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EDIBLE COATINGS AND THE NEED FOR BIODEGRADABLE POLYMERS WITH FOCUS ON DAIRY PRODUCTS

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ABSTRACT: Natural polymers are non-toxic, affordable, and abundantly accessible; hence they're often used in edible coatings. Covering vegetables with edible coatings that include antimicrobials, browning inhibitors, and nutraceuticals is a unique way to increase their nutritional value. Natural polymers are non-toxic, affordable, and abundantly accessible; hence they're often used in edible coatings. Covering vegetables with edible coatings that include antimicrobials, browning inhibitors, and nutraceuticals is a unique way to increase their nutritional value. Most edible coatings employ non-toxic, inexpensive, readily accessible natural polymers. Using biodegradable synthetic polymers and liquid and solid lipids, nano systems may be built at room temperature. To minimise food waste, edible food packaging utilises high-quality, low-impact packaging materials. Dairy consumer goods are among the industries targeted by the attack. Polymer nanocomposites, a kind of nano reinforcement, may act as a small gas barrier by increasing the difficulty of passing through the material. To put it simply, we now have the ability to accurately estimate the shelf life of our products thanks to developments in packaging technology, as well as biodegradable packaging and several other advantages. Packaging nanotechnology applications are categorised by their principal function. In conclusion, biodegradable synthetic polymers and liquid and solid lipids may also be used to create nano systems at ambient temperature. It is argued that recent advances in the usage of nano systems such nanoparticles, nanotubes, composites, and emulsions, are reviewed critically in this study. For food preservation purposes, nano dispersions may be supported by polymers, although the main focus of this article was on providing information on nano systems and how they can be used in various food substrates.

Keywords: Biodegradable, Dairy products, Edible coating, Food industry, Nanotechnology.

INTRODUCTION

Nanotechnology is a rapidly expanding field that draws from a wide range of scientific and engineering disciplines. Nanotechnology has been applied to the fields of biology, chemistry, engineering, and physics in order to create new types of materials. Because of the changes in their physical, chemical, and biological properties that occur as they are scaled down to the nanoscale range, nanomaterials are finding new uses in a variety of fields. Nanoparticles (10-9 m) have the potential to be used in a wide variety of applications due to their singular qualities, which include their unusually small particle size and enormous surface area (Duran and Marcato, 2013; Patil et al., 2019). In the food industry and processing industry, potential applications of nanotechnology include the detection of pathogens, the administration of drugs, the packaging of food, and the distribution of bioactive components. Utilizing nanotechnology within food systems enables a fresh approach to the protection of food and the enhancement of its nutritional content (Rashidi and Khosravi-Darani, 2011; Kiss, 2020). It is common practice in the manufacturing of edible coatings to make use of natural polymers because they are non-toxic, inexpensive, and widely available. Covering vegetables with edible coatings that contain active compounds such as antimicrobials, browning inhibitors, and nutraceuticals is a novel method for increasing the nutritional content of the produce that is being consumed (Dholariya et al., 2021).

The production of modern food and agriculture has profited significantly from considerable breakthroughs in nanotechnology due to the advent of smart and active packages, nano sensors, nano insecticides, and also nano fertilizer. Numerous innovative nanomaterials have been emerged in recent years with the goals of enhancing the quality and safety of food, as well as monitoring crops and the environment (He et al., 2019). Edible coatings are a type of food coating that refers to food products that have been coated with an edible polymer layer that possesses both biological and chemical capabilities. Plants and animals both contain reservoirs of biopolymers such as resins, oleoresins, gums, lipids, polysaccharides, proteins, and other resinous compounds.

