INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

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Review Article

# Neutraceuticals In Nanotechology

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ARTICLE INFO

Published: 11 May. 2026

Keywords:

Nutraceutical's, Nano technology, Food nanoscience, Nutraceutical delivery systems.

DOI:

10.5281/zenodo.20113342

## ABSTRACT

Products with nanotechnology are becoming more and more popular. In this case, nanotechnology is being used as a technological platform and in food science. The creation of foods and nutraceuticals with improved sustainability, reduced toxicity, and increased bioavailability is the primary usage of this technology among its several applications. Nano nutraceuticals are being employed as supplemental goods in the medical field to address a growing array of illnesses.The concepts and applications of nanonutraceuticals in health are outlined in this overview, alongside a particular focus on the treatment of inflammation and cancer. Because nanotechnology can improve the solubility, stability and bioavailability of active ingredients, its application in nutraceuticals is expanding quickly. Their small size and high surface to volume ratio are what give them their distinctive qualities. However, the possible negative Nanoparticles' effects on human health are also caused by these physico-chemical characteristics. Evaluation of their safety and efficacy is necessary to create novel nutraceutical formulations that can be sold.

## INTRODUCTION

## II. HIGHLIGHT:

- Nanotechnology has become a potent tool in the creation of nutraceuticals and functional meals.
- The solubility, stability and bioavailability of bioactive substances are significantly enhanced by nano-nutraceutical formulations.
- Nano delivery technologies exhibit encouraging possibilities in the management of inflammatory illnesses and malignant tumour.
- The biological performance of nanomaterials is significantly Because of their physicochemical characteristics, specifically particle dimensions and surface area.
- Concerns about toxicity and safety in applications related to human health may also arise from these similar characteristics.

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**Relevant conflicts of interest/financial disclosures**: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

- A thorough assessment of safety and efficacy is necessary for the commercialisation of nano-nutraceutical products.

