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Organic Nanoparticles and their Applications in Drug Delivery and Food Nanotechnology

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Nanoparticles: A Nanoparticles (NP), a solid colloidal particle is defined as "a discrete entity with at least one dimension being 100 nm or less" [1]. However, most of the particles utilized in drug delivery are in the size of 100-200 nm [2]. Because of their small size, NPs have different surface to volume ratios and surface properties become more important.

These properties give NPs their unique and potentially toxic features compared to the bulk material or their separate molecules. Among these features, increased electrical conductivity, and improved hardness and strength are very interesting for the electronic, medicine, textile, defense, food, agriculture, cosmetics widely throughout these industries. In food and agriculture systems, nanotechnology covers many aspects, such as food safety, packaging materials, disease treatment and new tools for molecular and cellular biology [3]

Organic Nanoparticles: Thousands of organic chemicals are present in various pharmaceuticals to consumer products being used like inks, dyes, flavouring agents and household cleaning products. In many of these products, the organic chemicals are dissolved to aid formulation or are chemically modified to improve their performance. If a chemical is insoluble in a liquid that is required for formulation, its activity and applicability is significantly limited. For instance, pharmaceutical products often have restricted bioavailability and efficacy due to their insolubility in water. This may either restrict the development of new drugs or the scope of current medicine. The same is true for nutraceuticals, biocides and a range of other potentially useful compounds. By forming very small dispersions of organic compounds, insoluble materials can be made to behave more like truly dissolved molecules without the need to produce new chemicals or use flammable, toxic or volatile solvents. This option is a valuable tool in the manufacturing and development of new products because the scope of chemical ingredients that becomes available offers huge potential for innovative and competitive product design. Organic Nanoparticles can be explained as solid particles composed of organic compounds (mainly lipids or polymeric) ranging in diameter from 10 nm to 1 μm [4]. They have received relatively little attention as compared to inorganic materials where enormous research and commercial investment has been made. The future benefits of inorganic Nanoparticles, such as quantum dots, silicas, gold Nanoparticles, titania and various catalysts, are not in question but grain nano solutions see a much larger commercial opportunity in the thousands of insoluble or poorly-soluble organic compounds that are used across many high- technology and commodity product areas. The

pharmaceutical industry has led the research into organic Nanoparticles over recent years. The search for nano-medicine has driven the development of new materials and the refining of welle-stablished techniques. Organic compounds are inherently and ultimately soluble in water or aqueous environments, even if they dissolve very slowly compared to their inorganic counterparts, but organic Nanoparticles will not be persistent in the environment for a long making them environment friendly. These organic Nanoparticles which are environment friendly, economical and more suited for biological applications,

Types and Applications of Organic Nanoparticles

Nanotechnology has provided opportunity for the development of many types of Nanomaterials/Nanoparticles, producing even more opportunities for applications in wide areas. Here in the present review, application of organic Nanoparticles in only two areas: food and drug delivery are discussed. [5,6].

Generally Recognized as Safe (GRAS) type Nanoparticles

The Nanoparticles used in food comes in direct contact with the humans, they therefore need to be safe for life and also for the environment. Natural products in general have the advantage of being more safer as compared to their chemically synthesized counterparts. Organic Nanoparticles derived from natural materials and are "Generally recognized As Safe" GRAS and therefore often used for food applications and drug delivery. They can further be subdivided into three categories as lipid based, protein based and polysaccharide based

Lipid Based GRAS System:

Lipid- based GRAS system are among the most promising encapsulation technologies employed in the rapidly developing field of nanobiotechnology. Lipid based systems are often made out of phospholipids, but other lipids can also be used. As compared to other encapsulation strategies, lipidbased nano-encapsulation systems have several advantages, including the possibility of being produced using natural ingredients on an industrial scale, target ability, and the ability to entrap compounds with different solubility [5,6]. Lipid based nanostructures that have been developed for drug delivery applications include lipid nanotubes, lipid nano sphere, and lipid Nanoparticles [7,8]. The main lipid based nano encapsulation system that can be used for the protection. and delivery of foods and nutraceuticals are nano liposomes, nanoco- chelates, and archaeosomes. Although their exploitation in food technology is yet to be explored, a recent study reported the use of nano-structured lipid carriers to disperse hydrophobic β-carotene in an aqueous phase, as a functional ingredient in beverages [9]. Moreover, liposomes also seem to be suitable for sensory purposes[10].

Protein-Based GRAS System:

Protein based GRAS system possess unique functional properties including their ability to form gels and emulsions, which allow them to be an ideal material for the encapsulation of bioactive compounds. Food proteins are widely used in formulated foods because they have high nutritional value and are GRAS. Protein hydro gels are the most convenient and widely used matrix in food applications. However, in the case of non-solid and semi-solid foods, it is essential to decrease the Nanoparticles size to allow their incorporation without affecting food sensory qualities [11]. By decreasing the matrix size from micrometer to nanometers, new protein vehicles with improved delivery properties can be developed. Protein based Nano Delivery Systems (NDSs) are relatively easy to prepare in the two above mentioned production approaches. Linear assemblies such as rod and tube like structures are of particular interest, because they have unique properties with respect to their applications [12]. During the preparation of protein NDSs, no organic solvents are required and encapsulation is achieved under mild conditions, thereby minimizing destruction of sensitivity nutraceutical compounds. For instance, globular proteins such as whey protein from milk have the ability to denature, dissociate, and aggregate under different conditions of pH, ionic strength, and temperature to form particles with size of 40 nm. Furthermore, partial hydrolysis of R-lactalbumin leads to the formation of stable tubular structures with diameter of only 20 nm [13]. Another example of a protein-based NDS is a gelatin NP [14]. The major benefit of these NPs is their simple and reproducible production combined with low cost and multiple modification opportunities offered by the substance. However, as gelatin NDSs originate from animal slaughter material, the production of protein-based NDSs from plant is preferred as plants are considered to be safer [15]. Protein based NDSs are particularly interesting because various modifications allow them to form complexes with polysaccharides, lipids, or other biopolymers, and a wide variety of nutrients can be incorporated. These NPs can also conjugate nutrients via either primary amino groups or sulfhydryl group [16]. In general, controlled disassembly of the protein-based NPs results in controlled release of the encapsulated nutrient. It can be foreseen that food protein-based materials will play an important role in increasing the efficacy of functional foods over the next decade. However, at the present stage, greater fundamental understanding of protein-protein and protein-nutraceuticals interaction at the molecular level and their impact on functional properties of proteins is still required to ensure the design of ideal nutraceutical carriers for food applications.

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