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# Techniques For Nanoencapsulation Of Food Ingredients

**Techniques for**

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**Nanoencapsulation of Food  
Ingredients Springer Science &  
Business Media**

**Recent developments in  
nanoparticle and microparticle  
delivery systems are  
revolutionizing delivery**

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**systems in the food industry. These developments have the potential to solve many of the technical challenges involved in creating encapsulation, protection, and delivery of active ingredients, such as**

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**colors, flavors, preservatives,  
vitamins, minerals, and  
nutraceuticals. Nanoparticle-  
and Microparticle-based  
Delivery Systems:  
Encapsulation, Protection and  
Release of Active Compounds**

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**explores various types of colloidal delivery systems available for encapsulating active ingredients, highlighting their relative advantages and limitations and their use. Written by an**

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**international authority known for his clear and rigorous technical writing style, this book discusses the numerous kinds of active ingredients available and the issues associated with their**

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**encapsulation, protection, and delivery. The author takes a traditional colloid science approach and emphasizes the practical aspects of formulation of particulate- and emulsion-based delivery**

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**systems with food applications. He then covers the physicochemical and mechanical methods available for manufacturing colloidal particles, highlighting the importance of designing**



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**particles for specific applications. The book includes chapters devoted specifically to the three major types of colloidal delivery systems available for encapsulating active**

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**ingredients in the food industry: surfactant-based, emulsion-based, and biopolymer-based. It then reviews the analytical tools available for characterizing the properties of colloidal**

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**delivery systems, presents the mathematical models for describing their properties, and highlights the factors to consider when selecting an appropriate delivery system for a particular application**

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**backed up by specific case studies. Based on insight from the author's own experience, the book describes why delivery systems are needed, the important factors to consider when designing**

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**them, methods of characterizing them, and specific examples of the range of food-grade delivery systems available. It gives you the necessary knowledge, understanding, and**

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**appreciation of developments  
within the current research  
literature in this rapidly  
growing field and the  
confidence to perform reliable  
experimental investigations  
according to modern**

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**international standards.**

**Encapsulations, a volume in  
the Nanotechnology in the Agri-  
Food Industry series, presents  
key elements in establishing  
food quality through the  
improvement of food flavor**

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**and aroma. The major benefits of nanoencapsulation for food ingredients include improvement in bioavailability of flavor and aroma ingredients, improvement in solubility of poor water-**



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**soluble ingredients, higher ingredient retention during production process, higher activity levels of encapsulated ingredients, improved shelf life, and controlled release of flavor and aroma. This volume**

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**discusses main  
nanoencapsulation processes  
such as spray drying, melt  
injection, extrusion,  
coacervation, and  
emulsification. The materials  
used in nanoencapsulation**

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**include lipids, proteins, carbohydrates, cellulose, gums, and food grade polymers. Applications and benefits of nanoencapsulation such as controlled release, protections, and taste masking**

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**will be explained in detail.  
Includes the most up-to-date  
information on  
nanoencapsulation and  
nanocontainer-based delivery  
of antimicrobials Presents  
nanomaterials for innovation**

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**based on scientific  
advancements in the field  
Provides control release  
strategies to enhance  
bioactivity, including methods  
and techniques for research  
and innovation Provides useful**

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**tools to improve the delivery  
of bioactive molecules and  
living cells into foods  
Nanotechnology in the  
Beverage industry:  
Fundamentals and  
Applications looks at how**

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**nanotechnology is being used to enhance water quality, as well as how the properties of nanomaterials can be used to create different properties in both alcoholic and no-alcoholic drinks and enhance the**

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**biosafety of both drinks and their packaging. This is an important reference for materials scientists, engineers, food scientists and microbiologists who want to learn more about how**



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**nanotechnology is being used to enhance beverage products. As active packaging technology, nanotechnology can increase shelf-life and maintain the quality of beverages. In the field of**

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**water treatment,  
nanomaterials offer new  
routes to address challenges.  
Encyclopedia of  
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Nutrient Delivery  
Principles and Applications**

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**Volume One**

**Nanoencapsulation of Food  
Bioactive Ingredients  
Breakthroughs in Research  
and Practice**

*The emergence of the discipline  
of encapsulation and controlled*

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*release has had a great impact on the food and dietary supplements sectors; principally around fortifying food systems with nutrients and health-promoting ingredients. The successful incorporation of these*

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*actives in food formulations depends on preserving their stability and bioavailability as well as masking undesirable flavors throughout processing, shelf life and consumption. This second edition of Encapsulation and*

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*Controlled Release Technologies in Food Systems serves as an improvement and a complement companion to the first. However, it differentiates itself in two main aspects. Firstly, it introduces the reader to novel encapsulation*

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*and controlled release technologies which have not yet been addressed by any existing book on this matter, and secondly, it offers an in-depth discussion on the impact of encapsulation and controlled*