## III.GRAPHICAL ABSTRACT:

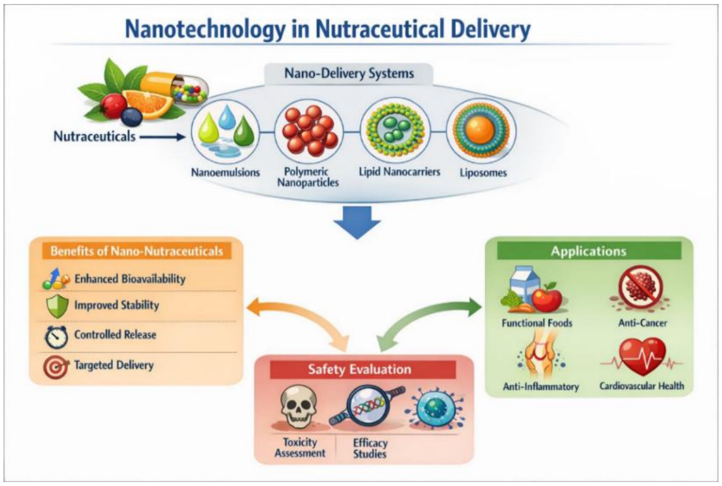


**Fig:1. Nanotechnology in Nutraceutical delivery**

Nutraceuticals are defined as foods or parts of foods that provide medical and health benefits, such as the prevention and treatment of diseases. Nutraceuticals are apart from nutrient and dietary supplement products, like cereals and beverages. A few years ago, people tried to improve the quality of life by modifying their diet and substituting modern medicine with alternative and natural products. Therefore, the nutraceutical market and related R&D are rapidly growing.[1] Nutraceuticals are substances that offer therapeutic advantages above and beyond basic diet, helping to maintain general health and prevent disease. The phrase combines the words nutrition and pharmaceutical indicating their two functions with in both Clinical benefit and nourish.[2] These chemicals include a variety of polyunsaturated fatty acids (PUFA) while well as vitamins, minerals, antioxidants, prebiotics, probiotics, herbal items and spices. Functional foods, nutritional supplements and Enhanced food items like cereals, soups and drinks frequently include them.[3] It may consist a mixture of vital nutrients, metabolites, botanicals, herbs, amino acids, or bioactive extracts. Dietary supplements must be properly labeled, and they can only make certain health claims backed by solid scientific data, according to regulatory bodies like the US Food and Drug Administration (USFDA).[4] They offer advantages consisting anti-aging, antioxidant qualities, encouraging health and reducing illnesses, lesser side effects easy availability. The use of dietary supplements and nutraceuticals has enhanced largely because of increase in interest of consumers in naturally derived substances Innovative initiatives for preventative healthcare.[5] Numerous studies demonstrate their therapeutic potential in reducing oxidative stress-related disorders, such as cancer and cardiovascular diseases, neurodegenerative diseases like Alzheimer's disease and Parkinson's disease , metabolic disorders like diabetes mellitus and obesity , immunological and inflammatory disorders. Numerous studies demonstrate their therapeutic potential in reducing disorders associated with oxidative stress, such as cancer and heart related conditions, neurological degenerative disorders like Parkinson's disease, Alzheimer's disease, and metabolic disorders like diabetes mellitus, obesity, inflammatory and immunological illnesses. Agriculture and food systems could be completely transformed by nanotechnology, an enabling technology. The unique characteristics of materials on the nanometer ($10^{-9}$ m) length scale, along with this advancement using technology to work with or self-assemble these materials molecule by molecule, offering potentially ground-breaking commercial, scientific and technological prospects.[6] Numerous macroscale features, including taste, texture, and more sensory qualities, process ability and stability over duration of shelf life, may be altered via nanoscale control over food molecules.[7] The nanotechnology in agricultural & food systems is expanding quickly. Awareness in this has grown fascinating area of research since the first feature an article in Food Nanotechnology was published in 2003. Food nanotechnology's possible applications in food safety and security, food materials' nanoscale characteristics, functional foods for health promotion applications and structural design concepts for the transfer of bioactive susbstance have been included within a many additional elements journals published. The evolution of new functional food ingredients with increased water solubility, thermal stability, oral bioavailability and sensory qualities and physiological performance is a significant application of nanotechnology in nutrition and food. Functional food is defined by the International Food Information Council (IFIC) as foods that provide health benefits beyond basic nutrition. The meal with functional properties industry exists anticipated excessively develop at a 5.7% yearly growth rate from 2007 to 2012 due to rising customer demand for innovative food items and growing fortification with healthy food ingredients. For instance, phytochemicals health promoting dietary supplements are commonlyincorporated into everyday meals. Because of their low solubility, many phytochemicals are not well absorbed by the human body. Increasing the bioavailability of phytochemicals by modifying their pharmacokinetics (PK) and biodistribution (BD) is one of the most important and fascinating applications for phytochemical encapsulation. In an effort to add functional ingredients to food, a great deal of research has been done throughout the past few years to investigate the health promoting qualities Utilizing different phytochemicals and to create innovative including resources and methods. Encapsulating The useful components with food grade or generally recognized as safe (GRAS) materials that can display controlled release behaviour is one way to improve the stability and nutritional value of the functional meals. Polysaccharides off plant or microbial origin, food proteins, emulsifiers. One major issue in this field is the limited bioavailability of nutraceuticals, which are usually excreted from the body without providing any therapeutic benefit area. Nanotechnology can be utilised to improve nutritional and health supplement absorption, bioavailability, and controlled release. The layout, manufacture and Certain substances whose dimensions and form have been designed on a nanoscale when distinct chemical, physical, electrical and mechanical properties arise, is known as nanotechnology. The distinctive characteristics of Nano materials (NM) include their little size which typically range from 1 to 100 nm (though there is still disagreement over what constitutes a nanomaterial), due to their high ratio of surface area to volume, and their high reactivity, which causes a rise in uptake and interaction with biological barriers.

