An Overview of Opportunities and Challenges of Food Nanoscience/Technology

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Rickey Y. Yada, Ph.D.
Professor and Dean
Faculty of Land and Food Systems
University of British Columbia
Vancouver, BC Canada
r.yada@ubc.ca
Word is relatively new but the concept is not

- Creation of the word/field is relatively “new”
  - Richard Feynman 1959 talk “There’s Plenty of Room at the Bottom” - "nano-scale" machines
  - Nori Taniguchi 1974 “Nano-technology' mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or by one molecule.”
    
    *On the Basic Concept of 'Nano-Technology*

- Concept is old:

[Image of dichroic glass and fullerene]

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The Lycrgus Cup (Rome) is an example of dichroic glass; colloidal gold and silver in the glass allow it to look opaque green when lit from outside but translucent red when light shines through the inside.

http://www.nano.gov/nanotech-101/timeline

Richard Smalley discovered the Buckminsterfullerene (C60), more commonly known as the buckyball, which is a molecule resembling a soccerball in shape and composed entirely of carbon, as are graphite and diamond.

http://www.nano.gov/nanotech-101/timeline
Nano, nano everywhere!

David Hawxhurst
Woodrow Wilson International Center for Scholars
Terminology and Nomenclature
Defining Nanotech

- Two principal parts to defining what is to be considered nanotechnology:
  - (i) **Scale** and (ii) **Uniqueness/novelty**

Nanotechnology is the understanding and control of matter….

- (i) … at dimensions between approximately 1 nm to 100 nm
- (ii) … where unique phenomena enable novel applications
Nano – Food Packaging

Nanoscience in Food Packaging and Food Safety

- Pathogen, Contaminant and Allergen Detection
- UV Protection
- Anticounterfeiting and Security
- High Gas Barrier Plastics
- Antimicrobials
Diffusion of Fluorescently Labeled Bacteriocin from Edible Nanomaterials and Embedded Nano-Bioactive Coatings

• Assess release rates of fluorescently labeled antimicrobial peptide nisin (lantibiotic/biopreservative) from liposomal nanocarriers

• Lanthionine-containing peptides (lantibiotics) are promising antimicrobial agents being investigated as substitutes for current antibiotics

• Pore formation in cell membranes

• Lantibiotics are effective against food-borne microbes including *Listeria monocytogenes* and *Clostridium botulinum*
Diffusion of Fluorescently Labeled Bacteriocin from Edible Nanomaterials and Embedded Nano-Bioactive Coatings

Antimicrobial activity of biodegradable hydroxypropyl methylcellulose (HPMC) coatings against *L. monocytogenes*

A:
- (I control) coatings without nisin
- (II control) coatings embedded with empty nanoliposomes
- (III) active coatings containing nisin
- (IV) nanoactive coatings containing nanoliposomes encapsulated nisin

B:
Quantitative anti-listerial activity assessment of active and nano-active coatings

http://pubs.acs.org/doi/full/10.1021/acsami.6b04621
Nano-Sensors

Potential Applications:

- Pathogen detection (bacteria, viruses)
- Toxin and pesticide detection
- Spoilage detection
- Authenticity and traceability
- Quality control
Nano-Sensors

- UV activated, oxygen sensitive, colored ink based on titanium dioxide.
- Changes color in presence/absence of oxygen.

*Photographs of oxygen indicator ink printed on a MAPed food package. Left: Before UV activation. Middle: After UV activation. Right: On opening the package. (Photographs: David Hazafy, University of Strathclyde)*
Nano-sensors

Microfluidic SERS for “lab-on-a-chip” device of detection of foodborne pathogens

• The “lab-on-a-chip” systems allow the integration of sample preparation, manipulation, separation and detection to achieve a high and fast throughput.

Courtesy of Dr. Xiaonan Lu, UBC
Overview: Microfluidic “Lab-on-a-Chip”

- Sample Interface
  - Liquifaction
  - Cell lysis
  - DNA/RNA extraction
  - Concentration
  - Filtering

- Sample Preparation

- Amplification
  - Thermal cycling (PCR)
  - Isothermal PCR
  - RCA
  - ....

- Separation
  - Electrophoresis
  - Chromatography
  - Hybridization
  - Forces (DEP, centrifugal etc.)

- On-Chip Waste Storage

- Detection
  - Optical
  - Electrochemical
  - Sensors

Xu et al., 2013, *Appl. Phys. Lett.*, 102, 023702
Functional ingredients are essential components in many foods
  - e.g., vitamins, colours, flavours, preservatives, antimicrobials, etc.)

