Nanotechnology applications in Food Science

Dra. Ing. Alicia Gallo

Seminario internacional
La nanotecnología: Eje importante para el futuro de la cooperación CELAC-UE
Organizado por IRELAC y los socios del proyecto EULANetCermat
28 de febrero 2013
A new scale ???

1 micrón \( 10^{-6} \) metro

1 nanómetro \( 10^{-9} \) micron

1 nanómetro \( 10^{-9} \) metro
Nanotechnology has spread its wings in various spheres of life.

It has progressed from the first generation passive nanomaterials to nanotechnology active (drug delivery) and nanosystems (for example, robotics).

And, what about the nanofood??
Still in its childhood?
Where is “the nano” in food??

Ingredients: molecules, macromolecules, biopolymers, water

Structures: fibers, gels, emulsions, foams

Properties: texture, flavor, shelf life, bioavailability

Nature

Molecules

Ingredients

Processing

Fresh food

Processed foods

Digestive Process

Molecules
Microstructural changes during processing

JMAguilera, 2009
How to build a food structure, a paradigm shift

Traditional

FORMULATION

Structure assembling

Structure stability

Metastable structure

Future

Molecules

Assembling

Interactions

Elemental structures

Matrix precursors

Arquitectura

Funcional structure
But .... What is the driving force for a food product development?
Changes in consumer demand

Healthier food
Less fat
0% trans fats
Less sugar
Low sodium
More fiber
w3, w6 Rich
APPLICATION OF THIS NEW CONCEPT

SAFETY

NUTRITION

IDEAL FOOD

ACCEPTANCE
Application areas of nanotechnology in the food production chain

- Heat/Mass transfer
- Nano-scale reaction eng
- Nano-Biotechnology
- Molecular synthesis

- Delivery
- Formulation
- Packaging

Figure 1. Nano applications in food and the food industry.
Maillard-conjugation based core-shell co-assemblies for nanoencapsulation of hydrophobic nutraceuticals in clear beverages

Yoav D. Livney*, Gilad Markman, Jane Levinson, Yedidia Zaguri, and Sahar Halabi 2011

Figures

Legend:

A poly- or oligosaccharide

A protein or a peptide with a hydrophobic domain(s)

A hydrophobic nutraceutical

Figure 1. Schematic model of the Maillard-conjugation based core-shell co-assembled nanocapsule (Diameter ~ 10-50 nm)
Formación de fibrillas de amiloide de proteínas globulares, se muestra la formación de gigantescas cintas multitrenzadas helicoidales de lisozima y β-lactoglobulina. Condiciones de cinética de fibrilación: condiciones de temperatura (90 °C) y tiempo de incubación (0-30 h), y evaluación de los cambios estructurales durante la fibrilación por microscopía de fuerza atómica (AFM), dicroísmo circular (CD), y SDS-PAGE.
ENCAPSULATION
It is currently the most important application

The nano-encapsulation offers improvements in terms of:

- better protection against moisture and oxygen,
- ingredients and additives controlled release
- flavor and tastes masking
- Improvement of ingredients and additives dispersibility

Development of encapsulation nutrient systems: bioactive compounds, additives, processing aids.

The premise is develop carriers and nanometric materials, in order to improve the absorption and therefore, the bioavailability of compounds such as vitamins, phytochemicals, nutrients and minerals.
Salvona Technologies developed a multi-component delivery system. This system, MultiSal™, delivers multiple active ingredients that do not normally mix well, such as water-soluble and fat-soluble ingredients, and releases them consecutively.
Controlling morphology of phase separated gelatin-maltodextrin gels in emulsion droplets
Sophia Wassén, Niklas Lorén, Anne-Marie Hermansson, 2011

Figure 1. CLSM micrographs of emulsion droplets showing the effect of confinement on the internal morphology. The concentration is 4% w/w gelatin and 6% maltodextrin. The cooling rate was 55°C/min from 60°C to 20°C. The scale bars represent (a) 100μm (b) 25μm.

Figure 2. CLSM micrographs of microfluidic produced emulsion droplets. Different microstructures are obtained by changing the cooling rate (a) 90°C/min (b) 55°C/min. The concentration is 4% w/w gelatin and 7.3% maltodextrin. The scale bars represent 100μm.

