DOI:10.26524/nr.4.8
4(3) (2021) 1-3
OPEN ACCESS

Applications of Nanomaterials in Food Industry: A Review

V. Prabhakar Rao [1], Sri Saivenkatesh Korlam [2], T. Gunasekhar [3]

Abstract

TA nanoparticle is a small particle whose size ranges between 1 to 100 nanometres at least in one dimension. Undetectable by the human eye, nanoparticles can exhibit significantly different physical and chemical properties compared to their larger material counterparts. This is due to a very large surface area to volume ratio when compared to bulk material. When the particle size goes to nanometer range quantum mechanical effects such as quantum confinement dominate the material properties. This feature enables nanoparticles to possess unexpected optical, physical and chemical properties. Due to these unexpected properties, nanoparticles find enormous applications in various fields such as medicine, agriculture, food, energy storage, electronics, pharmaceuticals etc. In this article we concentrate on applications of nanoparticles in food industry.

Keywords: Nanoparticle, surface area to volume ratio, quantum confinement,one dimension.

Author Affiliation: [1]Department of Chemistry, Dr.YSR Govt. Degree College,Vedurukuppam,Andhra Pradesh.
[2]Department of Botany, Govt. Degree & PG College, Puttur,Andhra Pradesh.
[3]Department of Chemistry, S.V.Arts College,Tirupathi,Andhra Pradesh.
Corresponding Author: V. Prabhakar Rao.Department of Chemistry, Dr.YSR Govt. Degree College,Vedurukuppam,Andhra Pradesh.
Email: vipparlaprabhakararao@gmail.com

How to cite this article: V. Prabhakar Rao.Applications Of Nanomaterials In Food Industry:A Review 1-3.
Retrieved from https://nanoscalereports.com/index.php/nr/article/view/71
Received: 12 November 2021 **Revised:** 15 December 2021 **Accepted:** 27 December 2021

1.INTRODUCTION

Materials with any external dimension in the nanoscale (size range from approximately 1 – 100 nm) or having internal structure or surface structure in the nanoscale are called nanomaterials. The sources of nanomaterials are natural or incidental or engineered. Nano-objects are often categorized as to how many of their dimensions fall in the nanoscale. A nanoparticle is defined as a nano-object with all three external dimensions in the nanoscale. A nanofiber has two external dimensions in the nanoscale, with nanotubes being hollow, nanofibers and nanorods being solid nanofibers. A nanoplate/ nanosheet has one external dimension in the nanoscale [1,2], and if the two larger dimensions are significantly different it is called a nanoribbon. The first observations and size measurements of nano-particles were made during the first decade of the 20th century. Zsigmondy made detailed studies of gold sols and other nanomaterials with sizes down to 10 nm and less. He published a book in 1914.[3] He used an ultramicroscope that employs a dark field method for seeing particles with sizes much less than light wavelength. There were some other traditional methods employed for characterising nanomaterials such as light scattering, ultrasound attenuation spectroscopy. For characterizing surface charge or zeta potential of nano-particles in solutions, microelectrophoresis, electrophoretic light scattering and electroacoustics techniques were used.Novel effects can occur in materials when structures are formed with sizes in nanometer scale. In these cases, quantum mechanical effects can dominate material properties. Inaddition to this, high surface area to volume ratio of nanomaterials totally change the characteristics of these materials. Hence, nanomaterials find applications, with improved properties, virtually in every field of science and technology.

The food industry is beginning to use nanotechnology to develop nanoscale ingredients to improve colour, texture and flavour of food.[4,5] Nanotechnology also impacts every aspect of the food system from cultivation to food production to processing, packaging, transportation, shelf life and bioavailability of nutrients. Detailed discussion on applications is discussed in the next section.

2.APPLICATIONS

As it has been discussed in earlier section, nanomaterials have applications virtually in every walk of life. However, we are confined to applications in food industry only in this article.
The benefits of nanotechnology for the food industry are many and are expected to grow with time. This new, rapidly developing technology impacts every aspect of the food system from cultivation to food production to processing, packaging, transportation, shelf life and bioavailability of nutrients.