Usually need some sort of delivery system to optimize activity.

Pay load substantially decreased
Nanoencapsulation - nanoemulsions

- A number of potential advantages of using nanoemulsions rather than conventional emulsions for this purpose:
  - Carry the ingredient to the desired site of action
  - Control the release of the ingredient (e.g., release rate) in response an external trigger (e.g., pH, temperature, ionic strength, enzymes, etc.)
  - Greatly increase the bioavailability of lipophilic substances
  - Scatter light weakly and so can be incorporated into optically transparent products
  - Can be used to modulate the product texture
  - A high stability to particle aggregation and gravitational separation
  - Protect the ingredient from chemical or biological degradation
  - Must be compatible with the food attributes (e.g., appearance, texture, taste/flavour)

Various Nano Applications

Table 1  Summary of research and application for micro/nano-emulsion loaded functional compounds.

<table>
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<th>Applications</th>
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<td>Antioxidant</td>
<td>Medicine/Food</td>
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<tr>
<td>β-Carotene</td>
<td>Antioxidants/Vitamin A precursor</td>
<td>Food color</td>
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<tr>
<td>Curcumin</td>
<td>Antioxidant/Anti-inflammatory/Anticancer</td>
<td>Food color</td>
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<td>Phytosterol</td>
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<td>Medicine/Cosmetic/Food additive</td>
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<td>Lycopene</td>
<td>Antioxidant/Anticancer</td>
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<td>Lidocaine</td>
<td>Local anesthetic/Antiarrhythmic drug</td>
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<td>Quercetin</td>
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<td>Thalidomide</td>
<td>Immunomodulatory agent</td>
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<td>Polyunsaturated fatty acids (PUFA)</td>
<td>Anti-inflammatory</td>
<td>Food/Medicine</td>
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<tr>
<td>Oleuropein</td>
<td>Antioxidant</td>
<td>Food</td>
<td>17</td>
</tr>
</tbody>
</table>

5) X. Li, Biomaterials, 34, 481-491 (2013).
Value added versus commodities
Casein nanoparticles as nano-vehicles

- **Casein micelles**
  - Nano-capsules created by nature to deliver nutrients (calcium, phosphate, protein) to the neonate
  - Natural self-assembly tendency of bovine caseins
  - Morphology and average diameter of re-assembled micelles similar to those naturally occurring
  - Useful nano-vehicles for entrapment, protection and delivery of sensitive hydrophobic nutraceuticals within food products, e.g., vitamin D2

Cryo-TEM images of (A) naturally occurring CM in skim milk; (B) and (C) re-assembled CM; (D) D2- re-assembled CM. The bar on the bottom right is 100nm long. (The dark area on the bottom is the perforated carbon film holding the sample.)

Nano-encapsulation of saffron extract through double-layered multiple emulsions of pectin and whey protein concentrate

- Saffron used in foods, pharmaceuticals and cosmetics
- Natural colorant, antioxidant and therapeutic properties
- Crocin (color)
- Picrocrocin (aroma)
- Saffranal (flavor)
- These compounds are unstable
  - Processing temperature
  - Storage temperature
  - pH
  - Light
  - Oxygen
  - Enzymes
  - Proteins
  - Metallic ions

Nano-encapsulation of saffron extract by spray drying was performed successfully.

Encapsulated double-layer W/O/W emulsions had the maximum encapsulation efficiency.

Powder particles of W/O/W emulsions had:
- smooth surfaces
- no pores
- no wrinkles
Health issues

- Diabetes
- Obesity
- Cardiovascular diseases
- Micronutrient deficiencies
Sodium

Less Sodium Soy Sauce

Kikkoman Less Sodium Soy Sauce is brewed exactly the same way as all-purpose Kikkoman Soy Sauce. However, after the fermentation process is completed (approximately) 40% of the salt is removed. Although there is less sodium in Less Sodium Soy Sauce, all the flavor and quality characteristics remain because it is aged before extracting the salt. However, to maintain the full flavor, we recommend using it during the latter stages of cooking in braising sauces, soups and stews, vegetables or stir-fry.


Honzukuri Low Salt Miso 26.4 oz

Product Number - 01217
Bin Number - 7602

Love the flavor of miso paste, but want a healthier option? This low-salt miso paste has the miso taste you love with less salt. Perfect for making a savory, healthy miso soup. Check out our other varieties of miso soup and miso paste.