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*release technologies on the bioavailability of health ingredients and other actives. In common with the first edition the book includes chapters written by distinguished authors and researchers in their respective*



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*areas of specialization. This book is designed as a reference for scientists and formulators in the food, nutraceuticals and consumer products industries who are looking to formulate new or existing products using*

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*microencapsulated ingredients. It is also a post-graduate text designed to provide students with an introduction to encapsulation and controlled release along with detailed coverage of various encapsulation technologies and*

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*their adaptability to specific applications.*

*Encapsulation of bioactives is a fast-growing approach in the food and pharmaceutical industry.*

*Spray Drying Encapsulation of Bioactive Materials serves as a*

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*source of information to offer specialized and in-depth knowledge on the most well-known and used encapsulation technology (i.e., spray drying) and corresponding advances. It describes the efficacy of spray*

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*drying in terms of its advantages and challenges for encapsulation of bioactive ingredients.*

*Discusses the potential of this technique to pave the way toward cost-effective, industrially relevant, reproducible, and*

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*scalable processes that are critical to the development of delivery systems for bioactive incorporation into innovative functional food products and pharmaceuticals Presents the latest research outcomes related*

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*to spray drying technology and  
the encapsulation of various  
bioactive materials Covers  
advances in spray drying  
technology that may result in a  
more efficient encapsulation of  
bioactive ingredients Includes*

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*computational fluid dynamics,  
advanced drying processes, as  
well as the morphology of the  
dried particles, drying kinetics  
analyzers, process controllers  
and adaptive feedback systems,  
inline powder analysis*



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*technologies, and cleaning-in-place equipment Aimed at food manufacturers, pharmacists, and chemical engineers, this work is of interest to anyone engaged in encapsulation of bioactive ingredients for both nutraceutical*

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*and pharmaceutical applications.  
p="" This volume delivers a  
systematic overview of  
nanotechnology in the  
development of edible food  
packaging with noteworthy  
characteristics for improved food*

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*quality. It covers current research trends, history outlines, and state of the global market in combination with associated biomaterials and synthesis strategies. The contents detail the use of various emerging*

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*bionanostructured materials such as cellulose nanostructures, chitosan nanostructures, and more. It further deliberates an in-depth discussion on various synthesis strategies and routes for the development of edible*

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*food packaging in terms of utilizing various nanosystems such as polymeric nanocomposites, nanoencapsulation systems, nanoemulsion systems, and others. Further, it also discusses*

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*experimental practices for bionanostructured and edible packaging materials to check the effectivity in terms of offering enhanced shelf life of food products. It also touches upon the socio-techno challenges in-*

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*line with developing edible packaging materials using nanotechnology for high performance packaging application. The book is an excellent guide for both the academia and industry especially*

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*early career professionals in edible food packaging sectors for selecting proper biomaterial involving biofillers, modifiers, cross linkers, compatibilizers and others to enhance the property of edible food packaging for*



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*targeted features. ^*

*Nanotechnology has developed remarkably in recent years and, applied in the food industry, has allowed new industrial advances, the improvement of conventional technologies, and the*

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*commercialization of products with new features and functionalities. This progress offers the potential to increase productivity for producers, food security for consumers and economic growth for industries.*

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*Food Applications of Nanotechnology presents the main advances of nanotechnology for food industry development. The fundamental concepts of the technique are presented, followed by examples*

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*of application in several sectors, such as the enhancement of flavor, color and sensory characteristics; the description of the general concepts of nano-supplements, antimicrobial nanoparticles and other active*

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*compounds into food; and developments in the field of packaging, among others. In addition, this work updates readers on the industrial development and the main regulatory aspects for the safety*

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*and commercialization of  
nanofoods. Features: Provides a  
general overview of  
nanotechnology in the food  
industry Discusses the current  
status of the production and use  
of nanomaterials as food*

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*additives Covers the  
technological developments in  
the areas of flavor, color and  
sensory characteristics of food  
and food additives Reviews  
nanosupplements and how they  
provide improvements in*

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*nutritional functionality Explains  
the antibacterial properties of  
nanoparticles for food  
applications This book will serve  
food scientists and technologists,  
food engineers, chemists and  
innovators working in food or*



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*ingredient research and new product development. Gustavo Molina is associate professor at the UFVJM (Diamantina—Brazil) in Food Engineering and head of the Laboratory of Food Biotechnology and conducts*

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*scientific and technical research. His research interests are focused on industrial biotechnology. Dr. Inamuddin is currently working as assistant professor in the chemistry department of Faculty of Science,*

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*King Abdulaziz University,  
Jeddah, Saudi Arabia. He is also  
a permanent faculty member  
(assistant professor) at the  
Department of Applied  
Chemistry, Aligarh Muslim  
University, Aligarh, India. He has*

