Health Effects of Foodborne Engineered Nanoparticles: Case Studies of Nanoemulsions and Titanium Dioxide Nanoparticles



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UMassAmherst Organic Nanoparticles in Foods: Origins & Applications

Lipids

- Examples: Surfactant Micelles & Lipid Droplets
- Function: Flavor, Texture, Appearance, Nutrition, Delivery

Proteins

- Examples: Casein Micelles & Protein Particles
- Function: Nutrition, Appearance, Delivery

Carbohydrates

- Examples: Nano-starch, Nano-cellulose, Nanogels
- Function: Texture, Appearance, Delivery











Inorganic Nanoparticles in Foods: Origins & Applications

Silver (Ag)

- Products: Containers, Packaging
- Function: Antimicrobial
- Iron Oxide (Fe₂O₃)
 - Products: Fortified Foods & Supplements
 - Function: Nutrition

• Titanium Dioxide (TiO₂)

- Products: Gums, Candies, Bakery Goods
- Function: Whitening

• Silicon Dioxide (SiO₂)

- Products: Salt, Sugar, Dried Milk, Dried Ingredients
- Function: Anticaking & Flow

• Zinc Oxide (ZnO)

- Products: Fortified Foods & Supplements
- Function: Nutrition







Food Nanoparticles:

Titanium Dioxide

- Origin: Chemical processing of titanium-rich ores
- Function: Lightening agents



http://nanocomposix.com/collections/titaniumdioxide-nanoparticles

Nanoemulsions

- Origin: Microfluidization
- Function: Appearance, Texture, Flavor, Delivery

Intentional versus Non-intentional



UMassAmherst Food Nanoparticles: Characteristics



Food Nanoparticles: Gastrointestinal Tract Fate



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Absorption of lipophilic food components (<u>LC</u>) encapsulated in <u>nanoemulsions</u>



Formation of mixed micelles (Cryo-TEM)



Oleic Acid (C_{18:1})

Linoleic Acid (C_{18:2})

Lenolenic Acid (C_{18:3})

Control **C18:2** C18:3 **C18:1**







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Nanoemulsions Enhanced Bioavailability of <u>Pterostilbene</u> in Mice



Human Feeding Study





Directed Assembly of <u>Lipid</u> <u>Nanoparticles</u> in Gastrointestinal Tract to Enhance Health Benefits of Lipophilic Food Components





Surh. YJ. NRC. 2003.

Food Design: Excipient Foods



Cooking Sauce (Cooked Vegetables)



Coatings (Raw Nuts)



Cream or Yogurt (Raw Fruit)



From: The hierarchical structure and mechanics of plant materials Lorna J. Gibson. Interface 12 (104), 2012





Salad Dressing (Raw Vegetables)

TiO₂ Nanoparticles are found in many foods





Whitening agents





TiO₂ Nanoparticles: Change in Particle Corona





Intestine

Bare Particle (pH 7) Mucin-Protein Coated-Particle (pH 7) Mucin-Protein Coated-Particle (pH 3) Bile Salt-Protein Coated-Particle (pH 7)



TiO₂ NPs: life-long exposure