Bio-molecular carriers

- **Double emulsions (W/O/W)**
  - Inner phase comprised of nano-sized droplets w/ NaCl.
  - Liquid foods - soups

- **Biopolymer-based nanoparticles**
  - pH-sensitive protein-polysaccharide carriers
  - Proprietary polysaccharide carriers
  - Solid foods – cheese
Nutragenomics is a University of Toronto start-up biotechnology company that is dedicated to empowering dietitians and their clients with comprehensive, reliable, genomic information with the ultimate goal of improving health through personalized nutrition. Our Nutragenomix® test kit enables dietitians to counsel their clients according to their unique genetic profile. Our service includes the genetic test kits, genotyping and customized reports based on cutting-edge research and validated biomarkers.

We had our official launch in Canada at the Dietitians of Canada’s annual conference in Toronto, June 14, 2012. Our Australian launch was September 7, 2012 at the International Congress of Dietetics in Sydney where we were official sponsors. We launched to dietitians in the US on October 6, 2012 at the Food & Nutrition Conference & Expo in Philadelphia with a launch to the US public March 1, 2013.

https://www.nutrogenomix.com/about-us
Ethical Issue?

Regulating Direct-to-Consumer Personal Genome Testing

Amy L. McGuire,1* Barbara J. Evans,2 Timothy Caulfield,3 Wylie Burke4

International cooperation and postmarket regulation are needed for Internet-based direct-to-consumer genome tests.

SCIENCE VOL 330 8 OCTOBER 2010

Courtesy Dr. Ahmed El-Sohemy
Problems with iron fortification

- Unpleasant taste and color
- Instability, precipitation
- Toxicity, nausea, vomiting, poor appetite, diarrhea and constipation
- Poor bio-availability
New product Fe (ave size 0.3 µm)

Ferric pyrophosphate (ave size 5.2µm)

Laser diffraction particle counter
Supersonic wave: 2 min.

Courtesy of Dr. Lekh Juenja
Stability of Iron Sources

Nano Fe
Clear

Ferric pyrophosphate
White precipitation

Ferrous sulfate
Brown precipitation

Sodium ferrous citrate
Yellowish-brown

5 mg Fe / 100 ml, pH 7.0, stored at 40°C under dark conditions
Storage time: Nano Fe for 3 months, all others 2 days

Courtesy of Dr. Lekh Juneja
A method of species identification based on DNA sequences derived from standard marker genes for animals (COI), plants (rbcL and matK) and fungi (ITS).

The hypothesis is that, for that gene segment, every species will have a unique sequence (or a unique assemblage of closely related sequences).

This sequence is termed a ‘barcode’. For example:

Species A: CCTAAGCTTACGTTTCC
Species B: CCTAGGCTTACGTTACC

Courtesy of Drs. Bob Hanner and Steve Newmaster, Univ. of Guelph
Authenticity/Traceability

STUDY » YOU THOUGHT YOU ORDERED SEA BASS

Fishy business
You say tuna, I say tilapia: DNA testing shows that one-quarter of fish is mislabeled

BY REBECCA DUBE

Before you bite into that fish and chips or spend $30 on halibut at the supermarket, you may want to take a second look: 25 per cent of fish is mislabelled, according to a University of Guelph study published today that used DNA analysis to determine the true identity of fish sold in Toronto and New York.

One sample sold as tuna turned out to be tilapia; halibut was really hake; and red snapper was, on different occasions, lavender jobfish, Labrador redfish, perch and cod.

"There's not a lot of regulation around fin fish; it's basically been ignored," says study co-author Robert Hanner, associate director for the Canadian Barcode of Life Network and an assistant professor of biology at the University of Guelph.

"Now that we have the tool to do it, we probably have an obligation to start testing."

He and co-author Eugene Wong tested 96 samples of fish from grocery stores, markets and restaurants in New York and Toronto. They analyzed the DNA of each fish and compared it with a global database of species. They intended simply to test the database, which performed well, identifying each piece of fish they found. Discovering so much fish fraud was a surprise.

SEE ‘FISH’ PAGE 3
That herbal supplement may not be what you think it is, scientists find

HELEN BRANSWELL
TORONTO — The Canadian Press
Published Friday, Oct. 11 2013, 8:25 AM EDT
Last updated Friday, Oct. 11 2013, 8:55 AM EDT

DNA doesn’t lie.

And when scientists from the University of Guelph scoured the DNA in a number of herbal products, they found that many times the labels on the merchandise didn’t accurately reflect what was in the container.