It is possible to recover and purify these compounds from their raw sources by employing the appropriate processing methods and procedures. Resins, oleoresins, gums, lipids, polysaccharides, and proteins are examples of biopolymers. Because plants have a high polyphenolic chemical content, which may serve as probable antioxidants and antibacterial agents, it is common practice for edible coatings to be obtained from plants. This is due to the fact that polyphenols are found in high concentrations in plants (Bhagath and Manjula, 2019). It is absolutely necessary for nanocomposites to have increased stability in order to keep their antibacterial action intact and stop the migration of metal ions in preserved

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foods. Polymers are primarily developed for the development of nanocomposites in the culinary industry that contain metal or metal oxide nanoparticles (He and Hwang, 2016). Utilizing nanoparticles such as nano chitosan, which have distinct physical and chemical qualities (small size, high surface area, and positive surface charge) that make them a viable alternative, it is possible to protect fruits from diseases (Melo et al., 2020). It is well knowledge that nanotechnology can be utilized to increase the amount of time that food can be stored. When compared to bigger systems, the smaller particle size that may be achieved in nanometric systems results in materials with distinct and better properties. It is now possible for hydrophilic and lipophilic compounds, such as antimicrobials and antioxidants, to extend the shelf life of a wide range of products, such as whole and freshly cut fruits and vegetables, nuts, seeds, cheese, and so on. The majority of edible coatings make use of natural polymers, which are often non-toxic, inexpensive, and easily accessible. On the other hand, biodegradable synthetic polymers as well as liquid and solid lipids can be employed to build nano systems even when the temperature is room temperature (Zambrano-Zaragoza et al., 2018). The improvements that have been made possible by nanotechnology have made it feasible to create a wide variety of brand-new structure, materials, and systems. These include those in the fields of agriculture, food, and medicine (Singh et al., 2017).

POTENTIAL APPLICATION IN FOOD INDUSTRY

There is a possibility that nanotechnology will have an effect on a diverse variety of food and agricultural production methods. In the fields of agriculture and food systems research and engineering, nanotechnology has a wide range of applications, some of which include food security, new methods for the delivery of disease treatments, new tools for molecular and cellular biology, innovative materials for the detection of pathogens, and environmental protection. The following are some of the ways in which the application of nanotechnology can benefit the food industry:

- Manufacturing, processing, and shipping of food has become more secure thanks to pathogen and contamination detecting sensors.
- It is important to have devices that can track particular shipments and retain environmental data for a specific product.
- Intelligent/smart systems that incorporate sensors, location, reporting and remotely maintenance of food products can increase the efficiency and stability of food processing as well as transportation.
- Food ingredients can be transported, preserved, and distributed to their designated sites of action using encapsulation and tracking system to accomplish these tasks. Biosciences and engineering applications are the primary focus of nanotechnological research. Table 1 shows a variety of uses.

Table 1 - Application matrix of nanoscience and nanotechnology in main areas of food science and technology (Hamad et al., 2018; Kumari and Yadav, 2014; Rashidi and Khosravi-Darani, 2011; Santeramo et al., 2018)

Area of application	Purpose and fact	Approaches
Design of nanomaterial	Nanoparticles, Nano emulsions, Nanocomposites, and Nanobiocomposites are all forms of nanotechnology (nano biopolymeric starch)	Self-assembling, self-healing, and modifying attributes in a novel specified material.
Nano sensors and nano biosensors	Nanolaminates Quality control and food safety	Monitoring and labeling of food items; detection of extremely trace amounts of chemical contaminants by the use of a sensor assessment system that incorporates an electronic nose and tongue The identification of food-borne pathogens can be accomplished by using nucleic acid, protein, or any other metabolite produced by microbes.
Processing	Nanofiltration Nanoscale enzymatic reactor Heat transmission and mass exchange Nanofabrication Nano capsules designed to alter the way substances are absorbed	By using a nanoceramic pan, it was possible to cut down on the amount of time needed to roast the food, the amount of oil used, and the amount of trans fatty acids produced by using plant oil rather than hydrogenated oil. Because of this, scientists were able to create nutrient-delivering nano capsules for food that are safe to ingest and may be put into food in order to facilitate greater absorption.
New products	Packaging Delivery Formulation Evaluation DNA recombinant technology	Barrier properties (mechanical, thermal, chemical, and microbial) are improved with the use of nanocomposites as coatings, release devices, and novel packaging. Mechanical and thermal properties are gotten better; effective antibacterial surfaces are developed; microbial contamination and biochemical changes can be detected and signalled; and dirt repellent coatings for packaging are developed. • Targeted delivery of nourishment by nanomycells (nutrition nano therapy) • Sustained - release of nutrients, proteins, antioxidants, and tastes with nano capsules • Development of a new product by the use of a nanoscale enzymatic reactor • Omega-3 fatty acid, haemoglobin, lycopene, beta-craton, phytosterols, and DHA/EPA fortification of food As a nano biological system for the creation of new goods, enzyme and protein evaluation • Nano porous medium for the manufacture of recombinant enzymes with a wide range of applications.