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*extensive research experience in multidisciplinary fields of analytical chemistry, materials chemistry, and electrochemistry and, more specifically, renewable energy and environment. Prof. Abdullah M. Asiri is professor of*

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*organic photochemistry and has  
been the head of the chemistry  
department at King Abdulaziz  
University since October 2009,  
as well as the director of the  
Center of Excellence for  
Advanced Materials Research*

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*(CEAMR) since 2010. His research interest covers color chemistry, synthesis of novel photochromic and thermochromic systems, synthesis of novel coloring matters and dyeing of textiles, materials chemistry,*

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*nanochemistry and nanotechnology, polymers, and plastics. Franciele Maria Pelissari graduated in Food Engineering; earned her master's degree (2009) at the University of Londrina (UEL), Londrina, Brazil;*

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*and her PhD (2013) at the  
University of Campinas  
(Unicamp), Campinas, Brazil.  
Since 2013, she has been  
associate professor at the  
Institute of Science and  
Technology program at the*



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*Federal University of  
Jequitinhonha and Mucuri  
(UFVJM), Diamantina, Brazil, in  
Food Engineering, and also full  
professor in the graduate  
program in Food Science and  
Technology.*

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*Food Nanotechnology  
Application of  
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Ingredients in Food Products  
Handbook of Food  
Nanotechnology  
Nanoemulsions*

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*Microencapsulation*

*New Polymers for Encapsulation  
of Nutraceutical Compounds*

Release and Bioavailability of  
Nanoencapsulated Food Ingredients,  
volume five in the Nanoencapsulation  
in the Food Industry series, reviews

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different release mechanisms of nanoencapsulated food ingredients. The book discusses mathematical and intelligent modeling of the release of bioactive agents from nano-vehicles to better understand their release mechanisms, while also covering

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different approaches for studying the release profile of these ingredients (such as in-vitro and in-vivo assays). Authored by a team of global experts in the fields of nano and microencapsulation of food, nutraceutical and pharmaceutical

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ingredients, this title will be of great value to those engaged in various fields of nanoencapsulation.

Thoroughly explores the different release mechanisms of nanoencapsulated food ingredients

Examines the release of bioactive

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ingredients by in vitro and in vivo systems Discusses different approaches for modeling the release data of nanoencapsulated ingredients  
Characterization of Nanoencapsulated Food Ingredients, Volume Four in the

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Nanoencapsulation in the Food Industry series, introduces some of the common instrumental analysis and characterization methods for the evaluation of nanocarriers and nanoencapsulated ingredients in terms of their morphology, size



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distribution, surface charge and composition, appearance, physicochemical and rheological properties, and antioxidant activity. Divided in five sections, the book covers the qualitative and quantitative properties of nanoencapsulated food

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ingredients by different characterization techniques, besides correlating nanocarrier behavior to their physicochemical and functional properties. Authored by a team of global experts in the fields of nano- and microencapsulation of food,

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nutraceutical, and pharmaceutical ingredients, this title is of great value to those engaged in the various fields of nanoencapsulation and nanodelivery systems. Shows how different properties of nanoencapsulated food ingredients

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can be analyzed Presents the mechanism of each characterization technique Investigates how the analytical results can be understood with nanoencapsulated ingredients Consumers prefer food products that are tasty, healthy, and convenient.

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Encapsulation is an important way to meet these demands by delivering food ingredients at the right time and right place. For example, encapsulates may allow flavor retention, mask bad tasting or bad smelling components, stabilize food ingredients, and

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increase their bioavailability.

Encapsulation may also be used to immobilize cells or enzymes in the production of food materials or products, such as fermentation or metabolite production. This book provides a detailed overview of the

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encapsulation technologies available for use in food products, food processing, and food production. The book aims to inform those who work in academia or R&D about both the delivery of food compounds via encapsulation and food processing

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using immobilized cells or enzymes. The structure of the book is according to the use of encapsulates for a specific application. Emphasis is placed on strategy, since encapsulation technologies may change. Most chapters include



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application possibilities of the encapsulation technologies in specific food products or processes. The first part of the book reviews general technologies, food-grade materials, and characterization methods for encapsulates. The second part

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discusses encapsulates of active ingredients (e.g., aroma, fish oil, minerals, vitamins, peptides, proteins, probiotics) for specific food applications. The last part describes immobilization technologies of cells and enzymes for use within food

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fermentation processes (e.g., beer, wine, dairy, meat), and food production (e.g., sugar conversion, production of organic acids or amino acids, hydrolysis of triglycerides). Edited by two leading experts in the field, Encapsulation Technologies for

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Food Active Ingredients and Food Processing will be a valuable reference source for those working in the academia or food industry. The editors work in both industry or academia, and they have brought together in this book contributions

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from both fields.