Some products contained fillers like wheat or rice that were not listed on the label. Some were contaminated with other plant species that could have caused toxicity or triggered allergic reactions. And still others contained no trace of the substance the bottle purported to contain.
Challenges

- Regulatory challenge
- Consumer attitude/acceptance
Regulatory Challenges

EFSA Scientific Network of Risk Assessment of Nanotechnologies in Food and Feed
European Food Safety Authority

European Food Safety Authority (EFSA), Parma, Italy

TECHNICAL REPORT

EFSA Scientific Network of Risk Assessment of Nanotechnologies in Food and Feed
European Food Safety Authority

SUMMARY

EFSA is closely following developments in the area of nanotechnologies in food and food in order to address the need to provide further operational support and to strengthen cooperation with the Member States and institutional partners in the EU and International framework formulated by EFSA’s Management Board and networking with Member States, the Science Board, and other stakeholders.

The main overall goals of the Nano Network are to promote understanding of risk assessment by completing scientific assessments carried out in EU Member States and EFSA. These assessments develop EU-wide guidance.

The network is currently composed of coordination actions and is organized by the EFSA for the countries participating in the Network. The first meeting in February 2011, one meeting was held in July 2011.

The 2011 report of the Nano Network, entitled "Nano Network (2011) - EFSA Scientific Network of Risk Assessment of Nanotechnologies in Food and Feed, Supporting Publications 2012-EFSA" (http://www.fda.gov/ScienceResearch/SpecialTopics/Nanotechnology/default.htm), highlights the importance of nanotechnologies in food and food products. It notes that nanomaterials can be found in foods, food products, and in foods and food products, and highlights the need for a comprehensive risk assessment.


Acknowledgement: EFSA wishes to thank the EFSA Scientific Network of Risk Assessment of Nanotechnologies in Food and Feed for their support and cooperation.


One of the challenges of regulation in Canada – many agencies

http://nanoportal.gc.ca/default.asp?lang=En&n=23410d1f-1
Canada:

  - Food and Drugs Act
  - Cosmetic Regulations
  - Food Additive Regulations
  - Food and Drug Regulations
  - Medical Devices Regulations
  - Natural Health Products Regulations
  - New Substances Program Advisory Note 2007-06
  - Interim Policy Statement on Health Canada's Working Definition for Nanomaterials


- Environment Canada
  - Regulating Nanomaterials under the Canadian Environmental Protection Act
FDA’s approach
http://www.fda.gov/ScienceResearch/SpecialTopics/Nanotechnology/ucm301114.htm

- Regulation and oversight
- Regulatory Science Research Plan
  http://www.fda.gov/ScienceResearch/SpecialTopics/Nanotechnology/ucm273325.htm
United States Food & Drug Authority

FDA issues guidance to support the responsible development of nanotechnology products

Today, three final guidances and one draft guidance were issued by the U.S. Food and Drug Administration providing greater regulatory clarity for industry on the use of nanotechnology in FDA-regulated products.

One final guidance addresses the agency’s overall approach for all products that it regulates, while the two additional final guidances and the new draft guidance provide specific guidance for the areas of foods, cosmetics and food for animals, respectively.

Nanotechnology is an emerging technology that allows scientists to create, explore and manipulate materials on a scale measured in nanometers—particles so small that they cannot be seen with a regular microscope. The technology has a broad range of potential applications, such as improving the packaging of food and altering the look and feel of cosmetics.

“Our goal remains to ensure transparent and predictable regulatory pathways, grounded in the best available science, in support of the responsible development of nanotechnology products,” said FDA Commissioner Margaret A. Hamburg, M.D. “We are taking a prudent scientific approach to assess each product on its own merits and are not making broad, general assumptions about the safety of nanotechnology products.”

The three final guidance documents reflect the FDA’s current thinking on these issues after taking into account public comment received on the corresponding draft guidance documents previously issued (draft agency guidance in 2011, and draft cosmetics and foods guidances in 2012).

The PDA does not make a categorical judgment that nanotechnology is inherently safe or harmful, and will continue to consider the specific characteristics of individual products. All four guidance documents encourage manufacturers to consult with the agency before taking their products to market. Consultations with the FDA early in the product development process help to facilitate a mutual understanding about specific scientific and regulatory issues relevant to the nanotechnology product, and help address questions related to safety, effectiveness, public health impact and/or regulatory status of the product.
European Food Safety Authority

- European Food Safety Authority

- Inventory of Nanotechnology applications in the agricultural, feed and food sector

- Nano inventory PDF presentation
Nanotechnology and Food

(Last updated January 2014)

The term nanotechnology is used to describe engineered matter that is generally less than 100 nanometres (nm) in size in one dimension. One nm is one billionth of a metre.

