

NANOTECHNOLOGY IN FOOD SECTOR



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OUTLINE

- What is nanotechnology in food?
- Why use nanomaterial and nanoparticles in food?
- Methods to study the engineered nano-materials (ENM) in food
- How are ENM food quality assured and regulated from field to laboratory?

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What is nanotechnology in food?

The RS/RAEng 2004 report

- **Nanotechnologies** is defined as:

“the design, characterisation, production and application of structures, devices and systems by controlling shape and size at the nanometre scale”

In context of food sector:

the nanoscience is the passive observation of food to understand the structure and behaving,

and nanotechnologies are:

the more active manipulation of food to produce a desire effect.

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Pear and nano-Au



Photo: Pears with nano-sized gold by Eom Jung-ui (farmer) and SM Nanotech Inc. South Korea(2009).

The pears included 0.05 – 0.14 mg Au/kg, and the prize: 10 Eur / pear. Photo by EPA/Yonhap.

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Why use nanomaterial and nanoparticles in food?

Pros

- With help of nanomaterials and nanoparticles, it is expected to improve materials behaviour or include new properties to the food products
 - i.e. use of reduced salt, fat or sugar
 - i.e. increase vitamin and nutrient content or stability (controlled release of encapsulated nutrients, moisture and pH triggered)
- With nanotechnology to design new applications, to improve the environment and humans well-fare
 - create new flavours (taste masking) and texture to healthier food products
 - improve the shelf-life of food
 - detection of pathogens in food system
 - use of less energy to retain products under frozen or chilled condition

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Why use nanomaterial and nanoparticles in food?

Cons

- increase the complexity of packaging?
- increase the waste?
- difficult to recycle?



“Smart food wrapper” made of polyester and dye known as Bis(benzoxazoly)-stilbene (BBS) excimers (A.Pucci, Univ. of Pisa, Italy).

(www.nanowerk.com, Nanowerk News, Jan 2007)

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Application of nanomaterial

- Main application of man-made nanomaterial in food-sector areas:
 - packaging
 - bio-indicators
 - food supplements
 - food additives



- Main application of nanomaterial and nanoparticles in food is to:
 - alter texture of the food components
 - encapsulating food components / additives
 - developing new tastes / sensations
 - control release of flavours
 - increase bioavailability of nutritional components

*i.e. giving the opportunity to have **potential indirect or direct food applications** with help of nanotechnology.*

Why use nanomaterials and nanoparticles in food?

Ref. *International Union of Food Science & Technology (IUFoST) Scientific Information Bulletin*, Dec. 2007

Potential indirect food applications

- Electronics, computing and communications siliconchip, nanosensor, polymer emitting diodes (store, displays), new type of labelling



Metallic nanobarcodes particles; Nanoplex Technologies Inc.

- Embedded into food products/packaging and scanned like bar codes

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Why use nanomaterial and nanoparticles in food?

• Access more information about the foods:

- brand security
- supply chain tracking
- source
- history
- storage

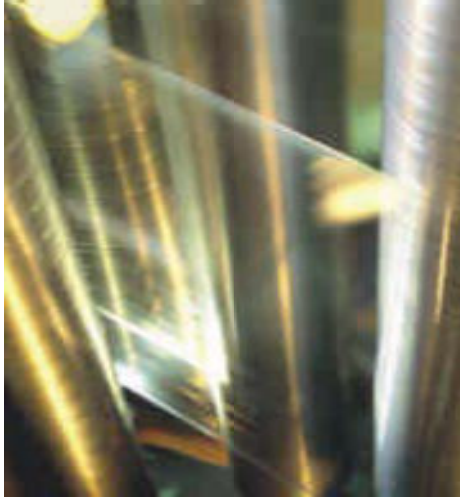
- Nanomaterials /-science develop / improve “**smart**” materials as food biopolymers, nanocomposites.

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Why use nanomaterial and nanoparticles in food?



D. Parker; MNT Network, UK, Durethan Polyamide (PA) film, layered with layered silica barrier.

• The SiO₂ layers control the diffusion rate of water and gas through the PA film, *i.e* makes it difficult for O₂ (g) to penetrate

• Exfoliated nanocomposite film has:

- improved tensile strength
- improved stiffness
- low viscosity
- increased barrier properties

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Why use nanomaterial and nanoparticles in food?