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It is possible to design novel structures out of functional nanostructures and give food products new functionality by employing these nanostructures as building blocks. Nanoliposomes, nano emulsions, nanoparticles, and nanofibers are only a few examples of the various types of nanomaterials. Weiss has provided specific information about a few of these buildings, in addition to their past, present, and potential future applications in the food sector. According to the most recent information available, nanomaterials employed in applications related to food preparation can be either inorganic or organic. Inorganic, surface-functionalized, and organic engineered nanomaterials (ENMs) are the types of designed nanomaterials that can be discovered in nanofood items (Sekhon, 2010).

Sensors that operate on the nanoscale Biosensors on food, for instance, might make use of biological molecules like sugars or proteins in order to determine the presence of infections and other impure chemicals. The use of sensors that can detect illness and contaminants in food nano sensors would make food production, processing, and shipping significantly safer. It is feasible to compensate for the shortcomings of the sensors that are currently in use by employing nano sensors because of their tiny size and portability as well as their rapid processing and specialized nature (Sharon et al., 2010). Active food packaging adds preservatives such as antimicrobials to food at the beginning of the rotting process, whereas intelligent food packaging can warn the user to the food breakdown. By utilizing nano-composites in food packaging, it is feasible to protect food against contamination such as illnesses, gas leaks, and other potentially harmful substances. In addition to preventing the growth of bacteria, fungi, and other pathogens, bio-nanoparticles such as silver titanium oxide, zinc oxide, and other bio-nanoparticles function as a barrier to the exchange of gases. Enhancing a product's barrier capabilities can assist maintain food quality and increase its shelf life, even in the absence of the application of artificial or chemical preservatives. Nano-composites are a type of reinforcing material that has a size less than 100 nanometres and is classified as a polymer with a single dispersion phase that can either be organic or inorganic (Sharma and Dhanjal, 2016). It is possible to utilize coatings and films to communicate food contents, restrict the movement of moisture and other things such as carbon dioxide and aromas, and improve the mechanical qualities of the meal. This can be done by preventing the flow of moisture and other substances. Starch, chitosan, cellulose, and galactomannans are some of the compounds that can be used to make edible or biodegradable coatings and films. Other possible substances include galactomannans (Zhang et al., 2014).

Biopolymers such as polysaccharides, proteins, lipids and waxes, plasticizers, and additives can all be utilized in edible food packaging. Other types of biopolymers include cellulose, hemicellulose, and cellulose acetate. Edible food packaging relies on high-quality and environmentally friendly packaging in order to reduce the amount of food that is wasted. The dairy industry, the fruit and vegetable industry, the grain and cereal industry, fisheries, the meat and poultry industry, as well as consumer food products and other fields are among those that are being targeted. It is also feasible to improve food qualities by combining established methods of food preservation with edible packaging. These methods include thermal treatments and cold processing, preservatives and water management, and non-thermal processing, among others. Consumables that have been wrapped in a variety of secondary and tertiary packing materials are able to be exported and transported with relative ease (Ghosh and Katiyar, 2021).