Food and water are naturally made up of nm-scale particles. For example, proteins are in the nanoscale size range and milk is an emulsion of nanoscale fat droplets.

Humans are also exposed to ultrafine and nm scale particles such as smoke, dust, ash, and fine glass fibres through the air, food and water. Scientists estimate that in urban air we may inhale millions of nanoscale particles in every breath.

Any new foods manufactured using nanotechnologies that may present safety concerns will have to undergo a comprehensive scientific safety assessment before they can be legally supplied in Australia and New Zealand.

Using the best available scientific evidence, FSANZ has adopted a range of strategies to continually review and manage potential risks associated with nanotechnologies in foods to ensure the public are not exposed to any health or safety issues.

These strategies include:

- amending the FSANZ Application Handbook to support new food regulations and ensure applicants provide all the necessary information to help FSANZ conduct a risk assessment
- advising the food industry about the amendments to the Application Handbook involving nanotechnology and asking industry for information about proposed nanotechnology applications
- engaging with other national and international regulatory agencies, industry and the public to outline FSANZ’s regulatory response

FSANZ has not received any applications to approve new or novel nanoscale particles for food use.

Find out more about nanotechnology on the Department of Industry website.

More information

International organizations

- **OECD Working Party on Nanotechnology (WPN)**
  - Working Party on Manufactured Nanomaterials (WPMN, subsidiary to the Chemicals Committee)
  - Working Party on Biotechnology (WPB)
  - National Experts for Scientific and Technological Indicators (NESTI) and their parent committees

- **International Cooperation on Cosmetic Regulation (ICCR)**
When talking about nanoscience/technology are all objects/particles synthesized (Engineered Nano Materials)?

**NO!!**


http://www.foodscience.uoguelph.ca/deicon/casein.html

Scientific American Jan. 18 2008
Science, Philosophy Debates

- Is the debate around nanotechnology similar to the debate around genetically modified organisms (GMO)?
Abstract

In matters characterized by a high degree of complexity or uncertainty, such as the social and ethical dimensions of an emerging technology, it is often useful to begin with historical analogies (Steinbruner 2002). In the case of nanotechnology, one of the favored analogs is genetically modified (GM) foods. Even a cursory read of the first generation of social and ethical issues (SEI) literature on nanotechnology reveals that the GM food analogy plays prominently in motivating and framing the discourse, if not the agenda of SEI research. This chapter offers critical reflections on the comparisons between nanotechnology and GM foods. The aim is to identify the respects in which the comparisons are helpful in clarifying and responding to the SEI associated with emerging nanotechnologies, as well as the respects in which the comparisons are unhelpful or misleading. After reviewing several similarities and dissimilarities between the two types of technologies, three potential lessons from the GM food experience for emerging nanotechnologies are evaluated: a lesson on public engagement; a lesson on technological fixes; and a lesson on case by case assessment.
What are some of the issues consumers/public concerned about?

- Transparency and inclusivity
- Fear of the unknown
- Can we guarantee zero risk?
- Is science static?
Abstract

Purpose – Nanotechnology is a technology that holds much promise for food production. It is, however, not clear to what extent consumers will accept different types of nanotechnologies in food products. The purpose of this paper is to research consumer attitudes towards differing applications of food nanotechnologies.
How much do consumers really know about nanotechnology?

‘Better safe than sorry’: consumer perceptions of and deliberations on nanotechnologies
Lucia A. Reisch¹, Gerd Scholl² and Sabine Bietz³

Abstract
Although nanotechnologies are considered key technologies that can drive growth-generating innovations in well-saturated markets, worldwide investment in nanotechnologies has to date focused largely on technology-related development programmes and little effort has been expended to research associated risks. As a result, even though prior discourses have sensitized western consumers to potential health-related dangers, solid knowledge on, for example, the toxicological and eco-toxicological risks and unintended side effects of nanotechnology are scarce. This paper therefore presents an overview of the current evidence on consumer knowledge and perceptions of nanotechnology and public engagement with it, with a focus on the US, the UK and Germany. Overall, even though survey data suggest that awareness of the term ‘nanotechnology’ has risen slightly, today’s consumers are generally ill informed about its nature and its applications in consumer-related products. Hence, based on our analysis of these data, we argue that early political engagement in the nanotechnology issue – for example, consumer policy options that support consumer interest in the marketing of ‘nanos’ – would facilitate objective public discourse.
Abstract