Nanotechnologies in Food provides an overview of the products and applications of nanotechnologies in agri-food and related sectors.

Following on from the success of the first edition, this new edition has been

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revised and updated to bring the reader fully up to date on the emerging technological, societal, and policy and regulatory aspects in relation to nanotechnologies in food. This book contains new chapters discussing some of the aspects that

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have attracted a lot of debate and research in recent years, such as how the regulatory definition of 'nanomaterial' is shaping up in Europe and whether it will result in a number of exciting food additives being regarded as nanomaterials, how

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the new analytical challenges posed by manufactured nanoparticles in food are being addressed and whether the emerging field of nano delivery systems for food ingredients and supplements, made of food materials or other soft/degradable polymers, can



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raise any consumer safety concerns. The edition concludes by discussing the future trends of the technological developments in the area of nanotechnologies and potential future 'fusion' with other fields, such as biotechnology and synthetic biology.

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This book provides a source of much needed and up-to-date information on the products and applications of nanotechnology for the food sector - for scientists, regulators, and consumers alike. It also gives an independent, balanced, and impartial

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view of the potential benefits as well as risks that nanotechnology applications may bring to the food sector. Whilst providing an overview of the state-of-the-art and foreseeable applications to highlight opportunities for innovation, the book also discusses

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areas of uncertainty in relation to public perception of the new technological developments, and potential implications for consumer safety and current regulatory controls. The book also discusses the likely public perceptions of

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nanotechnologies in the light of past technological developments in the food sector, and how the new technology will possibly be regulated under the existing regulatory frameworks.

## Novel Approaches of Nanotechnology

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in Food

Volume 3 in the Nanoencapsulation  
in the Food Industry series  
Impact of Nanoscience in the Food  
Industry  
Characterization of  
Nanoencapsulated Food Ingredients

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Nanomaterials for Food Applications  
A Practical Implementation Guide

***Novel Approaches of  
Nanotechnology in Food, a  
volume in the Nanotechnology  
in the Agri-Food Industry  
series, represents a summary***

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***of the most recent advances made in the field of nanostructured materials that have significant impact on the agri-food industry. Because the current food market needs innovation, nanotechnology***



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***coupled with novel interdisciplinary approaches and processing methods has enabled important advances that have the potential to revolutionize agri-food sector. Nanotechnology can serve to***

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***resolve challenges faced by the food and bioprocessing industries for developing and implementing systems that can produce qualitative and quantitative foods that are safe, sustainable, and***

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***ecofriendly. This book is a valuable resource for scientists, researchers, and engineers in food science and biotechnology fields, as well as students who want information on cutting-edge technologies.***

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***Provides worldwide research applications of nanomaterials and nanotechnology useful in food research Presents analytical methods for enzyme immobilization onto magnetic nanoparticles Includes***

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***strategies of behavior and  
structure function to increase  
application enhancement and  
control Discusses  
nanomaterial regulations and  
for consumer protection  
awareness***

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***This extensive and singular work focuses on current applications of nanotechnology in food systems. The functionality and applicability of food-related nanotechnology is covered in depth, presenting***

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***a view on the food processing,  
packaging, storage and safety  
assessment of nanotechnology  
in the food industry. Multiple  
nanostructures are covered,  
each with their specific  
ingredient choice, production***

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***strategy, functionality and application in food engineering. Individual chapters focus on current processing methods and applications of nanotechnology in foods. Nano-food***



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***Engineering Volume One  
brings together panels of  
highly accomplished experts in  
the field of composites,  
nanotechnology and chemical  
engineering and food  
technology. The work***

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***encompasses basic studies and addresses novel issues, covering all engineering aspects, opportunities and challenges and solutions of nano-foods.***

***Spray drying is a well-***

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***established method for transforming liquid materials into dry powder form. Widely used in the food and pharmaceutical industries, this technology produces high quality powders with low***

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***moisture content, resulting in a wide range of shelf stable food and other biologically significant products.***

***Encapsulation technology for bioactive compounds has gained momentum in the last***

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***few decades and a series of valuable food compounds, namely flavours, carotenoids and microbial cells have been successfully encapsulated using spray drying. Spray Drying Technique for Food***

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***Ingredient Encapsulation provides an insight into the engineering aspects of the spray drying process in relation to the encapsulation of food ingredients, choice of wall materials, and an overview***

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***of the various food ingredients encapsulated using spray drying. The book also throws light upon the recent advancements in the field of encapsulation by spray drying, i.e., nanospray dryers for***

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***production of nanocapsules  
and computational fluid  
dynamics (CFD) modeling.  
Addressing the basics of the  
technology and its  
applications, the book will be a  
reference for scientists,***



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***engineers and product  
developers in the industry.  
Nanomaterials for Food  
Applications highlights recent  
developments in  
nanotechnologies, covering the  
different food areas where***