CLSM (confocal laser scanning microscopy)
Flavors or Odors Masking

The addition of nanocapsules containing tuna oil, omega 3 fatty acids rich in bakery

The capsules are designed to open in the stomach, as the omega 3 is susceptible to oxidation.
Fig. 2. Various protein nanocarriers as pillars of protein nanotechnology. Protein nanotechnology includes various nanocarriers system like metallic, polymeric and self assembly.
Curcumin encapsulated in chitosan nanoparticles: A novel strategy for the treatment of arsenic toxicity

Water-soluble nanoparticles of curcumin were synthesized, characterized and applied as a stable detoxifying agent for arsenic poisoning.

Chitosan nanoparticles of less than 50 nm in diameter containing curcumin were prepared.

The particles were characterized by TEM, DLS and FT-IR.

The therapeutic efficacy of the encapsulated curcumin nanoparticles (ECNPs) against arsenic-induced toxicity in rats was investigated.
<table>
<thead>
<tr>
<th>Product</th>
<th>Company</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constantia multifilm N-COAT</td>
<td>Constantia Multifilm</td>
<td>Nanocomposite polymer A clear laminate with outstanding gas-barrier properties developed primarily for the nuts, dry food and snack markets</td>
<td><a href="http://www.constantia-multifilm.com/">http://www.constantia-multifilm.com/</a></td>
</tr>
<tr>
<td>Adhesive form</td>
<td>Ecosynthetix</td>
<td>50–150 nm starch nanospheres The adhesive requires less water as well as less time and energy to dry</td>
<td><a href="http://www.physorg.com/news71748835.html">http://www.physorg.com/news71748835.html</a></td>
</tr>
<tr>
<td>MacDonald’s burger containers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food additives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AdNano</td>
<td>Evonik (Degussa)</td>
<td>Nano ZnO (food grade) Free flow aid for powdered ingredients in the food industry An optimum carrier system of hydrophobic substances for a higher and faster intestinal and dermal resorption and penetration of active ingredients</td>
<td><a href="http://www.advancednano.com">www.advancednano.com</a> <a href="http://www.aerosil.com">www.aerosil.com</a></td>
</tr>
<tr>
<td>Aerosil, Sipernat</td>
<td>Evonik (Degussa)</td>
<td>Silica (food grade)</td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>Manufacturer</td>
<td>Description</td>
<td>Application</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Synthetic Lycopene</td>
<td>BASF</td>
<td>LycoVit 10% (&lt; 200 nm synthetic lycopene)</td>
<td></td>
</tr>
<tr>
<td>Nano Slim</td>
<td>Nano Slim</td>
<td>NANO-DIIFUSE Technology Nanodusters</td>
<td>Orosolic acid (derived from the Lagerstroemia spactosa plant)</td>
</tr>
<tr>
<td>Nanoceuticals Slim Shake Vanilla</td>
<td>RBC Lifescience</td>
<td>Nanodusters</td>
<td></td>
</tr>
<tr>
<td>Fortified fruit juice</td>
<td>High Vive.com</td>
<td>300 nm iron (SunActive Fe)</td>
<td></td>
</tr>
<tr>
<td>Daily Vitamin Boost</td>
<td>Jamba Juice Hawaii</td>
<td>300 nm iron (SunActive Fe)</td>
<td>22 essential vitamins and minerals and 100%, or more of your daily needs of 18 of them!</td>
</tr>
<tr>
<td>Oat Chocolate Nutritional Drink Mix</td>
<td>Toddler Health</td>
<td>300 nm iron (SunActive Fe)</td>
<td>Toddler health is an all-natural balanced nutritional drink for children from 13 months to 5 years. One serving of Toddler</td>
</tr>
</tbody>
</table>
Microstructure and physico-chemical evaluation of nano-emulsion-based antimicrobial peptides embedded in bioactive packaging films

Imran, Revol-Junelles, René, Jamshidian, Javeed Akhtar, Arab-Tehrany, Jacquot, Desobry*, 2012
Application on pear and orange juices (2011)

Microscopía de fluorescencia

Nanoencapsulation of essential oils to enhance their antimicrobial activity in foods

Francesco Donsi\textsuperscript{a,\ast}, Marianna Annunziata\textsuperscript{b}, Mariarenata Sessa\textsuperscript{a}, Giovanna Ferrari\textsuperscript{a,\ast}

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\textsuperscript{b}Department of Food Science, University of Naples, Italy