## V. Content:

### A. Nano food

Food that has been grown, created, Nano food refers to food that has been packaged or processed using nanotechnology tools or techniques, or to which produced nanoparticles have been added[8]. Since many food systems are Of course found nanofood at the nanoscale has really been involved in food preparation for a very long time. Nano-food aims to reduce costs, enhance dietary intake and flavour, and increase food safety. A new field in food science called "nano food" uses nanoparticles to increase the functionality, safety and quality of food. To stop food from spoiling due to microbes, nanoparticles are used as carriers for antimicrobial polypeptides. For instance, when microbes enter food packaging, starch-based nanoparticle coatings containing antimicrobial agents may release the active ingredient. In food research, nanotechnology also makes it possible to quickly identify food pathogens using nanosensors, which are quicker, more sensitive, and need less work than traditional techniques. Improved flavour variety, extended shelf life, and increased nutritional value are some advantages of nano foods. However, because of their distinct physicochemical characteristics, which set them apart from bulk materials, nanoparticles may interact with biological systems and raise possible toxicity issues. Nevertheless, more than 100 food items and packaging materials currently include nanotechnology without the need for extra FDA testing or labeling. Canola Active Oil, Nano Tea, fortified fruit juices, Nanoceutical Slim Shake, Nano Slim drinks, oat nutritional drinks, vitamin-boosted juices, and Nano capsules containing omega-3 fish oil in bread are a few examples of nano food products. Furthermore, ε-polylysine, a food-grade antimicrobial polypeptide, fills the spaces between nanoparticles in nano emulsions to prevent food oils from oxidising.

### B. Analytical food nanotechnology

Understanding the advantages and possible toxicity of food delivery systems using nanotechnology requires the discovery and characterisation of these organisations. Food Nanodelivery systems that are composed of proteins, lipids and/or polysaccharides have been described in detail, along with the analytical methods now employed to identify and characterise these food product delivery methods.[9] Three categories of analytical techniques have been identified: separation techniques, imaging techniques and characterisation techniques. Recent developments analytical nanotechnology have been documented in relation to the meal business as well as dietary analysis including a focus regarding nanosensing.[10] Food packaging incorporates nanosensors to indicate if the item is still suitable for consumption by humans. The European project GOODFOOD (2004–2007) created nanosensors for food quality and safety control, and nanosieves is usable to filter milk for making cheese or beer.[11] In order to create new nanostructured materials, Microbial cellulose nanofiber made via fermentation was also investigated. Researchers demonstrated that the most promising techniques are field flow fractionation and high-performance liquid chromatography methods for separating the nano delivery systems through the food matrix to obtain an adequate characterisation. Online mass spectrometry and photon correlation spectroscopy subsequently demonstrated to be a useful combo of methods for characterizing a broad variety of nanodelivery methods.[12] There have been reports on the identification and properties of artificial nanoparticles in food. Salmonella typhimurium, Shigella flexneri, and E. coli O157:H7 are three food-borne pathogenic bacteria can be simultaneously detected using a quick and affordable method that uses antibody-conjugated semiconductor quantum dots as fluorescence indicators and magnetic microparticles for enrichment.[13] To stop negative responses to foods like peanuts, tree nuts and gluten Nano sensors can identify allergen proteins.[14]