This study assesses two key types of knowledge assessments, factual and perceived knowledge, in the study of knowledge gaps. In addition, we distinguish between communication channels in exploring the phenomenon, examining nanotechnology knowledge gaps based on levels of attention to traditional media, science blog use, and the frequency of interpersonal discussion. Using regression analysis, we find that how researchers measure knowledge can significantly affect the discovery of gaps. We also find differential effects based on communication channels, including evidence that the direction of perceived gaps in knowledge can be reversed as media consumption increases. Implications of these findings are discussed.

Undergraduate Students' Risk Perception and Argumentation Concerning Nanomaterials in Consumer Products

Authors: Karlsson, Caroline; Enghag, Margareta; Wester, Misse; Schenk, Linda

Source: Journal of Nano Education, Volume 6, Number 1, June 2014, pp. 50-62(13)

Publisher: American Scientific Publishers

Abstract:

In the present paper we combine two analytical frameworks in order to extend our understanding of how students reason about a socio-scientific issue, namely, nanomaterials in consumer products. Using the results from two focus group discussions including seven students each, we first thematically explored undergraduate engineering students' risk perception. Two main themes were found in this analysis: "Exploring the concept of nanotechnology" and "Handling risks with nanotechnology." Second, we analyzed the nature of students' arguments using the SEE-SEP model, which is a coding scheme based on the subject areas Sociology/Culture, Environment, Economy, Science, Ethics/Morality, and Policy, intertwining the three aspects Knowledge, Values, and Personal experience. According to this analysis, 55% of the participants' arguments were based on values, 25% on knowledge, and 20% on personal experiences. Despite the absence of specific knowledge, however, the students could conduct a complex argumentation about nanomaterials and actively examined the paradox of new opportunities but unresolved risks. The students' reasoning reveals that arguments in favor and arguments against the use of nanomaterials in different products do not cross each other out, but co-exist. The results indicate that the risk perception was influenced to some degree by the area of use, such as skin care products or car treatment. It was also found that when lacking specific knowledge, our participants turned to analogies to other technology developments. Implications for education on nanotechnology are discussed.
Educating the public, especially the young

For K-12 Students

No matter how old or you are, learning about nanotechnology can be fun and exciting. All around the country, we have found new ways to learn about nanotechnology. There are museum exhibits with hands-on experiments and exhibits, and even if you can't get there, you can watch the experiments and visit the museums online. There are magazines with cool stories and games about nanotechnology. Check out the nanotechnology bus that drives around the country and find out when it's coming to your town. There's even a program to learn about nanotechnology by playing with Legos®!

Here you will see that nanotechnology is not just one thing. It is chemistry, physics, biology and materials science at the molecular level. After all, every one of us is made of atoms!

Check out these links to learn more about the fun and interesting ways you can learn about nanotechnology. (You may need to install the latest version of Flash to play some of the games.)

NanoMaze is an online and print science magazine created by Cornell University as part of the education programs of the NNN—the National Nanotechnology Infrastructure Network. It has online games, articles, and a blog, and you can view it in English, Spanish, and Portuguese.

http://www.nano.gov/education-training/k12
Helping the public understand nanotechnology

http://www.understandingnano.com/introduction.html

http://www.umt.edu/ethics/debatingscienceresourcecenter/nanotechnology/NanoODC/default.aspx
Educating the public, especially the young

http://www.nanooze.org/english/nanooze_newsletters.html
Effective in touch with people to improve perception

Courtesy of Dr. Hongda Chen, USDA, NIFA
Education - Websites

http://nanoyou.eu/
Educational Programs
Nanoscience B.Sc. Program

A dramatic transformation in science and technology is coming. The next fifty years will see new inventions, novel products, stunning medical advances, remarkable energy solutions, and creative answers to controlling and understanding biological processes - and nanoscience is making them all possible.

The Guelph Factor

The University of Guelph strongly believes in the personal approach to education. Professors teaching Nanoscience are always eager to help you become an independent learner, one step at a time.