\textsuperscript{\ast}Corresponding author. E-mail addresses: francesco.donsi@unito.it, maria.annunziata@unina.it, mariarenata.sessa@unino.it, giovanna.ferrari@unino.it
Relevant Nanomaterials in foods

- Processed nanostructured in food (NANOTEXTURES)
  - Nano-emulsions
  - Surfactant micelles
  - Emulsion blayers
  - Double or multiple emulsions
  - Reverse micelles
  - Spreads
  - Mayonnaise
  - Cream
  - Yoghurts
  - Ice creams

- Nanodeliver systems based on encapsulated technology
  - Nanomicelle-based carrier system
  - Nanocluster delivery system
  - Vegetable oil enriched in vitamins, minerals and phytochemicals

- Nanomaterials relevant to food applications
  - Inorganic NMs (TiO₂, silver, silica, selenium, calcium, iron)
  - Surface functionalized NMs
  - Organic NMs (synthetic nanosized form of lycopene, fullerenes, carbon nanotubes)

- Nano-enabled food contact materials (FCMs) and packaging
  - NP reinforced materials (polymer composites with nano-clays, nano-metals or metal oxides, coating contained NPs and antimicrobial nanoemulsions)
  - Intelligent packaging concepts based on nanosensors
  - Nanoclay-polymer composites
  - Oxygen detecting ink containing TiO₂ NPs
  - Nanolayer of silver that react with hydrogen sulfide

- Nanotechnology in the agricultural sector
  - Animal feed
  - Agrochemicals
  - Natural biopolymer from yeast cell walls that bind mycotoxins
  - Polystyrene (PS) base, polyethylene glycol (PEG) linker, and mannose targeting biomolecule to bind E. coli
  - Slow- or controlled-release fertilizers and pesticides

Figure 2. Nanomaterials relevant to food.
## Nanocapsules with bioactive ingredients

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Dietary Supplements</th>
<th>Pro &amp; Beverages</th>
<th>Food Additives</th>
<th>Cosmetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>NovaSOL A</td>
<td>Vitamin A-Solubilisate</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NovaSOL ADEK</td>
<td>Solubilisate of Vitamin A, D, E, K</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL ADEK-Q10</td>
<td>Solubilisate of Vitamin A, D, E, K &amp; Coenzyme Q10</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL BC</td>
<td>β-Carotene-Solubilisate</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>NovaSOL C</td>
<td>Ascorbic Acid - Solubilisate</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>NovaSOL S</td>
<td>Ascorbic Acid / DL-α-Tocopherol - Solubilisate (for processed meat/ sausage)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL COF</td>
<td>Ascorbic Acid / DL-α-Tocopherol-Solubilisate (for oils / fats)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>NovaSOL CT</td>
<td>Ascorbic Acid / Mixed-Tocopherol - Solubilisate (for essential oils, flavors, fragrances, cosmetics)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>NovaSOL Citric</td>
<td>Citric Acid-Solubilisate</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>NovaSOL DS/4</td>
<td>Sorbic Acid-Solubilisate (preservation of food, drinks &amp; cosmetics)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>NovaSOL DC/12</td>
<td>Benzolic Acid-Solubilisate (preservation of cheese rind &amp; sausage casings)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>NovaSOL DS/12</td>
<td>Benzolic Acid-Solubilisate (preservation of food, drinks &amp; cosmetics)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
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<tr>
<td>NovaSOL DC/44</td>
<td>Sorbic acid / Benzolic acid-Solubilisate (preservation of cheese rind &amp; sausage casings)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL DS/44</td>
<td>Sorbic acid / Benzolic acid-Solubilisate (preservation of food, drinks and cosmetics)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>NovaSOL E</td>
<td>DL-α-Tocopherol-Vitamin E-Acetate-Solubilisate</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL ISO</td>
<td>Isoflavone-Solubilisate, Capsule Grade</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>NovaSOL ISO (source: soy isoflavones)</td>
<td>Isoflavone-Solubilisate, Food Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NovaSOL Lipoic</td>
<td>α-Lipoic acid-Solubilisate</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL Lutein</td>
<td>Lutein-Solubilisate</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>NovaSOL Omega</td>
<td>Omega 3-fatty acid - Solubilisate</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NovaSOL Q</td>
<td>Coenzyme Q10 Basic-Solubilisate, - GRAS</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL Q</td>
<td>Coenzyme Q10-Solubilisate, Soft Gel Grade - GRAS</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NovaSOL Rosemary</td>
<td>Rosemary Extract - Solubilisate</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