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***these novel products or technologies can be applied. The book covers five major themes, showing how nanotechnology is used in food, the use of ingredients in nanoform to improve***

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***bioavailability or  
nanoencapsulation  
technologies,  
nanotechnologies for food  
processing, nanosensors for  
food quality and safety,  
nanotechnologies for food***

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***packaging, and methods to evaluate potential risks and regulatory issues. This is an important research reference that will be of great value to academic and industrial readers, as topics of***

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***importance, both at a research level and for commercial applications, are covered. Regulatory agencies will also be interested in the latest developments covered in the book as they will help set the***

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***foundation for further regulations. Demonstrates how nanotechnology can improve food quality and safety Shows how nanotechnology is used to create more effective food processing techniques***

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***Discusses the regulatory issues surrounding the use of nanomaterials in food to ensure they are used safely and responsibly***  
***Spray Drying Techniques for Food Ingredient Encapsulation***

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***Encapsulations***

***Nanoparticle- and***

***Microparticle-based Delivery***

***Systems***

***Encapsulation Technologies***

***and Delivery Systems for Food***

***Ingredients and Nutraceuticals***



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***Nanoencapsulation of Food  
Ingredients by Specialized  
Equipment***

This book is intended to provide  
an overview and review of the  
latest developments in

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microencapsulation processes and technologies for various fields of applications. The general theme and purpose are to provide the reader with a current and general overview of the existing microencapsulation

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systems and to emphasize various methods of preparation, characterization, evaluation, and potential applications in various fields such as medicine, food, agricultural, and composites. The book targets readers, including

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researchers in materials science processing and/or formulation and microencapsulation science, engineers in the area of microcapsule development, and students in colleges and universities.

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Improved technologies for the encapsulation, protection, release and enhanced bioavailability of food ingredients and nutraceutical components are vital to the development of future foods. Encapsulation

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technologies and delivery systems for food ingredients and nutraceuticals provides a comprehensive guide to current and emerging techniques. Part one provides an overview of key requirements for food ingredient

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and nutraceutical delivery systems, discussing challenges in system development and analysis of interaction with the human gastrointestinal tract. Processing technologies for encapsulation and delivery

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systems are the focus of part two. Spray drying, cooling and chilling are reviewed alongside coextrusion, fluid bed microencapsulation, microencapsulation methods based on biopolymer phase



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separation, and gelation phenomena in aqueous media. Part three goes on to investigate physicochemical approaches to the production of encapsulation and delivery systems, including the use of micelles and

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microemulsions, polymeric amphiphiles, liposomes, colloidal emulsions, organogels and hydrogels. Finally, part four reviews characterization and applications of delivery systems, providing industry perspectives

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on flavour, fish oil, iron  
micronutrient and probiotic  
delivery systems. With its  
distinguished editors and  
international team of expert  
contributors, Encapsulation  
technologies and delivery

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systems for food ingredients and nutraceuticals is an authoritative guide for both industry and academic researchers interested in encapsulation and controlled release systems. Provides a comprehensive guide to current

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and emerging techniques in encapsulation technologies and delivery systems Chapters in part one provide an overview of key requirements for food ingredient and nutraceutical delivery systems, while part two

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discusses processing technologies for encapsulation and delivery systems Later sections investigate physicochemical approaches to the production of encapsulation and delivery systems and review

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characterization and applications  
of delivery systems

Application of

Nano/Microencapsulated

Ingredients in Food Products, a

volume in the

Nanoencapsulation in the Food

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Industry series, presents applications of nano/micro-encapsulated ingredients such as vitamins, minerals, flavors, colorants, enzymes, probiotics antioxidants and many other bioactive components in different



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groups of food products. Each chapter explores nano/microencapsulated ingredients in food products, including beverages, cereal flours and bakery products, meat, oils and fats, salt, spices

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and seasonings, functional supplements, and in chewing gum. In addition, the book explores active food packaging and edible coatings with nano/microencapsulated ingredients. Authored by a team

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of global experts in the fields of nano and microencapsulation of food, nutraceutical and pharmaceutical ingredients, this title is of great value to those engaged in the various fields of nanoencapsulation. Clarifies

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which nanoencapsulated ingredients can be applied for different food products  
Thoroughly explores the influence of nanoencapsulated ingredients on the qualitative properties of different food

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Today, nano- and microencapsulation are increasingly being utilized in the pharmaceutical, textile, agricultural and food industries. Microencapsulation is a process

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in which tiny particles or droplets of a food are surrounded by a coating to give small capsules. These capsules can be imagined as tiny uniform spheres, in which the particles at the core are protected from outside elements

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by the protective coating. For example, vitamins can be encapsulated to protect them from the deterioration they would undergo if they were exposed to oxygen. This book highlights the principles,

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applications, toxicity

and regulation of nano- and  
microencapsulated foods.