Research-based Curriculum

Our wide ranging research forms the basis of the nanoscience
Scientific Challenges

- Identification and characterisation of nanoparticles within the food matrix
- Uptake and absorption
- Safety
Some current references
Progress Review on the Coordinated Implementation of the National Nanotechnology Initiative 2011 Environmental, Health, and Safety Research Strategy

Subject Area:
NNI Publications and Reports
NNI Strategic Documents
EHS-related Documents
Author: CcT/NSET/NEHI
Publication Date: Jun. 25 2014

Description:

Executive Summary

This document provides an overview of progress on the implementation and coordination of the 2011 NNI EnvironmentaL, Health, and Safety (EHS) Research Strategy that was developed by the Nanoscale Science, Engineering, and Technology Subcommittee’s Nanotechnology Environmental and Health Implications (NEHI) Working Group. Consistent with the adaptive management process described in this strategy, the NEHI Working Group has made significant progress through the use of various evaluation tools to understand the current status of nanotechnology-related EHS (nanoEHS) research and the Federal nanoEHS research investment.

Most notably, the participating agencies reported to the NEHI Working Group examples of ongoing, completed, and anticipated EHS research (from FY 2009 through FY 2012) relevant to implementation of the 2011 NNI EHS Research
Abstract

The risks and benefits of nanomaterials in foods and food contact materials receive conflicting international attention across expert stakeholder groups as well as in news media coverage and published research. Current nanomaterial characterization is complicated by the lack of accepted approaches to measure exposure-relevant occurrences of suspected nanomaterials in food and by broad definitions related to food processing and additive materials. Therefore, to improve understanding of risk and benefit, analytical methods are needed to identify what materials, new or traditional, are “nanorelevant” with respect to biological interaction and/or uptake during alimentary tract transit. Challenges to method development in this arena include heterogeneity in nanomaterial composition and morphology, food matrix complexity, alimentary tract diversity, and analytical method limitations. Clear problem formulation is required to overcome these and other challenges and to improve understanding of biological fate in facilitating the assessment of nanomaterial safety or benefit, including sampling strategies relevant to food production/consumption and alimentary tract transit. In this Perspective, we discuss critical knowledge gaps that must be addressed so that measurement methods can better inform risk management and public policy.
Towards reference materials for nanoparticles in food

The JRC-IRMM combined its competence in the measurement of nanomaterials with its proficiency in the production of reference materials to develop a soup reference material spiked with silica nanoparticles.

A set of four reference materials for the detection and quantification of silica nanoparticles in tomato soup were produced. These materials aim to support the challenging work of verifying the correct labelling of nanomaterials in complex matrices such as food and consumer products.

Silica, e.g. labelled as E551, is already an approved food additive in the EU and can be used as an anti-caking agent in soup powders and similar foodstuff. It may contain nanoparticles and Regulation 1169/2011 stipulates that from December 2014 on, consumers must be informed whether ingredients are present in their nano-form. Without suitable methods to check the correctness of statements, the implementation of such legislation will not be possible. To improve the availability of reliable and validated methods, the EU Project Nanolyse developed and validated analytical methods for the detection and quantification of nanomaterials in food. A second aspect of this project was the development of the first reference materials for nanoparticles in food matrices worldwide.

In close collaboration with the other project partners, homogeneity and stability of the material were assessed and first steps towards a value assignment were made. The data obtained demonstrate that the production of a certified reference material should be feasible.


Measurement Methods to Evaluate Engineered Nanomaterial Release from Food Contact Materials

Gregory O. Noonan, Andrew J. Whelton, David Carlander, and Timothy V. Duncan

Abstract: This article is one of a series of 4 that report on a task of the NanoRelease Food Additive project of the Intl. Life Science Inst. Center for Risk Science Innovation and Application to identify, evaluate, and develop methods that are needed to confidently detect, characterize, and quantify intentionally produced engineered nanomaterials (ENMs) released from food along the alimentary tract. This particular article focuses on the problem of detecting ENMs that become released into food indirectly from food contact materials. In this review, an in-depth analysis of the release literature is presented and relevant release mechanisms are discussed. The literature review includes discussion of articles related to the release phenomenon in general, as experimental methods to detect ENMs migrating from plastic materials into other (nonfood) complex matrices were determined to be relevant to the focus problem of food safety. From the survey of the literature, several “control points” were identified where characterization data on ENMs and materials may be most valuable. The article concludes with a summary of findings and a discussion of potential knowledge gaps and targets for method development in this area.