Polyactic acid (PLA) packaging with antibacterial layer, of TiO₂, silver or nanoclay.

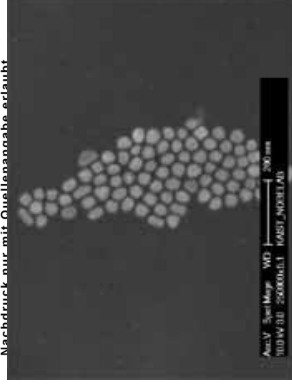


PLA Schale mit Deckel
PLA tray with lid
(Photo: natura packaging)



Tomimax: For oral use,
Antibacterial, virus, fungal,
bacteria etc.!!

Mischdruck nur mit Quellensgabe erlaubt



Bioneer HQ: SEM-images of synthesized Silver Nano Colloid particles,
Ø ~ 85 -17 nm.

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Why use nanomaterial and nanoparticles in food?

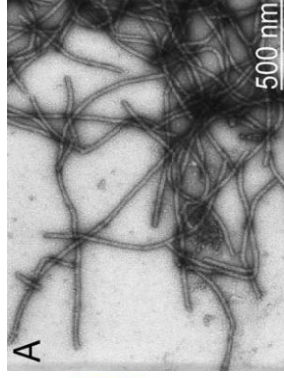
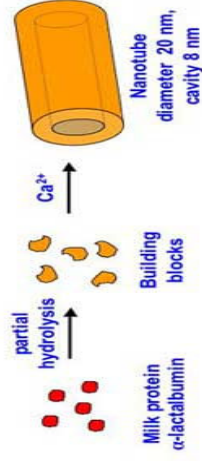
Ref. *International Union of Food Science & Technology (IUFoST) Scientific Information Bulletin*, Dec. 2007 . Parker D, *MINT for food&Packaging*, MINT Network, UK

Potential direct food applications

- **Nanostructures in food may enhance good food quality**

Food protein has naturally globular structures of

Ø 1 – 10 nm.



J.F. Graveland –Bikker: Trends in Food-Science and Technology, 2006
Milk protein where α-lactalbumin, is hydrolysed into nanotubes in presence of Ca²⁺.

- self- assembly nanotubes made by (aerobic) of hydrolysis **Bacillus licheniformis**.
- withstand pasteurisation and the nanotubes are strong and stiff. Incorporation of drugs, vitamins into nanotubes.
- need of less protein in food and used as gelation agent.

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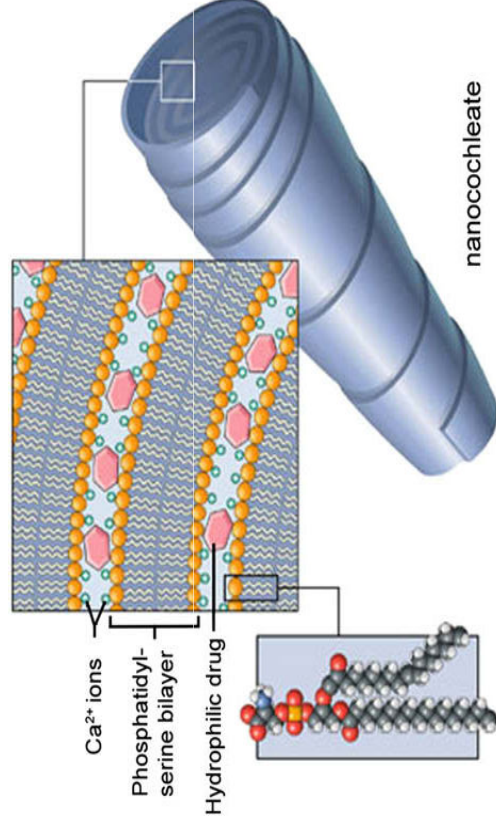


Why use nanomaterial and nanoparticles in food?

Cochleates of phospholipid layer (soya bean) stacked sheet and rolled to spiral form of Ø 50 nm

(CaCl₂ is added dropwise to liposome suspension causing the liposomes to fuse)

- Cochleates are able to transport liposomes or colloidal particles. And they are accepted as food products.