### C. Nano encapsulation

The term Nano encapsulation refers to a technology that uses methods like nanocomposite, nano emulsification and nanoestructuration to bring materials in tiny amounts. This technology allows for controlled core release in the final product. This method may be utilised to create functional foods using improved Stability and functionality by protecting bioactive compounds such as vitamins, antioxidants, proteins, lipids and carbs. Numerous methods for producing nanocapsules have been discovered and used in various fields. [15] Numerous bioactive and functional substances can be nanoencapsulated for usage in nutraceuticals thanks to a new patented method. After delivering the active contents, nano capsules decompose and are absorbed similarly to traditional foods. Encapsulation, controlled-release technology, and innovative food delivery system design are the main areas of recent advancement. [16] Formulators can save money by using fewer active chemicals thanks to nano encapsulation. Researchers looked at the encapsulation and controlled release of active foods using nanotechnological methods additives.[17] Polylysine-octenyl succinic anhydride has the capacity to develop into dual-purpose compounds that may be employed has antibacterial agents or as surfactants or emulsifiers in the containment of medications or nutraceuticals. Curcumin was encapsulated in micelles made of hydrophobically modified starch.[18] By increasing antioxidants' solubility and bioavailability, stability both in vitro and in vivo and capacity to avoid unwanted contacts with other dietary ingredients, lipid-based nanoencapsulation systems improve their performance. The main lipid-based nanoencapsulation systems include nanoliposomes, nanocochleates, and archaeosomes systems that can be used for food also nutraceutical delivery and preservation. Nanoliposome technology presents intriguing opportunities for food scientists' prospects in fields like food material encapsulation and regulated release, in addition to improved bioavailability, stability and shelf-life of delicate components. Enzymes, food additives, food antimicrobials, nutrients, and nutraceuticals have all been documented to be transported via nanoliposomes. [19] Nanoliposomes of the coenzyme Q10 were created within the appropriate stability and the quality of encapsulating.[20] The Colloidosomes are tiny tablets that form a hollow shell out of particles that contain a tenth the size of an individual cell. Any kind of molecule can fit inside this shell. Researchers think that vitamins, medications, and fat blockers might be inserted into the colloidosomes.[21] A technique for creating water-soluble nanoparticles with regulated functionality and encapsulated β-carotene was put forth. In order to make beta-carotene, which is often hydrophobic, easily distributed and stabilized in drinks, scientists created a nanostructured lipid carrier.[22] Nanoencapsulation technologies have the ability to address issues in the food sector related to regulated release of taste compounds and efficient delivery of health-functional substances. Zein, a prolamine found in corn endosperm, envelops and binds lipids to prevent deterioration. Zein has also been demonstrated to create periodic structures and adsorb fatty acids. Of particular relevance are nanoscale layers of cooperatively constructed zein sheets and fatty acids.[23] The primary structural component of aqueous nanodispersions that contain large concentrations of water-insoluble active ingredients is soy lecithin. Flavors, fat-soluble vitamins and water insoluble nutraceuticals are examples of these active components. Improved stability and higher bioavailability are demonstrated by the encapsulated actives easy dispersion in water-based products. A different study found demonstrated the absorption of CoQ10 in nanodispersions by intestinal cells was seven times greater than in conventional powder formulations.[24] Phosphatidic acid, phosphatidylinositol, phosphatidyl glycerol, dioleoylphosphatidylserine, phosphotidyl serine and or a combination with other lipids of one or more of these lipids make up nanocochleates which are pure soy-based phospholipids that contain zumindest 75% by the lipid's weight. Diphosphotidylglycerol, dioleoyl phosphatidic acid, dimyristoyl phosphatidylserine, distearoyl phosphatidylserine, dipalmitoyl phosphatidylgycerol, phosphatidylcholine, and phosphatidylethanolamine are other possible lipids. A wide variety of micronutrients can be stabilized and protected by nanocochleates, which are nanocoiled particles that can potentially improve the nutritional content of processed meals.[25]

## VI. Materials & Methods

### TYPES OF NANOTECHNOLOGY

In Nutraceuticals:

In nutraceuticals, there are primarily four types of nanotechnology.