- **Nanomaterialsas antimicrobial agents:** Fresh fruits, vegetables, meat and poultry products are potential vehicles for the transmission of human pathogens leading to foodborne disease outbreaks[6] which draw public attention to food safety. Therefore, there is a need to develop new antimicrobials to ensure food safety. Because of the antimicrobial properties of nanomaterials, nanotechnology offers great potential for novel antimicrobial agents for the food and food-related industries. Also, the antimicrobial properties of nanomaterials enable them to preserve food during storage and transport. [7,8,9] A wide range of nanomaterials have been demonstrated to possess antimicrobial effects, including iron (III) oxide, zinc oxide, magnesium oxide, silver[10] gold, copper[11] and copper oxide, calcium oxide, titanium dioxide and cadmium oxide among others.

- **Nanomaterials for colour, texture and flavour of food:**The food industry is beginning to use nanotechnology to develop nanoscale ingredients to improve colour, texture and flavour of food.[12] The nanoparticles TiO2 and SiO2[13] and amorphous silica[14] are used as food additives. TiO2 is used as a colouring in the powdered sugar coating on doughnuts. It is added as colouring agent to make food more visually appealing. Silica is used as an anti-caking agent to improve flow property of powered ingredients and as a carrier for flavours or active compounds in food.
- **Nanomaterials in food production and packaging:**Nanomaterials used for food packaging provide many benefits such as improved mechanical barriers, detection of microbial contamination and potentially enhanced bioavailability of nutrients. This is perhaps the most common application of nanotechnology in food and food-related industries.[15] A number of nanocomposites, polymers containing nanoparticles, are used by the food industry for food packaging and food contact materials[16]. The use of ZnO and MgO nanoparticles for food packaging has been reported.[17] Amorphous silica is used in food and in food containers and packaging.[14] Engineered water nanostructures generated as aerosols are very effective at killing foodborne pathogens such as Escherichia coli, Listeria and Salmonella on steel food production surfaces.[18]
- **Nanomaterials in nutrients and dietary supplements:**Nanomaterials are used as ingredients and additives in nutrients and health supplements (e.g., vitamins, antimicrobials, antioxidants) for enhanced absorption and bioavailability.[19] Also, using nanotechnology nano-encapsulated nutrients such as vitamins or nano-sized calcium or iron are created and added to drinks and food with no effects on clarity or visual appeal. Nutrientsin nano stateare absorbed faster in the body. Fortification of edible products (e.g., food, food constituents or supplements) with nutrients or non-nutrient bioactive components can help to balance the total nutrient profile of a diet and supplement nutrients lost in processing and thus to correct or to prevent insufficient nutrient intake and from the associated deficiencies.[20] Compounds of natural origin, such as curcumin (CUR) occurring in turmeric, ω-3-fatty acid in fish oil, vitamins from fruits, when encapsulated in an appropriate nanocarrier, will be released after consumption of the food in the target organ and utilized according to its nutritional property.[21]
- **Food nanosensors:**Nanomaterials are used as sensors to detect contamination and regulate the food environment. They can detect pathogenic bacteria, food-contaminating toxins, adulterants, vitamins, dyes, fertilizers, pesticides, taste and smell. Therefore, they are used as sensors in food production andat packaging plants. They can monitor the condition of food during transport and storage.[22] They can detect nutrient deficiency in edible plants and dispensers containing nutrients can deliver them to plants when needed. Therefore, nanomaterials can be used as nanosensors and nanotracers with almost unlimited potential by the food industry.[23] Nanosensors can detect pathogenic bacteria, food-contaminating toxins, adulterant, vitamins, dyes, fertilizers, pesticides, taste and smell. Food freshness can be monitored using time–temperature and oxygen indicators. Overall, nanosensors with unique properties are improving food security.

