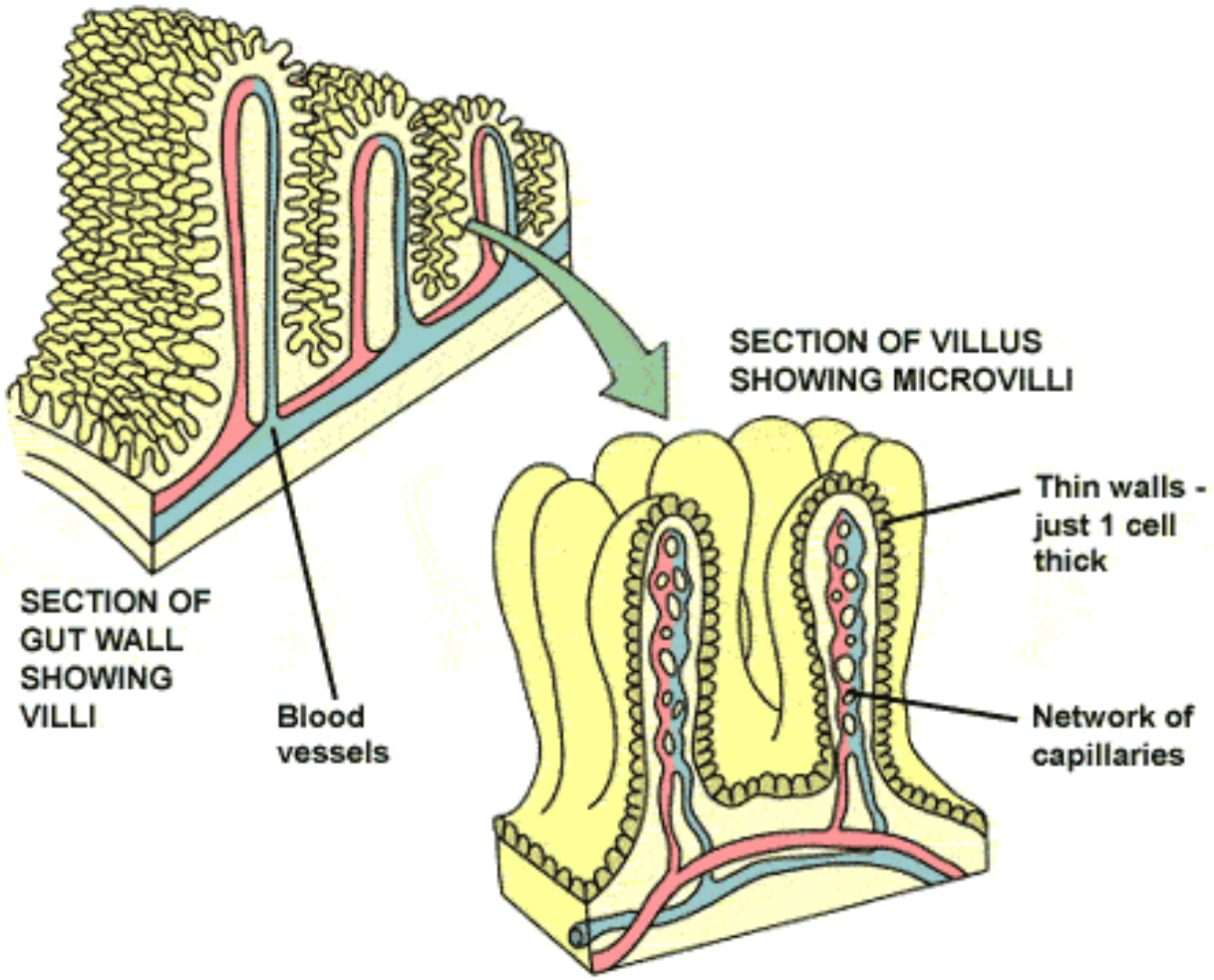


Image source: www.bbc.co.uk/gcsebitesize

A Possible Way Forward

- Due diligence by (health)food industry whilst promoting nanofood products, in that:
  - there are clear advantages in the use of nanotechnology over other available technologies
  - the benefits outweigh any risks, and the risks are acceptable
- Need for an industry body to assure product quality, promote research to fill knowledge gaps, assess risks and benefits, and ensure regulatory compliance:
  - case-by-case assessment to segregate products into risk categories
  - consumer information, involvement and education in regard to benefits as well as possible risks
  - possible voluntary labelling for potentially high-risk products and applications

Summary

- **Early days for food applications of nanotechnology**
  Many more products are likely to be available in the near future
- **Potential benefits for industry and the consumer**
  Maintenance of quality and freshness, new tastes, flavours, textures, greater nutritional value, shelf life, better traceability and safety, less salt, sugar, fat and preservatives
- **Concerns over consumer safety**
  Need for some basic research into potential health effects of nanofoods; and for a vigilant self regulation/ best practice by the industry
- **Consumers information/ involvement**
  Consumer information/ involvement/ education a must for the success of nanofoods

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