Schematic representation of nanocochleate structure. Copyright BioDelivery Sciences International, Inc.

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Why use nanomaterial and nanoparticles in food?



D. Parker; MNT Network, UK, Omega-3 fatty acid cochleates (centre as powdered form) and baked goods with omega-3/ Nanocochleate

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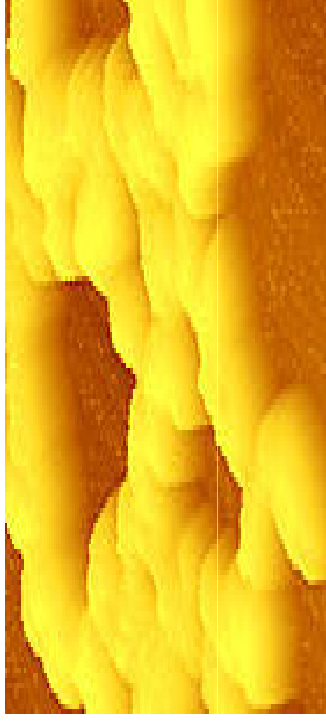
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Why use nanomaterial and nanoparticles in food?

Nanoencapsulated food

- Microencapsulated food ingredients (substances, additives) is vastly used in health food area.
- Mask the taste and odour and enhance the flavour



D. Parker, MNT Network, UK, New natural and synthetic polymer capsules (from milli-to nano-meter size), Durarome®, Flexarome®, FirCaps® and FirCryst® are examples of commercial available systems

- Other example of encapsulating is vitamins, liquids, nano-silver and nano-gold or live probiotic microbes to promote healthy gut function.

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Why use nanomaterial and nanoparticles in food?

- **Nutraceuticals**

- used as delivery vehicles for vitamins, antioxidants, antimicrobials
- nanocages or nanoclusters, $\text{\AA} < 100 \text{ nm}$.
- claims to enhance absorption and bioavailability in the body



Shenzhen, China: Nano-selenium-enriched Nanotea,
www.nanowerk.com

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Methods to study the engineered nano-materials (ENM) in food

Table 1: Parameters for characterisation of ENM

Chemical composition/identity	Dissolution/Solubility
Particle size	pH
Physical form and morphology	Viscosity
Particle and mass concentration	Density and pour density
Specific surface area	Dustiness (powder products as spices, creamers, soup powders)
Surface chemistry	Chemical reactivity/catalytic activity
Surface charge	Photocatalytic activity (coatings, packaging, inks)
Redox potential	

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Currently used analytical methods in food

- Light scattering,
 - Microscopy
 - Spectrometry
 - Chromatography
 - Size separation techniques
 - Surface characterisation
- ✓ No "gold standard" method for identification of various ENM:s or NP:s properties
- ✓ Not validated for ENM:s matrices
- ✓ **Validated** reference materials: SiO₂ (IRMM-304) and Au (NIST CRM 8011, 8012 and 8013)
- ✓ **New reference** NP:s material: Ag in chicken meat, SiO₂ in tomato soup, C₆₀ in edible oil, organic NP:s in beverage

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How are ENM food quality assured?

- ✓ NP:s are controlled through the conventional

Food Sector Legislation

- General Principles of Food Law

Regulation EC/178/2002

- ✓ *Used tools are the description of composition, product-labelling and trade-documents*

Novel Food Regulation

- Regulation EC/258/97 applies to novel food and food ingredients.
- ✓ Is now revised to bring nano-technologies / nanomaterials into the regulation

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Are ENM in food regulated?

Food Additives

Regulated under Directive 89/107/EC and EC/1333/2008

→ Only authorised additives may be used in food

✓ EFSA (European Food Safety Authority) has launched a scientific opinion

”Guidance for the risk assessment of the application of nanoscience and nanotechnologies in food and feed chain”.

EFSA Journal 2011;9(5):2410, p. 1-36

✓ *No application of today has been made on nano-modified food in EU or in Finland.*

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SUMMARY

- Definition of nanotechnology in context of food
- Use of nanomaterials and nanoparticles and their application in food
- Methods and challenges of ENM measurement in food
- Food quality and regulation of engineered nano-materials



Thank you!

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