i. Nano liposomes

ii. Nano emulsions

iii. Nanoparticles

iv. Nano gels

### i. Nanoliposomes:

Nanotechnology in food uses nanocarrier systems to increase the bioavailability of bioactive ingredients and stabilise them against a variety of chemical and environmental changes. Nanoliposome technology presents intriguing opportunities for food scientists' prospects in areas like food material encapsulation and regulated release, in addition to improved bioavailability, stability and longevity of delicate elements. In addition to being used in the food business to provide nutrients and flavours, liposomes and nanoliposomes have lately been studied for their capacity to include antimicrobials that may help shield food items from microbial infection. Liposomes are tiny synthetic vesicles consisting of an core of water encased in a phospholipid bilayer. Since their initial development by Bangham in 1961, they has been employed in numerous applications, including food, cosmetics, and medicine delivery. Phospholipids are usually dispersed in an aqueous solution to create liposomes. The watery solution is enclosed within a vesicle by the phospholipids' spontaneous formation of bilayers. The preparation technique can regulate the vesicles' size, which can vary ranging in diameter from a few nanometres to many micrometres.[26] Phospholipid and lipid molecules reduce interaction with molecules of water by producing structures with two layers called lipid vesicles or liposomes when they encounter an aqueous phase, like buffers. These bilayers create a membranous structure of colloidal particles by encasing one or more aqueous spaces.[27] As nanotechnology has advanced, the term "nanoliposome" has been coined to specifically describe lipid vesicles at the nanoscale in nanometric size ranges.[28] The liposomes are employed in in-vitro and in-vivo medicinal and nutraceutical applications. Unilamellar vesicles (ULV) and multilamellar vesicles (MLV) are the two types of liposomes based on their size and bilayer count. MLV liposomes resemble an onion shape, with multiple ULV of varying sizes encasing one another to create concentric phospholipid spheres in a multilamellar framework divided by water layers. Multivesicular vesicles (MVVs) are liposomes made up of numerous tiny, non-concentric vesicles enclosed in a single lipid bilayer.There are two types of unilamellar liposomes large unilamellar vesicles (LUV) and small unilamellar vesicles (SUV) are the two types of vesicles. Single-layered liposomes are spherical vesicles that are either a single amphiphilic lipid bilayer or a combination of these lipids and contain a watery mixture within the chamber. In unilamellar liposomes, the aqueous solution is encased in a single phospholipid bilayer sphere.[29]

**ii. Nanoemulsion:**

Numerous medicinal compounds are transported using nanoemulsions (NEs), which are tiny colloidal particle systems.[30] Their smaller droplet size, usually in the nanometer range, sets them apart from conventional emulsions. They usually include water, oil, and an emulsifier, which is essential for stabilizing the NEs, avoiding coalescence, and lowering the surface tension that separates the phases of water and oil.[31] Emulsifiers that are frequently utilized include lipids, proteins, and surfactants. NEs have several benefits, including protecting active chemicals, increasing their efficacy, and acting as delivery vehicles for food additives and nutraceuticals. The possibilities for NEs as sophisticated Systems for delivering nutraceuticals has been thoroughly examined in recent research, with an emphasis on there capacity to improve bioavailability, stability and useful characteristics. In one of these investigations, co-enzyme Q10 was encapsulated into NEs based on chitosan, which showed exceptional constancy and reduced Inflammation and oxidative stress in hepatocytes and cardiomyoblast cells in opposition to the harmful consequences of the powerful antitumor medication Doxorubicin. Additionally, they reduced the generation of TNF-α, interleukins, and nitric oxide while increasing hepatocyte and cardiomyocyte cell viability by 35–40%. Cellular absorption was improved by the chitosan surface's increased bio-adhesion and biocompatibility.[32] Similarly, another study used the ultrasonication approach to encapsulate in whey-protein NEs, clove oil, obtaining a zeta potential (ZP) of 35 mV, a droplet size of 280 nm, and a PDI of less than two. The characteristics helped maintain constancy at different temperatures, ionic concentrations, and pH levels. With minimum bactericidal and minimum inhibitory concentrations 50 and 90 μg mL−1 in that order, these NEs showed significant antibacterial action against E. coli and Bacillus subtilis strains, indicating their capacity for use in applications for food safety. Efficacy was probably increased by the negative zeta potential and tiny droplet size, which improved contact with microbial membranes. This discovery opens up a promising way to use the antibacterial qualities of clove oil in real-world food systems applications.[33] Three distinct bioactive substances, β-carotene, hesperetin, and naringenin, were encapsulated in an additional study using a NE blend of gardenia fruit oil and whey protein isolate (WPI), with impressive 80%, 51%, and 46% encapsulation efficiencies, respectively 80%, 51%, and 46% encapsulation efficiencies, respectively. The NEs were stabilized in difficult settings, such as reduced cationic concentrations, alkaline conditions, and lower temperatures, by using ultrasound to create small droplet sizes (<300 nm).