The primary idea behind this method is to change the atmosphere that is surrounding the fruits by either eliminating or adjusting the quantity of chemicals that are necessary for respiration. Some examples of these chemicals are oxygen, carbon dioxide, and ethylene. The application of edible coatings as a means of protecting the quality of fruit has revealed some encouraging outcomes. Agents, either biological or chemical, are placed to the surface of the product and left there in order to put a stop to the ripening process. The term "edible coating" refers to a thin layer of fruit that acts as a barrier between the fruit itself and the environment around it. This layer can be consumed by humans. The coating solution is either dipped onto the fruits or sprayed onto them in order to apply the edible coating to fresh or freshly cut fruits. An edible coating can act as a barrier to the interchange of gases, which in turn can lower the amount of water that is lost from the surface of the fruit and alter the atmosphere around it, leading to an improvement in the flavour of the fruit. In addition to reducing the rate of fungal development and enhancing the overall appearance of the fruit, this also stops anaerobic respiration and the aging process (Maringgal et al., 2020). Bioactive peptides are encapsulated in lipid bilayers. Compound encapsulation shields a delicate component from the potentially harmful effects of the surrounding environment by hermetically sealing the capsule. Because of this barrier, it is feasible to protect a chemical from oxygen, water, and light while yet allowing for regulated release and limiting contact with other components in a combination. This is made possible by the barrier's structure. Bioactive peptides are pieces of proteins that have the potential to improve the health and well-being of living creatures. The nitrogenous components that are biologically active are found in abundance in marine creatures. Limiting hypertension, decreasing cholesterol, controlling hunger, and inhibiting the growth of germs are just a few of the actions that have been associated to this chemical.

In addition, this substance possesses antibacterial, anticoagulant, and antidiabetic effects. With the assistance of these peptide-loaded nanocapsules, it would be feasible to stop the putrefaction of food and the development of potentially harmful microbes. When astaxanthin and maybe other carotenoid pigments are micro- or nano-encapsulated in food matrices, they may be more stable and have a greater therapeutic effect (Neves et al., 2015).

NANOTECHNOLOGY IN FOOD INDUSTRY

Food processing

Through the process of food processing, raw ingredients are converted into food and other forms that may be marketed and have a longer shelf life. These products can also be stored for longer. The elimination of toxins, the

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prevention and treatment of illness, and the conservation of materials are all examples of processing. Another example would be improving the consistency of the meal so that it can be distributed more easily. When it comes to transporting goods across great distances, processed meals are preferable to fresh foods since they are less likely to go bad than fresh foods. The application of nanotechnology has made each of these far more efficient. When foods are encapsulated with straightforward solutions like colloids, emulsions, biopolymers, and others, the food's functional characteristics are maintained. It is possible to use structural lipids, often known as "nanodrops," as a liquid transporter for beneficial components that are difficult to dissolve in water or fat (Ali et al., 2019; Giaconia et al., 2020). This is possible because structural lipids have a very small molecular size. They accomplish this by preventing cholesterol from being absorbed in the gastrointestinal tract and instead delivering it directly to the bloodstream where it may be used.

Food packaging

Food packaging is required to fulfil a number of requirements, including those pertaining to safety, resistance to tampering, and particular requirements for its chemical, biological, or physical makeup (King et al., 2017). Because of this label, you will be able to view any and all nutritional information that pertains to the food that you are about to consume. The viability of the food's business depends heavily on the packaging, which plays an important part in the preservation of the product. As a result of advances in packaging technology, we now have quality packaging, a means of estimating shelf life that is user-friendly for consumers, biodegradable packaging, and a plethora of other benefits. The various applications of packaging nanotechnology are broken down according to their primary purpose.