Section I describes the theories  
and concepts of nano-  
and microencapsulation for foods  
adapted from pharmaceutical



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areas, rationales and new strategies of encapsulation, and protection and controlled release of food ingredients. Section II looks closely at the nano- and microencapsulation of food ingredients, such as vitamins,

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minerals, phytochemical, lipid, probiotics and flavors. This section provides a variety of references for functional food ingredients with various technologies of nanoparticles and

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microencapsulation. This section will be helpful to food processors and will deal with food ingredients for making newly developed functional food products. Section III covers the application of encapsulated

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ingredients to various foods, such as milk and dairy products, beverages, bakery and confectionery products, and related food packaging materials. Section IV touches on other related issues in nano-

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and microencapsulation, such as bioavailability, bioactivity, potential toxicity and regulation.

Food Applications of  
Nanotechnology

Nano- and Microencapsulation  
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Fundamentals and Applications  
Techniques and Applications  
Nanoemulsions: Formulation,

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Applications, and Characterization provides detailed information on the production, application and characterization of food nanoemulsion as presented by experts who share a wealth of experience. Those involved in the nutraceutical, pharmaceutical and

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cosmetic industries will find this a useful reference as it addresses findings related to different preparation and formulation methods of nanoemulsions and their application in different fields and products. As the last decade has seen a major shift from



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conventional emulsification processes towards nanoemulsions that both increase the efficiency and stability of emulsions and improve targeted drug and nutraceutical delivery, this book is a timely resource. Summarizes general aspects of food

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nanoemulsions and their formulation Provides detailed information on the production, application, and characterization of food nanoemulsion Reveals the potential of nanoemulsions, as well as their novel applications in functional foods, nutraceutical

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products, delivery systems, and  
cosmetic formulations Explains  
preparation of nanoemulsions by  
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methods

Nutraceutical and Functional Food  
Components: Effects of  
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Techniques, Second Edition highlights the impact of recent food industry advances on the nutritional value, functional properties, applications, bioavailability, and bioaccessibility of food components. This second edition

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also assesses shelf-life, sensory characteristics, and the profile of food products. Covering the most important groups of food components, including lipids, proteins, peptides and amino acids, carbohydrates, dietary fiber, polyphenols, carotenoids,

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vitamins, aromatic compounds, minerals, glucosinolates, enzymes, this book addresses processing methods for each. Food scientists, technologists, researchers, nutritionists, engineers and chemists, agricultural scientists, other

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professionals working in the food industry, as well as students studying related fields, will benefit from this updated reference. Focuses on nutritional value, functional properties, applications, bioavailability and bioaccessibility of food

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components Covers food components by describing the effects of thermal and non-thermal technologies Addresses shelf-life, sensory characteristics and health claims

Nanoencapsulation of Food  
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and Applications brings different nanoencapsulated food bioactive ingredients, their structure, applications, preparation, formulations and encapsulation methodologies, covering a wide range of compounds and giving detailed examples of the issues

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faced in their nano-encapsulation. The book addresses findings related to the study of natural food colorants, vitamins, antimicrobial agents, phenolic compounds, antioxidants, flavors, essential oils, fish oil and essential fatty acids, and other

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related ingredients. As a definitive manual for researchers and industry personnel working, or interested in, various branches of encapsulation for food ingredients and nutraceutical purposes, users will find this a great reference. Explains different

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categories of nanoencapsulated food ingredients, covering their applications, nanoencapsulation techniques, release mechanisms and characterization methods  
Addresses findings related to the study of natural food colorants, vitamins, antimicrobial agents,

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phenolic compounds, antioxidants, flavors and essential oils Provides a deep understanding and potential of nanoencapsulated food ingredients, as well as their novel applications in functional foods and nutraceutical systems

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Nanotechnology can be used to address challenges faced by the food and bioprocessing industries for developing and implementing improved or novel systems that can produce safer, nutritious, healthier, sustainable, and environmental-friendly food

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products. This book overviews the most recent advances made on the field of nanoscience and nanotechnology that significantly influenced the food industry.

Advances in Processing  
Technologies for Bio-Based  
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multidisciplinary review of the complex mechanisms involved in the research, development, production and legislation of food containing nanostructures systems. Features: Presents the most recent advances made in the field of nanoscience and



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nanotechnology as applied to the food industry Discusses innovative approaches and processing technologies Shows how nanotechnology can be used to produce safer, nutritious, healthier, sustainable and environmental-friendly food

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products Covers the complex mechanisms involved in the research, development, production and legislation of food containing nanostructures Selected examples of nanotechnology applications in food industry are shown, focusing

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on advanced aspects of food packaging, processing and preservation; followed by one contribution that presents the potential commercialization and the main challenges for scale-up. Comprised of 15 chapters, this book provides much-needed and

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up-to-date information on the use of emergent technologies in bio-based nanosystems for foods, and serves as an ideal reference for scientists, regulators, industrialists, and consumers that conduct research and development in the food

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processing industry.