The accelerated oxidation experiment lasted for 14 days, they significantly reduced the production rate, peroxide value (Pov) and quantity list compounds that react with thiobarbituric acid (TARS), demonstrating the increased oxidation stability of gardenia fruit oil.[34] NEs stabilised by albumin containing Resveratrol had neuroprotective benefits in terms of cellular absorption and functional bioavailability by reducing hippocampal inflammation and postoperative cognitive impairment in older rats. Resveratrol's interaction with cellular targets was enhanced and it was shielded from degradation by the bioactive encapsulation and smooth surface. The SIRT1 signalling pathway being activated was connected to the neuroprotective effects, underscoring the influence of surface features on biological pathways.Furthermore, L. Chen and N. Walia demonstrated that vitamin D was encapsulated by pea protein-stabilized NEs improved its bioavailability as well as might help older persons with vitamin deficiency. The importance of protein–emulsifier interactions in maximizing nutrient delivery was highlighted by the protein surface's enhancement of cellular absorption. V. Campani et al. prepared vitamin K1 (VK1)-loaded PLGA NEs using low-energy methods, and these NEs showed interesting droplet size and stability under various storage settings. Transdermal distribution and skin penetration were made easier by the porous surface. Nebulization research indicated that topical treatments could be commercially viable by confirming the possibility of spray formulations without changing the NE characteristics.

**iii. Nanoparticles:**

In nanoscience and nanotechnology, With sizes ranging from 1 to 100 nm, nanoparticles (NPs) possess a special position due to both their unique characteristics brought about by their smaller size and their potential as building blocks for more intricate nanostructures. Furthermore, NPs are categorised according to their size, shape, and chemical paramagnetic properties. Apart from investigating nanotechnology, which manipulates matter at the atomic and molecular level, it also interacts with matter at a scale of one billionth of a meter ($10^{-1}$ m = 1 nm). The most basic element in the creation of a nanostructure is a nanoparticle, which is larger than an ordinary object but much smaller than the world of common objects defined by Newton's laws of motion. The most basic element in the creation of a nanostructure is a nanoparticle, which is larger than an atom or simple molecule, which are subject to quantum mechanics, but considerably smaller than the everyday world as defined by Newton's laws of motion.[35] Nanoparticles (NPs) are widely used in drug delivery methods due to their diversity in composition. These materials include proteins, lipids, and polymers like Chitosan, alginate, lignin, poly-d,l-lactide-co-glycolide (PLGA), polylactic acid (PLA), and poly-ε-caprolactone (PCL). These resources have special qualities that make it possible to encapsulate bioactives and guarantee regulated release. To guarantee Food-grade materials must be utilized for applications in the food and nutraceutical sectors in order to ensure safety and compliance. Among the food-grade ingredients used in NP formulations are zein, chitosan, gelatin, and lignin. These materials are good options for supplying bioactive ingredients in dietary supplements and functional meals since they are biocompatible, biodegradable, and compliant with regulations.