Barrier protection

It is important to keep food in an atmosphere that is low in oxygen and inert in order to prevent the growth of microbes and the subsequent rotting of the food. When nanocomposites are introduced into a polymer matrix, the increased surface area of the nanocomposites provides for improved filler-matrix interactions as well as performance (Bustamante-Torres et al., 2021). Nano reinforcement, which is also known as polymer nanocomposites, can function as a tiny gas barrier since it increases the difficulty of the material's passage through the material. Complex metallic ores are used in the production of nano clays, which are materials that are composite in nature. In order to enhance the quality of food packaging and provide a barrier against the permeability of gases contained within the container, polymer clays produced from nylons, polyolefins, PET, PA, epoxy resins, and poly methane are frequently utilized. In contrast, Durethan, Imperm, and Aegis nano clay, all of which are composed of nano clay based on polyamide, have undergone extensive development and are now available for commercial use. It has been praised for both its longevity and its level of protection. Due to the fact that packaging is such an essential component of the marketing of a product, numerous studies on cell-and-carbon nanotube nanocomposites have been conducted.

Antimicrobial packaging

Utilizing natural nanoparticles as a preventative measure against infections and spoilage brought on by the proliferation of microbes is possible (Saleh and Abu-Dieyeh, 2021). Silver nanoparticles can be found in a wide variety of products, including bio textiles, electrical appliances, refrigerators, and kitchenware, to name just a few of these categories. Its ions, in addition to silver nanoparticles in bulk, have the ability to obstruct a wide variety of biological processes that bacteria engage in. Zinc oxide is found in a variety of polymers, including polypropylene, and these properties become more pronounced as the particle size decreases. Zinc oxide has the ability to be activated by light and has antimicrobial properties; also, it can be activated by light. Titanium dioxide can be used as a coating on packages to prevent *E. coli* contamination of the contents. In order to help the disinfecting process along, silver is added to the solution. Recent research has shown that an antibacterial property can be discovered in a biopolymer called Chitosan, which is formed from chitin. Chitosan is also a great encapsulating material. Both the consumer and the manufacturer would stand to gain a great deal in terms of health and convenience from the use of antimicrobial packaging (Sreekumar et al., 2007; Abd El-Hack et al., 2020).

Biodegradable

The greatest concerning contributor to overall changes in environmental characteristics is pollution. The production of non-biodegradable plastics contributes to the emission of harmful gases into the environment, which in turn contributes to global warming. The production of a biodegradable polymer resulted in the material having a low mechanical strength and a high permeability to both water and gases (Moustafa et al., 2019; Zhang et al., 2022). Materials for packaging that are based on nanotechnology and possess qualities such as biodegradability, mechanical strength, and renewable resources can be developed to solve these concerns. Other sources of nanoparticles besides metal oxide nanoparticles and carbon nanotubes include animal and plant proteins, carbohydrates, and lipids. Nanoparticles can also be found in carbon nanotubes. Collagen nanofibers, zein nanofibers, and corn cellulose nanofibers all have a porous structure on their own. In the production of comfort packaging, these nanoparticles, in conjunction with nanoclays, are utilized. In addition to this, they have the capability to operate as biocatalysts, sensors, and they also have the potential to inhibit the growth of bacteria.

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CONCLUSION

Biodegradable synthetic polymers and liquid and solid lipids may also be used to create nano systems at ambient temperature. It is argued that recent advances in the usage of nano systems such nanoparticles, nanotubes, composites, and emulsions, are reviewed critically in this study. For food preservation purposes, nano dispersions may be supported by polymers, although the main focus of this article was on providing information on nano systems and how they can be used in various food substrates.

DECLARATIONS

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Authors' contribution
Nikitha R shalom designed and wrote the review.