Keywords: characterization, detection, food contact materials, food safety, measurement methods, migration, nanotechnology, release
Measurement Methods for the Oral Uptake of Engineered Nanomaterials from Human Dietary Sources: Summary and Outlook

Christopher Szakal, Lyubov Tsytisikova, David Carlander, and Timothy V. Duncan

Abstract: This article is one of a series of 4 that report on a task of the NanoRelease Food Additive (NRFA) project of the International Life Science Institute Center for Risk Science Innovation and Application. The project aims are to identify, evaluate, and develop methods that are needed to confidently detect, characterize, and quantify intentionally produced engineered nanomaterials (ENMs) released from food along the alimentary tract. This particular article offers an overview of the NRFA project, describing the project scope and goals, as well as the strategy by which the task group sought to achieve these goals. A condensed description of the general challenge of detecting ENMs in foods and a brief review of available and emerging methods for ENM detection is provided here, paying particular attention to the kind of information that might be desired from an analysis and the strengths and weaknesses of the various approaches that might be used to attain this information. The article concludes with an executive summary of the task group’s broad findings related to the 3 topic areas, which are covered in more detail in 3 subsequent articles in this series. The end result is a thorough evaluation of the state of ENM measurement science specifically as it applies to oral uptake of ENMs from human dietary sources.

Keywords: characterization, detection, food safety, measurement methods, nanomaterials, nanotechnology, nanotoxicology
Engineered Nanoscale Food Ingredients: Evaluation of Current Knowledge on Material Characteristics Relevant to Uptake from the Gastrointestinal Tract

Rickey Y. Yada, Neil Buck, Richard Canady, Chris DeMerlis, Timothy Duncan, Gemma Janer, Lekh Juneja, Mengshi Lin, Julian McClements, Gregory Noonan, James Oxley, Cristina Sabliov, Lyubov Tsytsikova, Socorro Vázquez-Campos, Jeff Yourick, Qixin Zhong, and Scott Thurmond

Abstract: The NanoRelease Food Additive project developed a catalog to identify potential engineered nanomaterials (ENMs) used as ingredients, using various food-related databases. To avoid ongoing debate on defining the term nanomaterial, NanoRelease did not use any specific definition other than the ingredient is not naturally part of the food chain, and its dimensions are measured in the nanoscale. Potential nanomaterials were categorized based on physical similarity; analysis indicated that the range of ENMs declared as being in the food chain was limited. Much of the catalog's information was obtained from product labeling, likely resulting in both underreporting (inconsistent or absent requirements for labeling) and/or overreporting (inability to validate entries, or the term nano was used, although no ENM material was present). Three categories of ingredients were identified: emulsions, dispersions, and their water-soluble powdered preparations (including lipid-based structures); solid encapsulates (solid structures containing an active material); and metallic or other inorganic particles. Although much is known regarding the physical/chemical properties for these ingredient categories, it is critical to understand whether these properties undergo changes following their interaction with food matrices during preparation and storage. It is also important to determine whether free ENMs are likely to be present within the gastrointestinal tract and whether uptake of ENMs may occur in their nanoform physical state. A practical decision-making scheme was developed to help manage testing requirements.

Keywords: bioavailability, food ingredient, nanotechnology
Methods to Evaluate Uptake of Engineered Nanomaterials by the Alimentary Tract

Heather Alger, Dragan Momcilovic, David Carlander, and Timothy V. Duncan

Abstract: This article is one of a series of 4 that report on a task of the NanoRelease Food Additive project of the International Life Science Institute Center for Risk Science Innovation and Application to identify, evaluate, and develop methods that are needed to confidently detect, characterize, and quantify intentionally produced engineered nanomaterials (ENMs) released from food along the alimentary tract. This particular article focuses on the problem of detecting and characterizing ENMs in the various compartments of the alimentary tract after they have been ingested from dietary sources. An in depth analysis of the literature related to oral toxicity of ENMs is presented, paying particular attention to analytical methodology and sample preparation. The review includes a discussion of model systems that can be used to study oral uptake of ENMs in the absence of human toxicological data or other live-animal studies. The strengths and weaknesses of various analytical and sample preparation techniques are discussed. The article concludes with a summary of findings and a discussion of potential knowledge gaps and targets for method development in this area.

Keywords: alimentary tract, characterization, detection, food safety, measurement methods, nanotechnology, nanotoxicology
Issues – moving forward

- Many potential benefits but must also identify any potential risks
- Various governments/agencies are in the process of developing policies/regulations
- Need to educate consumers/public to avoid a repeat of the discussion involving Genetically Modified Organisms
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Some nanofood for thought
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