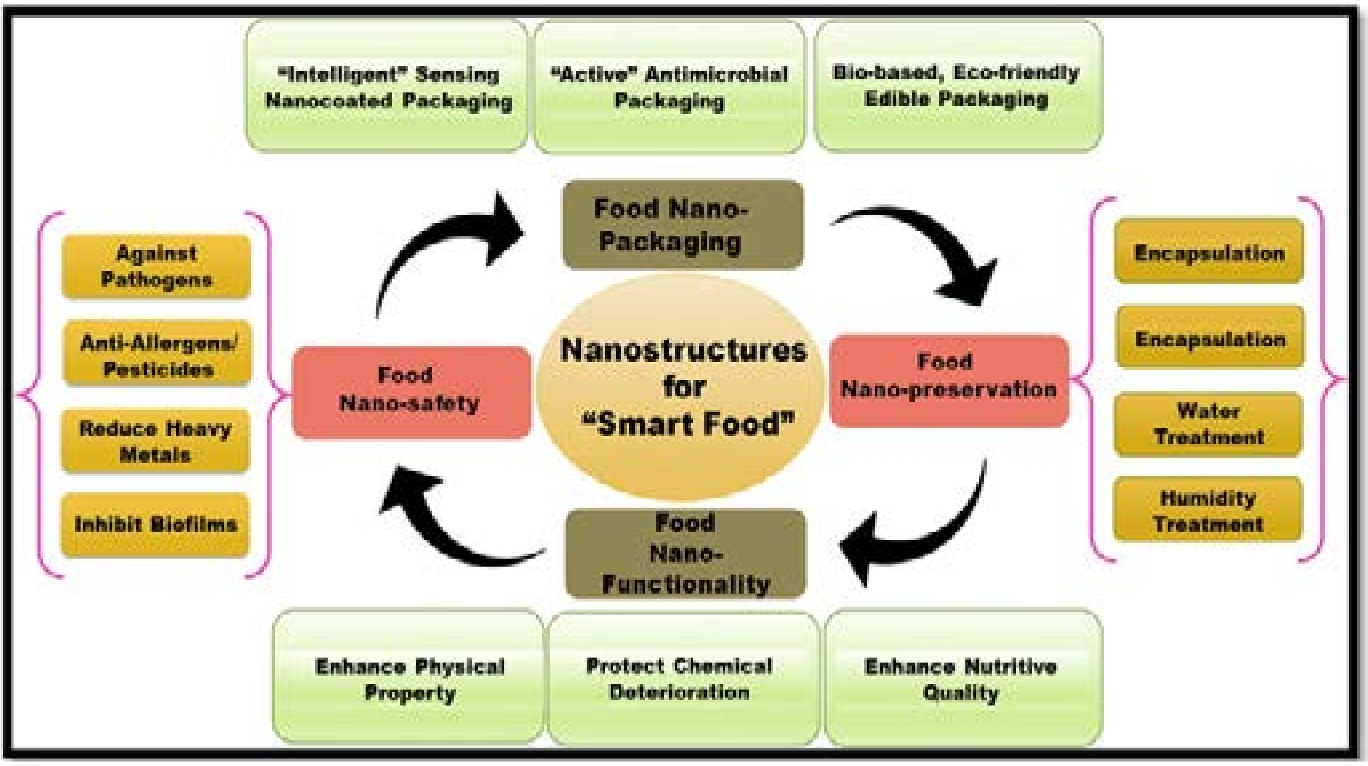

Figure: Applications of nanomaterials in various areas food industry

CONCLUSION

Undoubtedly, the nano materials have potential applications in every walk of life. Hence, much more research is to be done in nanotechnology to improve the quality of life. At the same time a note of caution is the health impact of nanomaterials in food which is of public interest and concern. Public acceptance of food and food-related products containing nanomaterials will depend on their safety. These potential risks of using nanomaterials in food industry are determined by nanoscientists using nanotoxicology, which is a branch of toxicology and an interdisciplinary field that concerns varied toxic aspects of nanomaterials. A greater concentration on nanotoxicology is the need of the hour.Finally, a uniform international regulatory framework for nanotechnology in food is necessary to address all these issues.