**Protein based nanoparticles:** Particle sizes ranging from 10 to 40 nm. protein-based NPs have a number of advantageous properties, including excellent nutritional value, bioavailability, non-antigenicity, biodegradability, and exceptional binding capacity for a variety of bioactive chemicals. Research interest in their creation has increased due to these characteristics as well as their non-toxic and biodegradable qualities. They come from bacteria, plants, animals, and fungi and can efficiently deliver both hydrophilic and hydrophobic nutraceuticals. Important methods for their creation include coacervation, desolvation, self-assembly, cross-linking, nanoprecipitation, emulsification, and nanospray drying.[36] Protein carriers include soy β-glycinin, wheat gliadin, and zein from plants, and animal-derived gelatin, casein, whey protein, albumin, and collagen. Protein-based NPs have become attractive options for targeted medication delivery in cancer therapy, going beyond nutraceutical administration. In order to cure colorectal cancer, a recent study created Capsaicin-encapsulated lactoferrin-functionalized egg albumin nanoparticles coated with carboxymethyl dextran (Cap-LF-CMD-EA-NPs). The hydrophobic interactions between capsaicin and protein polymers facilitated the creation of nanoparticles during the preparation phases of esterification, the Maillard reaction, and gelation. All things considered, Protein-based nanoparticles (NPs) provide a versatile and biocompatible medium for encapsulating and transporting bioactive substances. They are attractive options for use in nutraceuticals and targeted medication delivery due to their adjustable physicochemical characteristics,great encapsulation efficiency and the capacity for controlled release. Further study is required to optimize their stability, large-scale production, and in vivo performance in order to facilitate clinical translation.

**Polymer based nanoparticles:** With improved stability, biocompatibility, and therapeutic efficacy, polymeric nanoparticles (NPs) have become attractive carriers for the intended audience and regulated administration of nutritional supplements. These nanocarriers have particle diameters between 1 and 1000 nm and are made of natural, synthetic, or semi-synthetic polymers.[37] They are perfect options for resolving issues with traditional drug and nutraceutical delivery methods due to their biodegradability, biocompatibility, and the capacity to modify the surface. Gelatin, alginate, lignin, and chitosan/chitosan derivatives are the most widely used natural polymers. PLGA, PLA, PCL, and PAMAM (polyamidoamine) are examples of synthetic polymers. The potential of chitosan nanoparticles (CS-NPs) in targeted cancer therapy has been thoroughly investigated. In a single study, CS-NPs loaded with trans-resveratrol were used to create liver-targeting nanosystems that specifically targeted hepatic cancer. To improve adhesion to cancer cell lectins and cellular absorption, the researchers added biotin and avidin (A-B-CS-NPs) or biotin (B-CS-NPs) to the surface of the nanoparticles. Ionic gelation, a method renowned for its ease of use and capacity to encapsulate hydrophilic medications, was used to create NPs. CS-NPs that have been altered demonstrated better anticancer properties than Trans-resveratrol in free form in vitro tests on HepG2 cells, demonstrating improved cellular internalization and prolonged drug release. However, systemic applications may be limited by chitosan's solubility restrictions at physiological pH, requiring additional modification.