**Presentation**
NovaSOL® products are offered in a variety of forms such as:
- Pure liquid bulk solubilisate
- Capsules in bulk
- Packaged Capsules (Full Service)

**Documentation & Samples**
On request we will supply you with:
- Product data sheets
- Certificates of analysis
- Material safety data sheets (MSDS)
- Summary bioavailability studies
NovaSOL® is available in ready to use products, which represent a broad variety of substances. AQUANOVA’s technology offers the dietary supplement, functional foods and drinks, as well as the cosmetics industries, great opportunities to supply new value added products with properties hitherto not possible.

NovaSOL® Solubilisates are liquid, at the same time water and fat soluble raw materials & ingredients with micelle structure for e.g.:

Vitamins
Omega-3 fatty acid
Coenzyme Q10 (with GRAS status)
Isoflavones, flavonoids, carotenoids
Phyto extracts
Essential oils
Preserving agents
Food coloring substances
Other bioactive substances
daily multi-vitamin, Our Premier Product

An All Natural Nano-Encapsulated Multi-Vitamin, Mineral and Herbal Supplement
daily multi-vitamin isn’t just a vitamin supplement. It’s a complete cocktail of health and well being. The specially selected vitamins, minerals and herbal compounds in daily multi-vitamin provide a substantial increase in nutritional value, first, due to their combination, and second, due to nano-encapsulation. Our All Natural Patented Nanotechnology™ creates a particle size small enough to be absorbed with maximum efficiency.

The prefix ‘nano’ means one-billionth, so a nano-gram is one-billionth of a gram. Nanotechnology is the increasingly popular science of the incredible small. It overlaps into medicine, food, robotics and virtually any other high-tech system now emerging from the scientific community.

As it applies to food and nutritional supplements, nanotechnology is now being utilized to reduce the particle size of various compounds to a relatively small size for efficient absorption. One of the best ways to create nano size particles is through encapsulation. The technology literally separates, and then envelops molecules in the active compound. There are a number of different encapsulation technologies, but the most favorable type is natural – and that’s why we’ve developed All Natural Patented Nanotechnology™.

Well, what does this mean exactly? Why is “natural” nano encapsulation a better alternative?
The answer is quite simple. Our All Natural Patented Nanotechnology™ process uses only natural plant lipids as the basis for its nano-encapsulation. This ensures the compounds dissolve gradually, providing a sustained release of the vitamins, minerals and herbal compounds. By the time the body has absorbed the nutrients in this safe and efficient manner, the nano particle has completely dissolved. In other words, the plant lipids are metabolized just as any other food stuff would be.