Conflict of interests
The authors declare no conflict of interest

REFERENCES

Abd El-Hack ME, El-Saadony MT, Shafi ME, Zabermawi NM, Arif M, Batiha GE, Khafaga AF, Abd El-Hakim YM, and Al-Sagheer AA (2020). Antimicrobial and antioxidant properties of chitosan and its derivatives and their applications: A review. International Journal of Biological Macromolecules, 164: 2726-2744. https://doi.org/10.1016/j.ijbiomac.2020.08.153

Ali A, Ahmad U, Akhtar J, and Khan MM (2019). Engineered nano scale formulation strategies to augment efficiency of nutraceuticals. Journal of Functional Foods, 62:103554. https://doi.org/10.1016/j.jff.2019.103554

Bhagath Y and Manjula KJ (2019). Influence of composite edible coating systems on preservation of fresh meat cuts and products: a brief review on their trends and applications. International Food Research Journal, 26(2): 377-392. http://www.ifrj.upm.edu.my/26%20(02)%202019/(03).pdf

Bustamante-Torres M, Romero-Fierro D, Arcentales-Vera B, Pardo S and Bucio E, (2021). Interaction between filler and polymeric matrix in nanocomposites: Magnetic approach and applications. Polymers, 13(17): 2998. DOI: https://doi.org/10.3390/polym13172998

Dholariya PK, Borkar S, Borah A (2021). Prospect of nanotechnology in food and edible packaging: A review. Pharma Innovation, 10(5):197-203. DOI: https://doi.org/10.22271/tpi.2021.v10.i5c.6202

Duran N, and Marcato PD (2013). Nanobiotechnology perspectives. Role of nanotechnology in the food industry: a review. International Journal of Food Science & Technology, 48(6): 1127-1134. DOI: https://doi.org/10.1111/ijfs.12027

Giaconia MA, dos Passos Ramos S, Pereira CF, Lemes AC, De Rosso VV, Braga AR (2020). Overcoming restrictions of bioactive compounds biological effects in food using nanometer-sized structures. Food Hydrocolloids, 107:105939. DOI: https://doi.org/10.1016/j.foodhyd.2020.105939

Ghosh T and Katiyar V (2021). Edible food packaging: An introduction. Nanotechnology in Edible Food Packaging. Springer, Singapore, pp.1-23. DOI: https://doi.org/10.1007/978-981-33-6169-0_1

Hamad AF, Han JH, Kim BC and Rather IA (2018). The intertwine of nanotechnology with the food industry. Saudi journal of biological sciences, 25(1): 27-30. DOI: https://doi.org/10.1016/j.sjbs.2017.09.004

He X, Deng H and Hwang H-m (2019). The current application of nanotechnology in food and agriculture. Journal of Food and Drug Analysis, 27(1): 1-21. DOI: https://doi.org/10.1016/j.jfda.2018.12.002

He X and Hwang H-M (2016). Nanotechnology in food science: Functionality, applicability, and safety assessment. Journal of Food and Drug Analysis, 24(4): 671-681. DOI: https://doi.org/10.1016/j.jfda.2016.06.001

King T, Cole M, Farber JM, Eisenbrand G, Zabaras D, Fox EM, and Hill JP (2017). Food safety for food security: Relationship between global megatrends and developments in food safety. Trends in Food Science & Technology, 68:160-175. DOI: https://doi.org/10.1016/j.jff.2019.103554

Kiss É (2020). Nanotechnology in food systems: A review. Acta Alimentaria, 49(4): 460-474. DOI: https://doi.org/10.1556/066.2020.49.4.12

Kumari A and Yadav SK (2014). Nanotechnology in agri-food sector. Critical reviews in food science and nutrition, 54(8): 975-984. DOI: https://doi.org/10.1080/10408398.2011.621095

Maringgal B, Hashim N, Tawakkal ISMA, Mohamed MTMJTiFS and Technology (2020). Recent advance in edible coating and its effect on fresh/fresh-cut fruits quality. Trends in Food Science & Technology, 96: 253-267. DOI: https://doi.org/10.1016/j.tifs.2019.12.024

Melo NFCB, de Lima MAB, Stamford TLM, Galembeck A, Flores MA, de Campos Takaki GM, da Costa Medeiros JA, Stamford-Arnaud TM, Montenegro Stamford TCJIJoFS and Technology (2020). In vivo and in vitro antifungal effect of fungal chitosan nanocomposite edible coating against strawberry phytopathogenic fungi. International Journal of Food Science & Technology, 55(11): 3381-3391. DOI: https://doi.org/10.1111/ijfs.14669