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**"Nanoencapsulation  
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collects, in an easy and  
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The book addresses important  
modern technologies,  
including biopolymer based  
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**techniques, formulation based processes, such as nano-liposomes and nano-emulsions, process based nano-encapsulation, such as electro-spinning and nano-spray drying, natural nano-**

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**bioactive compounds Brings  
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**The incorporation of functional ingredients in a given food system and the processing and handling of such foods are associated with nutritional challenges for their healthy delivery. The**

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**extreme sensitivity of some components cause significant loss of product quality, stability, nutritional value and bioavailability, and the overall acceptability of the food product. Consequently,**

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**encapsulation has been  
successfully used to improve  
stability and bioavailability of  
functional ingredients.  
Encapsulation is one example  
of technology that has the  
potential to meet the**



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**challenge of successfully incorporating and delivering functional ingredients into a range of food types. The book will cover topics about 1) Characterization of novel polymers and their use in**

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**encapsulation processes. 2) Stability of nutraceutical compounds encapsulated with novel polymers. 3) Application of encapsulated compounds with novel polymers in functional food systems. This**

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**book provides a detailed overview of technologies for preparing and characterisation of encapsulates for food active ingredients using modified polymers. The use of modified**

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**polymers as coating materials  
it is a field that still needs  
study. The book is aimed to  
inform students and  
researchers in the areas of  
food science and food  
technology, and professionals**

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**in the food industry.**

**Nanotechnology offers great potential to revolutionize conventional food science and the food industry. The use of nanotechnology in the food industry promises improved**

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and consistency of foodstuffs  
and increased absorption and  
bioavailability of  
nutraceuticals. Food  
Nanotechnology: Principles  
and Applications examines**

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**the current state of nanoscale phenomena and processes, benefits and risks of nanotechnology. This work contains 18 chapters particularly focused on the design, production, and**

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**utilization of nanoparticles, with specific applications for the food industry. Through several studies, it has been proven that nanotechnology can offer distinct advantages over conventional methods in**



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targeted delivery of food  
bioactive compounds,  
improved food quality  
characteristics like texture,  
taste, sensory attributes and  
improved stability in the**

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**systems. With its practical focus on the fabrication and application of nanotechnology in food, this book is a valuable resource for students, researchers, food process engineers.**

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**reference examines the various types of microspheres and microcapsules essential to those who need to develop stable and impermeable products at high acidic conditions. It's also important**



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**Applications and Approaches  
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for a Sustainable Future**

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Nano- or micro-encapsulation is used in many different fields and industries, including pharmaceuticals, cosmetics, food, and agrochemicals. It offers advantages for various applications, especially drug delivery. Nano-encapsulation can help extend and control the release of drugs as well as increase

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drug bioavailability and efficacy. It improves the precision of targeted drug delivery and allows for fabricating nano-encapsulated drugs for diagnostic and theranaostic applications. This book covers recent advances in fabricating nano-/micro-capsules using natural carriers for therapeutic and diagnostic



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drug delivery applications as well as rheology and formulations of micro-emulsions for diverse applications. This book is essential for scientists and researchers with diverse backgrounds in chemistry, engineering, material sciences, pharmaceuticals, and drug delivery. This book presents an exhaustive review

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on the use of polymers for food applications. Polymer-based systems for food applications such as: films, foams, nano- and micro-encapsulated, emulsions, hydrogels, prebiotics, 3D food printing, edible polymers for the development of foods for people with special feeding regimes, sensors, among others, have been

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analyzed in this work.

Nanoencapsulation has the potential to improve human health through its capacity to both protect bioactive compounds and release them at a specific time and location into various substances, including food. Numerous nanoencapsulation technologies have

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emerged in recent years, each with its own advantages and disadvantages. The goal of this Brief is to discuss the various nanoencapsulation technologies, such as emulsification, coacervation, inclusion encapsulation, anti-solvent precipitation, nanoprecipitation, freeze drying, and spray drying, including their limitations.

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Recent safety and regulatory issues concerning the various nanoencapsulation technologies will also be covered.