For those unfortunate souls whose daily menus are limited by food allergies, look no further. daily multi-vitamin is allergen free of yeast, corn, wheat, lactose, dairy, citrus, egg, fish and nut products. It contains no sugar, artificial flavors, colors or sweeteners.
<table>
<thead>
<tr>
<th>Nature of application</th>
<th>Projected benefits</th>
<th>Potential risks</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processed nano-structured or</td>
<td>Use of less fat and emulsifiers, stable emulsions, better tasting food products. A</td>
<td>This application area is of least concern, as the food nanostructures are likely to be solubilised or digested in the GI tract and should not</td>
<td>Although the development of micronised dispersions is known to generate a range of droplet sizes—some in micro dispersion size—this food is</td>
</tr>
<tr>
<td>nano-textured food products</td>
<td>typical product of this type of application would be a nano-textured food (e.g.</td>
<td>carry insoluble materials to the circulatory system.</td>
<td>clear to the consumer. Slow dissolving of the micronised food product</td>
</tr>
<tr>
<td></td>
<td>ice cream, mayonnaise, spread, etc.) which is low-fat but as “creamy” as the full-fat</td>
<td></td>
<td>has been well received with more than 50% of consumer preference.</td>
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<tr>
<td></td>
<td>alternative. Such products would therefore offer “healthy” but tasteful products to</td>
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<tr>
<td></td>
<td>the consumer. Processing foodstuffs at submicron or nano-scale is also known to kill</td>
<td></td>
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<tr>
<td></td>
<td>any microbial pathogens.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nano-Carrier systems for delivery of nutrients and</td>
<td>Taste masking of certain ingredients/additives, such as fish oils, protection of</td>
<td>Increased absorption, uptake and bioavailability of certain additives and supplements may also alter tissue distribution of the substances</td>
<td></td>
</tr>
<tr>
<td>supplements in the form of liposomes or biopolymer-based</td>
<td>certain ingredients during processing, improved optical appearance, improved</td>
<td>in the body. ADME properties of some encapsulated substances may be different from conventional bulk equivalents.</td>
<td></td>
</tr>
<tr>
<td>nano-encapsulated substances</td>
<td>bioavailability of nutrients and supplements, antimicrobial action, and other health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic nano-sized additives</td>
<td>Due to larger surface area, lesser amounts would be needed for a function or a taste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(many of them naturally occurring substances) for food,</td>
<td>attribute. Other claimed benefits include better dispersibility of water-insoluble</td>
<td></td>
<td></td>
</tr>
<tr>
<td>health-food supplements, and animal feed applications</td>
<td>additives in food products without the need for additional fat or emulsifiers, and</td>
<td></td>
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<tr>
<td></td>
<td>enhanced tastes and flavours due to greater surface areas of the nano-sized additives</td>
<td></td>
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<tr>
<td></td>
<td>compared to bulk forms. Virtually all products in this category are also claimed for</td>
<td></td>
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<tr>
<td></td>
<td>enhanced absorption and improved bioavailability in the body compared to conventional</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bulk equivalents.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inorganic nano-sized additives for food, health-food and</td>
<td>Essentially the same benefits as claimed for organic nano-sized additives (see above).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>feed applications</td>
<td>Other projected benefits include increased food hygiene due to antimicrobial activity of nano-sized metal(oxide) additives.</td>
<td></td>
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<tr>
<td></td>
<td>Application area of nano-sized additives is available for some inorganic additives.</td>
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<tr>
<td></td>
<td>Examples include silver, silver, copper, titanium, biopersistent nanoparticles.</td>
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</tr>
</tbody>
</table>

Micronized ingredients

2012!!
Starch-based biodegradable polymers exhibit:

- Poor barrier properties against moisture
- Hydrophilic nature
- Poor mechanical properties
- When compared with plastics

Incorporation of nanoclays

(Avellà et al., 2005; Chen; Evans, 2005; de Carvalho; Curvelo; Agnelli, 2001; McGlashan; Halley, 2003; Park et al., 2003).
Nanocatalysts applications

Fig. 9. This diagram illustrates the interrelationships between crystal structure, surface chemistry, and size of nanocatalysts [134]. (Reproduced with permission from Royal Society of Chemistry 2011.)
Some example applications: NanoFood:

Nanocapsules and nano-objs for "on demand" preservatives, enriched food, flavour, smell, taste and colours

Interactive food: attractive surface treatment, glaziers and colours,

Improvement of food safety and quality, shelf-life extension

Nanocontrol of healthy digestion tube and micro-flora, digestion more compatible food

Improved cooking, food ingredients control

Alternative feeding: transmucosal, skin etc..

Special Food: Hospital Food, Space Food, Hot and Cold areas Food

Nanoparticle Controlled extraction and release

Nanocarriers for food and nutrient delivery

and more…

Helmut Kaiser Cons, set 2012
The application of high performance nanocatalysts provide advantages

- increase activity and selectivity by controlling pore size and particle characteristics,
- which improves the chemical reactivity and
- reduces process costs.

In this field it is foreseen a great application of ceramic materials in the enzymes immobilization.
New sizes...... New tools !!!!!
Zetasizer Nano ZS90

An entry level system for the measurement of particle size and molecular size at a 90 degree scattering angle using Dynamic Light Scattering, also with the ability to measure zeta potential and electrophoretic mobility using Laser Doppler Microelectrophoresis, and molecular weight using Static Light Scattering.

The Zetasizer Nano ZS90 is the perfect lower cost solution when the ultimate in sizing sensitivity is not necessary, or where identical results to a legacy system with 90 degree scattering optics is required.

- Size measurement from 0.3nm (diameter) to 5 microns using 90 degree scattering optics
- Zeta potential of proteins and particles from 3.8nm up to 100 microns (diameter) using patented M3-PALS technology
- Molecular weight measurement down to 9,800Da
- A Quality Factor gives confidence in the data
- The Expert advice report gives help to improve sample preparation or the measurement procedure
- 21CFR part 11 software option enables compliance with EU/ES
Particle-by-Particle Sizing

The example on the left demonstrates measurement of a polystyrene nanoparticle sample with three distinct size populations.