Moustafa H, Youssef AM, Darwish NA, Abou-Kandil AI (2019). Eco-friendly polymer composites for green packaging: Future vision and challenges. Composites Part B: Engineering, 172:16-25. DOI: https://doi.org/10.1016/j.compositesb.2019.05.048

Neves MA, Hashemi J and Prentice CJCO (2015). Development of novel bioactives delivery systems by micro/nanotechnology. Current Opinion in Food Science, 1: 7-12. DOI: https://doi.org/10.1016/j.cofs.2014.09.002

Patil A, Mishra V, Thakur S, Riyaz B, Kaur A, Khursheed R, Patil K, and Sathe B (2019). Nanotechnology derived nanotools in biomedical perspectives: An update. Current Nanoscience, 15(2):137-146. DOI: https://doi.org/10.2174/1573413714666180426112851

Rashidi L and Khosravi-Darani K (2011). The applications of nanotechnology in food industry. Critical reviews in food science and nutrition, 51(8): 723-730. DOI: https://doi.org/10.1080/10408391003785417

Saleh I, and Abu-Dieyeh MH (2021). Novel Prosopis juliflora leaf ethanolic extract as natural antimicrobial agent against food spoiling microorganisms. Scientific Reports, 11(1):1-7. DOI: https://doi.org/10.1038/s41598-021-86509-3

Santeramo FG, Carlucci D, De Devitiis B, Seccia A, Stasi A, Viscecchia R and Nardone G (2018). Emerging trends in European food, diets and food industry. Food research international (Ottawa, Ont.), 104: 39-47. DOI: 10.1016/j.foodres.2017.10.039

Sekhon B (2010). Food nanotechnology–an overview. Nanotechnology, Science and Applications, 2010: 1-15. DOI: https://doi.org/10.2147/NSA.S8677

Sharma D and Dhanjal DSJJ (2016). Bio-nanotechnology for active food packaging. Journal of Applied Pharmaceutical Science, 6(09): 220-226. DOI: http://dx.doi.org/10.7324/JAPS.2016.60933

Sharon M, Choudhary AK and Kumar RJJoP (2010). Nanotechnology in agricultural diseases and food safety. Journal of Phytology, 2(4): 78-82. https://www.cabdirect.org/cabdirect/abstract/20113034565

Singh T, Shukla S, Kumar P, Wahla V, Bajpai VK and Rather IAJ (2017). Application of nanotechnology in food science: perception and overview. Frontiers in Microbiology, 8: 1501. DOI: https://doi.org/10.3389/fmicb.2017.01501

Sreekumar S, Lemke P, Moerschbacher BM, Torres-Giner S, and Lagaron JM (2017). Preparation and optimization of submicron chitosan capsules by water-based electrospraying for food and bioactive packaging applications. Food Additives & Contaminants: Part A, 34(10):1795-1806. DOI: https://doi.org/10.1080/19440049.2017.1347284

Zambrano-Zaragoza ML, González-Reza R, Mendoza-Muñoz N, Miranda-Linares V, Bernal-Couoh TF, Mendoza-Elvira S and Quintanar-Guerrero DJIjoms (2018). Nanosystems in edible coatings: A novel strategy for food preservation. International journal of Molecular Sciences, 19(3): 705. DOI: https://doi.org/10.3390/ijms19030705

Zhang Y, Rempel C and Mclaren DJIFP (2014). Edible coating and film materials: Carbohydrates. Innovations in Food Packaging (2nd Edition), Elsevier Ltd. pp.305-323. DOI: https://doi.org/10.1016/B978-0-12-394601-0.00012-6

Zhang M, Biesold GM, Choi W, Yu J, Deng Y, Silvestre C, Lin Z (2022). Recent advances in polymers and polymer composites for food packaging. Materials Today, 53: 134-161. DOI: https://doi.org/10.1016/j.mattod.2022.01.022

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