Nanoencapsulation Technologies for the Food and Nutraceutical Industries is a compendium which collects, in an easy and compact way, state-of-the-art details on techniques for nanoencapsulation of

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bioactive compounds in food and nutraceutical industries. The book addresses important modern technologies, including biopolymer based nano-particle formation techniques, formulation based processes, such as nano-liposomes and nano-emulsions, process based nano-encapsulation, such as electro-spinning

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and nano-spray drying, natural nano-carrier based processes, like casein and starch nano-particles, and other recent advances. This definitive reference manual is ideal for researchers and industry personnel who want to learn more about basic concepts and recent developments in nanotechnology research. Serves as a

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compendium of recent techniques and systems for nanoencapsulation of bioactive compounds Brings together basic concepts and the potential of nanoencapsulation technologies, also including their novel applications in functional foods and nutraceutical systems Includes biopolymer based nano-particle



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formation techniques, formulation based processes, process based nanoencapsulation, and nano-carrier based process

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Nanotechnology in the Beverage Industry

**Nutrient Delivery:**

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Nanotechnology in the Agri-Food Industry, Volume Five, discusses the fabrication, merits, demerits, applications, and bioavailability enhancement mechanisms of various nanodelivery systems. Recent developments in various

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nanodelivery systems are also highlighted. Volume 5 contains twenty chapters, prepared by outstanding international researchers from Argentina, Brazil, Canada, China, Croatia, India, Iran, Ireland, México,

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Pakistan, Portugal, Serbia, Sri Lanka, and the United States. In recent years, the delivery of micronutrients at nanoscale has been widely studied as these systems have the potential to improve bioavailability, enable

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controlled release and enhance stability of food bioactives to a greater extent. The nanodelivery systems typically consist of the food bioactive compound encapsulated and stabilized in food grade ingredients such as

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lipids, proteins or polysaccharides with diameters ranging from 10 nm to 1000 nm. Among these, the lipid based delivery systems such as nanoemulsions, solid lipid nanoparticles, nanoliposomes

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and micelles are widely studied for the delivery of lipophilic bioactive compounds. These delivery vehicles improve the solubility, permeability, stability and bioavailability of the lipophilic compounds thereby



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enhancing their potential for oral delivery and functional food development. On the other hand, the hydrophilic bioactives are delivered through protein, polysaccharide or biopolymer based colloidal nanosystems

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such as hydrogels, nanogels and polymer nanoparticles. The major concern other than solubility is the intestinal permeability of the micronutrients. For instance, the delivery system for compounds

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with poor intestinal permeability and low solubility need to be carefully designed using suitable lipids and surfactants. Offers updated material for undergraduate and postgraduate students in food science,

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biotechnology, and related engineering fields Provides a valuable resource of recent scientific progress, along with most known applications of nanomaterials in the food industry for researchers,

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engineers, and academics

Includes novel opportunities and ideas for developing or improving technologies in the food industry

Encapsulation is a topic of interest across a wide range of scientific and industrial areas,

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from pharmaceuticals to food and agriculture, for the protection and controlled release of various substances during transportation, storage, and consumption. Since encapsulated materials can be

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protected from external conditions, encapsulation enhances their stability and maintains their viability. This book offers a comprehensive review of conventional and modern methods for

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encapsulation. It covers various thermal and nonthermal encapsulation methods applied across a number of industries, including freeze drying, spray drying, spray chilling and spray cooling,



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electrospinning/electrospraying, osmotic dehydration, extrusion, air-suspension coating, pan coating, and vacuum drying. The book presents basic fundamentals, principles, and applications of each method,

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enabling the reader to gain extended knowledge. The choice of the most suitable encapsulation technique is based on the raw materials, the required size, and the desirable characteristics of the final

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overview of specialized developed equipment for the nanoencapsulation of food ingredients. Electro-spinning, electro-spraying, nano-spray dryer, micro/nano-fluidics systems and sonication devices

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are just some of the equipment analyzed in the book. Each chapter reviews the mechanisms of innovative devices for preparation of nanostructures, exploring the key factors in each device to control the efficiency of

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nanoencapsulation and revealing the morphologies and properties of nanoencapsulated ingredients produced by each equipment.

Authored by a team of global experts in the fields of nano and microencapsulation of food,

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nutraceutical, and pharmaceutical ingredients, this title is of great value to those engaged in the various fields of nanoencapsulation. Thoroughly explores the mechanisms of

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nanoencapsulation by  
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Elucidates the key factors in  
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Discusses the morphologies and  
properties of nanoencapsulated



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ingredients produced by each  
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Health and nutrition has become  
a global focal point as the  
population continues to grow  
exponentially. While providing  
food for the global population is

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crucial, it is also necessary to provide options that are nutritious in order to promote healthier lifestyles around the world. Food Science and Nutrition: Breakthroughs in Research and Practice is an

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preservation, functional foods, and herbal remedies, this publication is ideally designed for researchers, academics, students, policy makers, government officials, and technology developers.

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in the Food Industry,  
Volume 12 in The  
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current food needs that  
cannot be fulfilled by***

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***Nanotechnology enables  
the development of tailored  
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structures to replace  
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***discusses how specialized nano-preservatives, sensors and food degradation and contamination detectors were developed and how they can be introduced in food products without***

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***degrading quality or  
properties of the final  
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