**iv. Nanogels:**

Because of their nanoscale size (usually less than 1000 nm), stability, high loading capacity, and capability to be safeguard and regulate the release of bioactive chemicals, nanogels are hydrogel particles with exceptional adaptability in nutraceutical delivery. Proteins and polysaccharides are frequently used as core materials in their synthesis, which is mostly accomplished via mechanisms such as ionic gelation, chemical alterations, self-assembly, and ultrasonication. The bioavailability, encapsulation effectiveness, and functional characteristics of nutraceuticals that are encapsulated have been significantly improved as a result of recent developments in nanogel formulation. He M. et al. created nanogels based on isolates of soy protein (SPI) that were altered using succinic acid anhydride and dextran to include curcumin. The functional characteristics of SPI, including as hydrophobicity and charge distribution, were improved by Anhydride of succinic acid and the Maillard process modification, which enabled self-formation of nanogels. This produced nanogels Using a loading capacity of 54%, an encapsulation efficiency of 93%, a dispersion index of 0.20, and 143 nm in particle size. Because of their exceptional stability and antioxidant activity, these nanogels can be used to treat disorders linked to oxidative stress. Similarly, Wang et al. used Isolate of rapeseed protein (ARPI) and denaturation of proteins caused by heat to create self-assembling nanogels. This method produced spherical particles with a light core-dark shell and a hydro-diameter of 170 nm shape by giving the nanogels distinct structures that are secondary and tertiary, less sulfhydryl groups, and more hydrophobic surfaces. Curcumin's capacity to combat cancer in several cell lines was greatly enhanced by ARPI nanogels' remarkable encapsulation efficiency of 95%. Nevertheless, Information on pH stability, performance in complex food matrices, and in vivo tests to prove their utility and safety are missing from the study. Xu et al. created a novel nanogel that encapsulates lutein in a self-assembly-based ovomucin and chitosan oligosaccharide combination approach, going beyond protein-based nanogels. The encapsulated lutein maintained its amorphous state, demonstrated exceptional stability over a broad pH range and ionic concentrations, and produced regulated release with notable antioxidant activity. At greater doses, L929 fibroblast cells were not cytotoxically affected by the nanogels. The paper discusses the possible use of Lutein-loaded ovomucin and chitosan oligosaccharide mix nanogels are a practical and effective oral lutein carrier. However, the lack of in vivo research raised questions about their long-term safety and oral bioavailability.

## VII.CONCLUSION:

Nanotechnology can be used to create novel food products, storage, and packaging, in addition to creating foods tastier, more wholesome and more nutrient-dense. Nonetheless, the majority of the applications are targeted at high-quality goods, at least temporarily, and many of them are still in the elementary level. There aren't many successful uses of nanotechnology in food. Nanotechnology can be used to improve the flavor and texture of food, lower fat content, or encapsulate nutrients—like vitamins, which are vital components for good health -so they don't deteriorate over time. Additionally, packaging that prolongs the product's freshness can be created using nanomaterials. With utilizing nanosensors, intelligent packaging for food may even be able to advise customers about the condition of the food within. Food packaging that has nanoparticles embedded in it alerts consumers when a product's safety is in jeopardy. Sensors are able to alert before food becomes rotten or is able to give us the the contents' precise nutritional status. Nanotechnology is going to actually alter how the whole packaging sector is manufactured. Developments in food nanotechnology present significant problems for industry and government. The food processing sector needs to guarantee that consumers will embrace and trust nanofoods. Guidelines regarding the standards to be adhered to for assessing food, food packaging, and supplement safety applications of nanoparticles with unique features should be written by regulatory organizations like the FDA. It is crucial to remember that nanofoods are not the same as traditional nanofoods because they are created in laboratories. The advantages of naturally occurring nanosystems have not received enough scientific investigation. Therefore, drawing broad conclusions about the benefits or drawbacks of nanotechnology is exceedingly challenging. However, compared to nanotechnology foods, nanotechnology food packaging was deemed less troublesome. Furthermore, Customers are not offered the choice to stay away from certain culinary items because nanofoods are not labeled as such. Therefore, it is preferable for nanomodified foods to undergo testing before being put on the market. The Assessment of Possible hazards connected to human exposure to nanoparticles urgently requires new methods as well as standardized assessments protocols to be investigate how biological cells are affected by nanoparticles. It is commonly believed that food items made with nanotechnology will be offered more and more to customers globally in the upcoming years.

## VIII. ACKNOWLEDGMENT:

I am grateful to my lecturer G. Uma Rani for the valuable help.

It remains in my memory the library of RBVRRWCP, and with the help of staff, which made my work easier through the reference of precious books and journals.

I express my respectful regards to RBVRR women's college of pharmacy, Hyderabad, for giving me a great opportunity to do my work, providing a platform for work.

**IX. FUNDING:** No outsources of fundings

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HOW TO CITE: R. Srija, K. Chaitanya Sree, G. uma rani*, Neutraceuticals in Nanotechology, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 5, 2189-2201. https://doi.org/10.5281/zenodo.20113342