Individual particle signals are recorded. The relationship between measured blockade event magnitude (nA) and particle volume allows the determination of the absolute size of particles in a sample (nm). Particle-by-particle data is displayed as size-distribution graph for the sample.

The SEM image confirms the presence of three populations at 220nm, 400nm and 780nm diameter.
And FINALLY.....

Nanotechnology use requires a multidisciplinary work because it must necessarily involve the knowledge of biological, chemical and physical processes at molecular level.
Nanotecnología

- Física
- Tecnología de los alimentos
- Fisiología
- Nutrición
- Microbiología
- Ciencia de los materiales
- Ingeniería
- Química
- Legislación bromatológica
- Biología
- Ingeniería
Risks and challenges

- There are no data on nanotechnology application risks in the food sector.

- The biggest concern is that nanoparticles, because of its scale, form, could penetrate into the human body, and the impacts were not evaluated.
Regulations and standards

Center for Food Safety and Applied Nutrition Nanotechnology Programs

With the advance of science and technology, nanomaterials are being explored in a variety of products, both food and cosmetics, regulated by the Center for Food Safety and Applied Nutrition (CFSAN). In order to provide sound, science-based regulations and guidelines to its stakeholders, the Center has invested resources in regulatory science research focused on safety assessment.

The goal of CFSAN’s nanotechnology regulatory science research is to improve information regarding safety assessment for nanomaterials and to inform regulatory decision-making, including any development of policy and guidance on food and cosmetic products. Currently, CFSAN’s nanotechnology regulatory science research focuses on the following:

- **Characterization of nanomaterials**
  Using systematic approach to understand the interaction of a variety of matrices and nanomaterials. Exploring the use of electron spin resonance spectroscopy (ESR) as a way to characterize the interaction and its possibility as a rapid screening tool;

- **Dermal penetration when applied in cosmetic products**
  Determining the dermal penetration of nanomaterials in vitro as a means to estimate consequent absorption and possible toxicity;

- **Migration to food when used in food packaging materials**
  Examining the possibility of nanomaterial leaching from food packaging materials and to determine if there is a safety concern related to these packaging materials; and

- **Possible consequent toxicity**
  Investigating different approaches to study the potential toxicity of nanomaterials used in foods and cosmetics, for example: developing pharmacokinetic-based models for quantitative risk assessment and using alternative animal models.
A Hard Pill to Swallow: Barriers to Effective Regulation of Nanotechnology-Based Dietary Supplements

William B. Schultz
Lisa Barclay
January 14, 2009

Project on Emerging Nanotechnologies
Woodrow Wilson International Center for Scholars
Research priorities

NanoSafe Australia’s current research priorities include the following areas:

- Toxicokinetics (including dermal penetration and distribution), toxicity testing and risk assessment of nanomaterials in sunscreens, specifically zinc oxide and titanium dioxide.
- The development of research tools for nanotoxicology research, specifically:
  - Appropriate physico-chemical characterisation methods for describing nanomaterial toxicity.
  - In vivo toxicokinetics and dermal penetration detection methods for nanomaterials.
  - Appropriate dosimetry models, dose-response relationships and mechanisms of action of nanomaterials.
  - High-throughput methods for rapid nanotoxicity screening.
- Evaluation of occupational health and safety (OHS) measures in the workplace for controlling exposure to engineered nanomaterials.

Many NanoSafe Australia participants are also members of the Australian Research Council Nanotechnology Network (ARCNN) and contributors to the Australian Consortium for the OECD Working Party on Manufactured Nanomaterials (WPMN).
Nanoscience and nanotechnology hand assembling structures of 1-100 nm, food technology does that for centuries using many types of molecules, although such "uncontrolled" process.

• Applications of micro and nanotechnologies to food structure can provide tremendous benefits to the conventional and functional food industry. Some examples: development of new processes, creating new textures, flavors, design of low-calorie foods, increased nutritional value or nutritional "targeted" special diets (hypertension, obesity).

• If we want to take advantage of the opportunities offered by nanoscience and nanotechnology, will be necessary to increase the knowledge of how food structures are formed, how they break and how are digested and absorbed.
Thanks you for your attention
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