Acknowledgemet

Nill

Funding

No funding was received to carry out this study.

References

1. Rawat, Pankaj Singh, "Structural, functional and magnetic ordering modifications in graphene oxide and graphite by 100 MeV gold ion irradiation", Vacuum 182:109700, (2020).
2. "ISO/TS 80004-2:2015 - Nanotechnologies – Vocabulary – Part 2: Nano-objects", International Organization for Standardization, Retrieved 8 January 2018, (2015).
3. R. Zsigmondy, "Colloids and the Ultramicroscope", J. Wiley and Sons, NY, (1914).
4. R. Kessler, "Engineered Nanoparticles in Consumer Products: Understanding a New Ingredient," Environ Health Perspect, 119(3) (2011) 120–125.
5. V.J. Morris, "Atomic Force Microscopy as a Nanoscience Tool in Rational Food Design", J Sci Food Agric, 91 (2011) 2117–2125.
6. Berger, "Fresh Fruits and Vegetables as Vehicles for the Transmission of Human Pathogens," Environ Microbiol, 12 (2010) 2385–2397.
7. R. Kessler, "Engineered Nanoparticles in Consumer Products: Understanding a New Ingredient," Environ Health Perspect, 119(3) (2011) 120–125.
8. H. Bouwmeester, "Review of Health Safety Aspects of Nanotechnologies in Food Production," Regul Toxicol Pharmacol, 53 (2009) 52–62.
9. J.C. Buzby, "Nanotechnology for Food Applications: More Questions Than Answers," J Consumer Affairs 44(3) (2010) 528–545.
10. S. Chernousova, "Silver as Antibacterial Agent: Ion, Nanoparticleand Metal,"Angew, Chem, Int Ed, 52(6) (2013) 1636- 1653.
11. A.P. Ingle, "Bioactivity, mechanism of action, and cytotoxicity of copper-based nanoparticles: a review" Appl, Microbiol, Biotechnol, 98(3) (2014) 1001-1009.
12. R. Kessler, "Engineered Nanoparticles in Consumer Products: Understanding a New Ingredient," Environ Health Perspect, 119(3) (2011) 120–125.
13. K. Gerloff, "Cytotoxicity and Oxidative DNA Damage by Nanoparticles in Human Intestinal Caco-2 Cells" Nanotoxicol, 3(4) (2009) 355–364.
14. G. Oberdorster, "Nanotoxicology; An Emerging Discipline Evolving from Studies of Ultrafine Particles", Environ Health Perspect, 113 (2005) 823–839.
15. E.L. Bradley, "Applications of Nanomaterial in Food Packaging with a Consideration of Opportunities for Developing Countries," Trends Food Sci Technol, 22 (2011) 604–610.
16. A. Llorens, "Metallic-Based Micro- and Nanocomposites in Food Contact Materials and Active Food Packaging," Trends Food Sci Technol, 24 (2012) 19–20.
17. K. Gerloff, "Cytotoxicity and Oxidative DNA Damage by Nanoparticles in Human Intestinal Caco-2 Cells," Nanotoxicol, 3(4) (2009) 355–364.
18. G. Pyrgiotakis, "Inactivation of Foodborne Microorganisms Using Engineered Water Nanostructures (EWNS)," Environ Sci Technol, 49(6) (2015) 3737–3745.
19. Q. Chaudhry, "Applications and Implications of Nanotechnologies for the Food Sector," Food Addit Contam, 25(3) (2008) 241–258.
20. J.T. Dwyer, "Fortification and health: Challenges and opportunities" Adv, Nutr, 6 (2015) 124–131.
21. P.J. Rao, "Nanoencapsulation of Bioactive Compounds for Nutraceutical Food," Sustainable Agriculture Reviews, 21 (2016) 129–156.
22. J.C. Buzby, "Nanotechnology for Food Applications: More Questions Than Answers" J Consumer Affairs, 44(3) (2010) 528–545.
23. C.I. Moraru, "Nanotechnology: A New Frontier in Food Science," Food Technol, 57 (2003) 24–29.